

Advanced Textbooks in Economics
Editors C.J. BLISS and M.D. INTRILIGATOR

International Trade and Resource Allocation

A.D. Woodland

North-Holland

INTERNATIONAL TRADE AND RESOURCE ALLOCATION

A.D. WOODLAND

University of Sydney, Australia



1982

NORTH-HOLLAND PUBLISHING COMPANY
AMSTERDAM • NEW YORK • OXFORD

©NORTH-HOLLAND PUBLISHING COMPANY – 1982

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.

ISBN 0 444 86370 2

Publishers

NORTH-HOLLAND PUBLISHING COMPANY
AMSTERDAM · NEW YORK · OXFORD

Sole distributors for the U.S.A. and Canada

ELSEVIER SCIENCE PUBLISHING COMPANY, INC.
52 VANDERBILT AVENUE
NEW YORK, N.Y. 10017

Library of Congress Cataloging in Publication Data

Woodland, A. D.

International trade and resource allocation.

(Advanced textbooks in economics ; v. 19)

Includes bibliographies and index.

1. Commerce. 2. Economics. I. Title.

II. Series.

HF1411.W59 1982 382 82-8045

ISBN 0-444-86370-2 (Elsevier Science Pub. Co.)

AACR2

PRINTED IN THE NETHERLANDS

INTRODUCTION TO THE SERIES

The aim of the series is to cover topics in economics, mathematical economics and econometrics, at a level suitable for graduate students or final year undergraduates specializing in economics. There is at any time much material that has become well established in journal papers and discussion series which still awaits a clear, self-contained treatment that can easily be mastered by students without considerable preparation or extra reading. Leading specialists will be invited to contribute volumes to fill such gaps. Primary emphasis will be placed on clarity, comprehensive coverage of sensibly defined areas, and insight into fundamentals, but original ideas will not be excluded. Certain volumes will therefore add to existing knowledge, while others will serve as a means of communicating both known and new ideas in a way that will inspire and attract students not already familiar with the subject matter concerned.

The Editors

TO
Narelle
and Lisa, Nicole and Todd
who are pleased that my “story” is finished

PREFACE

This book is a substantial revision and extension of lecture notes prepared for a graduate course in the theory of international trade at the University of British Columbia. The primary aim of the book is to present the essence of the modern theory of international trade within a unified framework, which emphasizes the generality of the results obtained and which treats the traditional two-dimensional model as an interesting special case of a more general model.

It has often been remarked that international trade theory is difficult since there are so many different models and theories that do not seem to hang together. I have found such remarks rather strange since I have always thought of international trade theory as having a very consistent framework fashioned by the general competitive equilibrium model. Yet there is some validity to the remark since the literature has not, until recent years perhaps, emphasized the general framework, relying as it did on a mixture of diagrammatic and algebraic techniques and a preoccupation with two-dimensional models and simple generalizations thereof. This book attempts to overcome these difficulties for students of international trade theory by presenting a general and unified analysis. Such a general analysis is made easier by the extensive use of modern duality theory. Thus, the analysis is cast in terms of cost, expenditure, indirect utility and gross national production functions which have very useful properties rather than production, direct utility and transformation functions.

Duality theory is not new to the economics literature, being used by Hotelling in the 1930s and by Shephard and Samuelson in the early 1950s. Nevertheless, it is only during the last few years that its power has been appreciated and its use has spread. This book has been written under the firm conviction that the use of duality theory will soon become standard practice. It is hoped that it will be useful for students and researchers who wish to study the theory of international trade and/or wish to see how duality can be used in this area.

The book is directed towards graduate students with a sound background in microeconomic theory. The mathematical prerequisite is that the student be familiar with differential calculus, elementary set theory, optimization and linear algebra. This appears to be consistent with the level of preparation of first-year

graduate students in most North American graduate schools. Since students may not be well prepared in the duality approach, a full chapter is devoted to its exposition and use in the theory of the producer and consumer.

While the emphasis is on the theoretical aspects of international trade, one chapter has been allocated to the task of relating the theory to some of the empirical research that has taken place. The intent is not to provide a comprehensive account of all empirical work that has been undertaken, but to select those empirical works that bear a strong relationship to the economic theory dealt with in this book. This should help the student to appreciate the theory and its connection with the real world.

Of further aid to the reader are the "notes on the literature" at the end of most chapters. These are not intended to be comprehensive but to give some guidance for further reading. Also, each chapter has a selection of problems for solution. These include proofs of assertions within the text, consideration of special cases, and extensions of the analysis.

