UK Tax Policy and Applied General Equilibrium Analysis

John Piggott and John Whalley

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and

applied general equilibrium analysis

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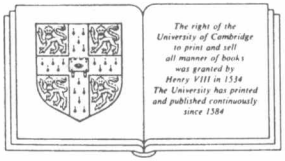

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In the last ten years, general equilibrium modelling has become a significant area of applied economic research. Its focus is to develop techniques to facilitate economy-wide quantitative assessment of allocative and distributional impacts on policy changes. *UK Tax Policy and Applied General Equilibrium Analysis* presents the first book length treatment of the development and application of an applied general equilibrium model of the Walrasian type, constructed to analyse UK taxation and subsidy policy.

The material splits naturally into two parts. Part I provides an account of the formal structures of general equilibrium models, with and without taxation and describes the procedures used for empirical implementation. This allows actual policies to be realistically analysed. These procedures depend upon the policies that the model is designed to address and for this reason an early chapter is devoted to a description of UK tax and subsidy policies.

Part II presents and interprets the results of a series of model experiments. These include the distorting effects of taxes on household consumption, industry production and factory use. A variety of further model extensions are also described, motivated by consideration of more specific tax policy issues. These include the interaction of taxes on savings and inflation, and the effects of taxes on the appropriate level at which public goods should be provided.

As a whole, *UK Tax Policy and Applied General Equilibrium Analysis* offers the reader two things. First, it gives a detailed account of the development of an applied general equilibrium model of the UK. Second, it provides results of model experiments which have been designed to inform the policy debate, not only in the UK but also in other countries. I should thus be of interest to both researchers and students undertaking research in the applied general equilibrium area, and to policymakers concerned with tax reform.

UK tax policy and applied general equilibrium analysis

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To our wives, Dorry and Maggie

PREFACE

This manuscript was originally prepared in camera ready copy in 1981, at which point the original publisher withdrew due to concerns over the small market for such a specialized research monograph. Since this date there have been many developments both within the field of applied general equilibrium analysis, and in UK tax policies.

Recent developments in applied general equilibrium are reflected in two conference volumes [Scarf and Shoven (1983) and Piggott and Whalley (forthcoming)]. A recent survey paper by Shoven and Whalley (1984) provides an up to date summary. On the tax front, developments in the UK have continued with the usual round of budget and other changes.

We decided not to revise our manuscript to reflect all of these developments. Not only does this involve a large volume of work, but we were concerned not to interrupt the flow of the present draft with a series of inserts. Even without any revisions we believe that our book makes a significant contribution to the applied general equilibrium literature by focussing applied modelling heavily towards results, and their ultimate policy applicability. While some of the model structure has been extended in subsequent work (particulary in dynamic sequenced models used to analyze taxation and savings issues), there are features of our model which are still not present in other modelling efforts. Among these are the incorporation of public goods as a model variant, and household detail on the demand side.

While the numbers may be a little dated, the approach to tax policy outlined and its ultimate policy applicability seem to be generating increasing interest. Our hope is that, even in its present slightly dated form, this book will help in the process of assimilating these developments.

ACKNOWLEDGEMENTS

This book has its origins in a model of the UK economy and tax system used in a Ph.D. thesis written by the second author at Yale in the early 1970's (Whalley, 1973). Since then a large number of adaptations and extensions have been made. The original model was of limited dimensionality, with few of the present features, and used data which in places were highly stylized.

During this period of time, help, encouragement, and support have been received from many quarters. The second author would like to acknowledge the excellent thesis supervision he received at Yale from William Brainard and Herbert Scarf, and the help and encouragement of John Shoven. John Shoven's support has been instrumental in this work from the beginning and still continues.

While at LSE (1973-1976) where the present model form developed, a research grant from the Social Science Research Council provided vitally needed support and enabled John Piggott to join the project. At this time, a number of United Kingdom government departments and statistical agencies, too numerous to list here but referred to in the text, dealt with our requests for data and information kindly, courteously, and expeditiously. LSE provided the significant amounts of computer time that model execution required at this stage.

At Western Ontario (1976 to the present), a research grant from the Social Sciences and Humanities Research Council, Ottawa, has enabled work to continue on the model, and for the present volume to be brought to fruition. The University has also generously provided additional computer support.

As our work and drafting has developed, many comments have been received from colleagues, students, and seminar participants too numerous to individually list, but we would nonetheless like to thank them all. We would also like to acknowledge the fine research assistance of France

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St. Hilaire, Jon Fuller, Bob Hamilton and Bernard Yeung. Various drafts have been typed by patient secretaries at the Universities of Western Ontario and Adelaide, and at the Australian National University. Mrs. Jan Anthony expertly prepared the final drafts and camera ready manuscript.

In two previous papers, Piggott and Whalley (1977), Piggott and Whalley (1981), we have discussed the structure of the model we use together with some of the results presented in the present volume. One point for readers to keep in mind is a difference in emphasis on summary statistics used to evaluate income distribution impacts of tax changes between Piggott and Whalley (1981) and the present volume. This is discussed more fully in the text.

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captured through a sequence of market interactions which are distorted through government intervention. Though highly stylized and excluding many features of actual economies, this approach is widely used in the analytical literature in public finance. On that basis it provides the framework for our analysis, even though we abstract from many important phenomena (such as unemployment).