My debt to those who have helped me in the task of writing this book is large indeed. The existence of this book owes much to the encouragement of Erwin Diewert to whom I am most grateful. I also wish to thank those who have read individual chapters and have contributed many valuable comments. These include W. Chang, A. Dixit, D. Donaldson, W. Ethier, M. Kemp, U. Kohli, P. Lloyd, D. Ryan, W. Schworm and L. Svensson. Thanks also go to the many graduate students who contributed suggestions regarding the substance and presentation of the lecture notes upon which the book is based. Finally, I wish to express my appreciation to the typists, too numerous to mention individually, but especially to Cathy Sevil who cheerfully handled the final revisions.

CONTENTS

<i>Introduction to the series</i>	v
<i>Preface</i>	xiii
 Chapter 1. Introduction to the theory of international trade	 1
1.1 Introduction	1
1.2 Scope and nature of international trade theory	2
1.3 An overview	5
1.4 Summary of notation	10
References	13
 Chapter 2. Producer and consumer theory: A duality approach	 15
2.1 Introduction	15
2.2 The price-taking firm	15
2.3 The duality between production and cost functions	17
2.4 Comparative statics for the firm	30
2.5 Profit maximization	32
2.6 The consumer	33
2.7 Extensions and notes on the literature	36
Problems	37
References	38
 Chapter 3. The production sector	 39
3.1 Introduction	39
3.2 A model of the production sector	40

3.3	Diagrammatic representation of equilibrium	43
3.4	Equilibrium and optimization	49
3.5	Equilibrium and optimization – derivations	52
3.6	Traditional formulation in terms of production functions	56
3.7	Properties of the GNP function	58
3.8	Notes on the literature	59
	Appendix A: Theorems in non-linear programming	60
	Appendix B: Computation of equilibria	61
	Problems	64
	References	65
Chapter 4. Comparative statics of the production sector		67
4.1	Introduction	67
4.2	Scale effects	68
4.3	Effect of a change in endowments upon factor prices	70
4.4	Effect of a change in endowments upon outputs	79
4.5	Effect of a change in product prices upon factor prices	86
4.6	Effect of a change in product prices upon outputs	92
4.7	A general treatment of the comparative statics	94
4.8	Notes on the literature	99
	Problems	100
	References	102
Chapter 5. Intermediate inputs and joint outputs		105
5.1	Introduction	105
5.2	Intermediate inputs	105
5.3	A general model of the production sector	120
5.4	Joint outputs	134
5.5	Concluding comments	141
5.6	Notes on the literature	142
	Problems	143
	References	145

Chapter 6. Consumer demand, income distribution and general equilibrium	147
6.1 Introduction	147
6.2 Consumer demand and the net export functions	148
6.3 Aggregate demand functions and preferences	154
6.4 Diagrammatic description of equilibrium in an open economy	164
6.5 Direct and indirect trade utility functions	169
6.6 Non-traded goods and endogenous factor supplies	172
6.7 Notes on the literature	174
Problems	175
References	176
Chapter 7. Free trade equilibrium and trade theories	179
7.1 Introduction	179
7.2 General equilibrium for a trading world	180
7.3 The classical theory of comparative advantage	183
7.4 The factor endowments theory of trade	191
7.5 A mathematical treatment of the HOS model	197
7.6 Factor endowments and commodity trade in a general HOS model	200
7.7 Problems of dimensionality	205
7.8 Notes on the literature	211
Problems	212
References	215
Chapter 8. Non-traded goods and endogenous factor supplies	217
8.1 Introduction	217
8.2 Non-traded goods	218
8.3 The effects of factor endowments	228
8.4 The effects of prices of traded goods	236
8.5 Endogenous factor supplies	239
8.6 Analysis of the endogenous factor supply model	243
8.7 Concluding comments	249
8.8 Notes on the literature	250
Problems	250
References	252

Chapter 9. The welfare effects of international trade	255
9.1 Introduction	255
9.2 The gains from free trade	256
9.3 The sources of the gains from trade	266
9.4 Utility possibility sets	267
9.5 Is some trade better than no trade?	269
9.6 Is free trade optimal for a nation?	272
9.7 Welfare and world prices	277
9.8 Notes on the literature	283
Problems	284
References	286
 Chapter 10. Transfers, tariffs and taxes	 289
10.1 Introduction	289
10.2 Stability of world markets	291
10.3 The transfer problem	296
10.4 Taxes on international trade	299
10.5 Trade taxes in the two-commodity model	302
10.6 Production and consumption taxes	309
10.7 Trade taxes with many goods	313
10.8 Effective rates of protection	316
10.9 Notes on the literature	324
Problems	326
References	329
 Chapter 11. Trade policy	 331
11.1 Introduction	331
11.2 Trade taxes and quotas	331
11.3 Optimal tax policies for achieving quota solutions	336
11.4 Piecemeal trade tax policies	341
11.5 Discriminatory trade policies: Normative theory of trading clubs	348
11.6 Discriminatory trade policies: Positive theory of clubs	355
11.7 Notes on the literature	359
Problems	360
References	362

Chapter 12. Empirical studies	365
12.1 Introduction	365
12.2 Estimation of import demand and export supply functions	365
12.3 Input–output studies	378
12.4 Production function studies	382
12.5 International comparisons of consumer preferences	386
12.6 Programming and general equilibrium models of trade	388
12.7 Concluding comments and notes on the literature	394
Problems	395
References	397
 Chapter 13. Trade and growth: A static approach	 401
13.1 Introduction	401
13.2 Growth, the terms of trade, and welfare	401
13.3 Sources of growth	405
13.4 Foreign ownership of factors	409
13.5 Migration of labour	421
13.6 Notes on the literature	426
Problems	427
References	430
 Chapter 14. Trade and growth: A dynamic approach	 431
14.1 Introduction	431
14.2 Capital accumulation and trade	432
14.3 A dynamic model of a trading world	447
14.4 Gains from trade	454
14.5 Growth and trade with fixed saving ratios	456
14.6 Notes on the literature	462
Problems	463
References	464

Chapter 15. Trade and growth: Dynamics of technology and investment	467
15.1 Introduction	467
15.2 Endogenous technical change: the infant-industry argument for protection	467
15.3 Heterogeneous capital goods and steady-state theorems	477
15.4 Foreign Investment	485
15.5 Notes on the literature	494
Problems	495
References	496
 Chapter 16. Further topics in trade theory	 499
16.1 Introduction	499
16.2 Distortions	499
16.3 Uncertainty	505
16.4 Exhaustible resources	509
References	511
 <i>Author index</i>	 513
 <i>Subject index</i>	 517

CHAPTER 1

INTRODUCTION TO THE THEORY OF INTERNATIONAL TRADE

1.1. Introduction

Although international trade is simply an extension of domestic trade beyond political boundaries it has been a very old tradition in the economics literature to provide a special treatment and analysis of international trade. There are at least two reasons for this. First, it is sometimes argued that there may be some factors of production and goods which are less mobile internationally than they are intranationally. This argument has been reflected in the traditional models which make the extreme assumption that factors are perfectly mobile intranationally but are completely immobile internationally, in contrast to goods which are perfectly mobile everywhere. Consequently, international trade deserves special attention because the basic framework is special. The second reason is that there are many questions that arise with regard to international trade simply because of the existence of political boundaries. For example, the effects of trade taxes such as import duties or of import quotas or of taxes on the earnings of foreign-owned capital constitute interesting avenues for enquiry that arise because of the fact that international governments can and do impose such restrictions on international trade.

Despite the fact that the study of international trade is given special treatment it is nevertheless true that the basic economic principles which govern domestic trade also govern international trade. Trade between individuals within an economy exists because they find it to their mutual benefit. Individuals in different nations also trade with one another because each finds it beneficial.

1.2. Scope and nature of international trade theory

There are two types of questions that can be asked about international trade. The first concerns *normative* economics, and involves the welfare consequences of international trade or of changes in the economic environment. For example, does the opening up of trade between two previously closed economies benefit the citizens of each nation? If not, can one devise appropriate tax policies which can be used in conjunction with trade to raise the welfare of all citizens? How are the benefits and losses from a change in the tariff structure distributed across individuals? Does the formation of a customs union or free trade agreement between two nations benefit the citizens of each nation? These, and many more, are questions that are concerned with the welfare consequences of changes in the economy.

The second type of question concerns *positive* economics, and is involved simply with the nature of international trade. For example, what are the reasons for international trade? How does the pattern of commodity trade relate to the relative factor endowments of trading nations? What is the effect of a change in the tariff structure upon the domestic prices of commodities, output levels, consumption levels, the pattern and volume of trade, the allocation of factors amongst the industries, the distribution of income, and the level of tariff revenue? How will the distribution of capital between nations be affected, both in the short and long runs, by a change in the economic environment such as a change in tariffs or technology? One has only to recall the after-effects of the sudden increase in the price of oil produced by OPEC (Organization of Petroleum Exporting Countries) to realize that the internal structure of economies and international distribution of capital and incomes can be vitally affected by changes that occur in the international market place.

In order to answer the types of questions posed above, it is necessary to construct a theoretical framework within which to work. This framework is dictated by the state of technology in the economics discipline and by the desirability to keep the analysis sufficiently simple for purposes of exposition. The framework taken is that of a perfectly competitive equilibrium model, and mostly it will be static in nature. In the competitive model there exist consumers, producers and traders each of whom makes decisions on the assumption that prices are given and beyond the individual's control. They are price-takers. Each consumer has given preferences described by a utility function and decides on a consumption vector which maximizes utility subject to the budget constraint. Each producer maximizes his profit subject to the constraints imposed by the available technology. There is freedom of entry and exit to any industry, such entry and exit being motivated by profit. Traders take prices as given and buy and sell to

maximize their profits. In short, whenever there exists the possibility of a profit in the economy, someone will seize the opportunity and by so doing in large numbers will eventually remove further opportunities for profit. That is to say, in a competitive equilibrium profit-seeking activities ensure that profits are eliminated.

Several remarks concerning the chosen framework deserve attention. First, the framework does not involve the concept of money and therefore implies a separation of the “real” and monetary aspects of international trade. Thus, the analysis is exclusively within the tradition of the “real” or “pure theory” aspect of the international trade literature. Secondly, most of the analysis is static in nature and time plays no essential role. While time could be introduced at the outset, as in Debreu (1959), by assuming the existence of futures markets for all goods, or using Hicks’ (1946) temporary equilibrium framework in which point expectations about future variables are formed, a treatment of time is postponed until the static model has been thoroughly analysed. This has pedagogical value and, moreover, many interesting questions can be posed and answered without involving time.

Thirdly, there is no treatment of models involving non-competitive behaviour. This is not because such behaviour is not viewed as being important theoretically or empirically, though its importance is sometimes exaggerated, but because of limitations of space and because its theoretical treatment is still in its infancy.

Despite the limitations of the theoretical framework, the competitive equilibrium model is a very useful vehicle which enables the analysis of many interesting questions in international trade. Nevertheless, its limitations should be kept in mind.

Two important characteristics of the international trade literature are its concentration upon simple two-dimensional models and upon the diagram as a tool of analysis. While the diagram can be a very powerful tool it loses its power as the complexity of the questions being asked is increased and when interest extends to dimensions greater than two. In this regard, it is noteworthy that much of the recent literature has been concerned with the question of whether propositions established for two-dimensional models carry over to multi-dimensional models. As a consequence, mathematics has almost completely replaced the diagram as a research tool since mathematics is more efficient for multi-dimensional problems.

Where possible the analysis in this book deals with multi-dimensional models (many products, factors and consumers) and it treats the two-dimensional model as an interesting special case which generally has considerably more structure. The diagram is often used, not to prove results necessarily but to provide a geometric interpretation of the nature of the problem or proposition involved. Thus, the

diagram and mathematics are viewed as complements.

If mathematics is chosen as the tool of analysis because it is more efficient than the diagram, then the type of mathematics should be chosen accordingly. With this in mind much of the analysis involves the use of *duality theory*. The use of duality theory to formulate and analyse competitive models is efficient in that it minimizes the number of variables in the model (pushing unwanted variables behind the scenes and concentrating attention upon the important ones), often yields results in a simple way, and emphasizes the economic assumptions in, and basic structure of, the model. Thus, when dealing with the firm it is convenient to define the minimum cost function, indicating the minimum factor cost attainable given the technology as a function of the output and factor price vectors, rather than dealing with the conditions for cost minimization expressed in terms of the production function. Similarly, the consumer's constrained utility maximization problem is dealt with in terms of the minimum expenditure function or the indirect utility function rather than the (direct) utility function itself.

At the aggregate level dual functions can also be used. On the production side, it is well known that competitive behaviour leads to maximum gross national product (GNP). Thus, it is useful to define the GNP function which gives the maximum GNP attainable as a function of the product prices and factor endowments. The GNP function is *dual* to the production possibility set in the sense that each one contains enough information to reconstruct the other exactly. They are, therefore, equivalent representations of the technology. On the consumption side, one can define an aggregate minimum expenditure function which is the minimum expenditure required to attain a given utility vector under a given price vector. If expenditure is required to be less than or equal to income, the utility possibility set, depending upon prices and income, is thereby defined.

Different dual functions can be defined for a particular problem. For example, as mentioned above, for the consumer problem one can work with the expenditure function or the indirect utility function. The latter is a "pure" dual function in that it does not contain any variables endogenous to the consumer's problem and depends only upon exogenous prices and income. The expenditure function, however, is only a "partial" dual since, while the consumption vector has been optimized out, the level of utility remains as an argument and it is endogenous to the consumer's problem. Both functions are dual to the utility function and hence are equally good characterizations of preferences. However, for some purposes it is more convenient to use the expenditure function and for others it is more convenient to use the indirect utility function. Duality theory enables the researcher to switch from one characterization to another to suit his purpose. One is not restricted by a particular model formulation.