The model incorporates production functions for UK industries and demand patterns for households and incorporates the distorting effects of the major taxes and subsidies which operate. We work with a basic variant model into which we incorporate a number of extensions as model alternatives. Counterfactual equilibria generated by alternative policies to those which charaterize the assumed base year of 1973 are compared to a base period equilibrium. We emphasize welfare and distributional comparisons between equilibria, and summarize the implications of our results for tax/subsidy policy in the UK.[1]

2. The Basic Structure of General Equilibrium Tax Models

The central idea underlying general equilibrium analysis of tax policy is that in order to evaluate the effects of changing a major tax, important economy-wide effects must be taken into account. Taxes distort the allocation of resources in the marketplace by causing resources to be used where productivity is lower than elsewhere and commodities to be offered to consumers at tax distorted prices adversely affecting consumer choice.

The basic analytics of general equilibrium tax models can be illustrated with the aid of diagrams depicting a two-factor, two-product, perfectly competitive economy, with fixed aggregate factor supplies, and, for convenience, consumers with identical, homothetic preference functions. In the absence of externalities and government interventions, such an economy will, in equilibrium, satisfy all the marginal conditions required for a Pareto optimal allocation. With distorting taxes this will no longer be true.

INTRODUCTION AND SUMMARY OF STUDY

1. Introduction

In the UK, as in other countries, there has been substantial discussion in recent years of tax reform. Many of the problems and difficulties encountered by the UK economy have, at times, been attributed to the structure of the tax system, and over the years both politicians and academic economists have produced a number of alternative proposals for tax reform. The Report of the Royal Commission on Taxation (1966), and more recently the Meade Report (1978), are evidence of this continuing interest. In spite of pressure for change, however, quantitative analysis of the effects which taxes and subsidies produce (especially those on resource allocation) remains surprisingly sparse, both in the UK and elsewhere.

In this study we use a conceptual approach, widely explored in theoretical literature in public finance, to analyze the impacts of the UK tax/subsidy system on the allocation of resources and the distribution of income using 1973 data. We explore general equilibrium efficiency and incidence effects of taxes and subsidies, emphasizing a numerical, empirically oriented version of this well-known approach. In Part I of the study we describe the structure of the model we use. Part II reports our empirical results.

The approach used is to build a general equilibrium model using explicit demand and production functions. In the model all markets clear in equilibrium. Demands equal supplies for both goods and factors, and no industry does any better than break even in terms of profitability. Equilibrium conditions hold both in the data which we use for the benchmark solution for the model, and in the counterfactual equilibria which we simulate for alternative policy regimes. We assume full employment of all factors, an absence of any monetary non-neutralities and complete information, all of the assumptions characteristic of classical general equilibrium analysis. The use of the model is based on the belief that the essence of the behaviour of the economic system is

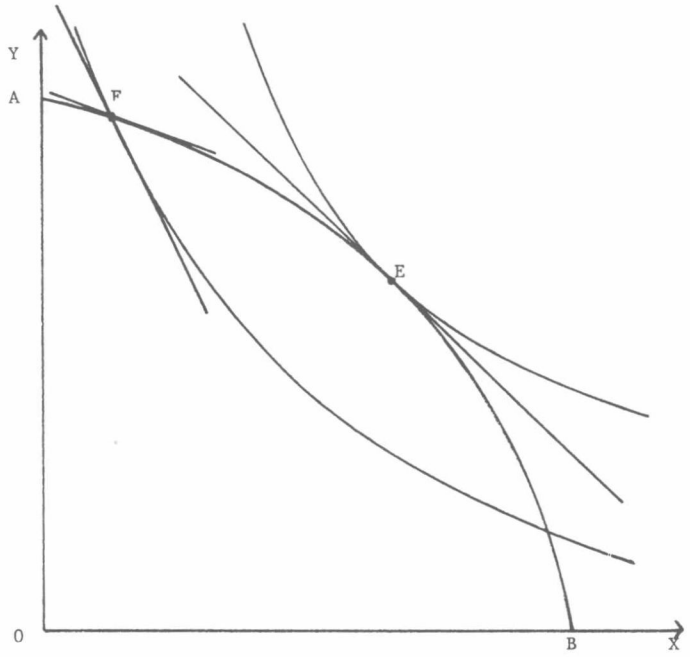
Figure I.1 depicts the simple case of a consumption tax on product X in a two-commodity economy. We consider a single consumer who selects from alternative combinations of the two goods X and Y represented by the economy's production possibilities frontier. The revenues from the tax are returned in lump sum form to the single consumer. Productive efficiency is not affected since the economy remains on the production possibility frontier AB, but the product mix is altered by the tax. The tax produces a distortion between the marginal rate of transformation (MRT) (the net of tax price ratio facing producers) and the marginal rate of substitution (MRS) (the gross of tax price ratio facing consumers). In an equilibrium in the presence of the tax (point F), consumers adjust their purchases so that their marginal rate of substitution equals the gross of tax commodity price ratio. The consumer price ratio exceeds the ratio of prices received by producers since these are net of taxes. The distorted equilibrium at point F corresponds to a lower indifference curve than that associated with the undistorted equilibrium at point E. Because MRS ' MRT the allocation of resources corresponding to point F cannot be Pareto optimal.

A consumer tax which induces a move along the production possibility frontier from E to F may also have other effects beyond those represented in the diagram. One issue frequently analyzed is the incidence of such a tax. In the two-sector framework, this usually involves functional incidence analysis; the impact on the income return to the two factors, capital and labour. The functional incidence of the tax in Figure 1 will depend upon the relative factor intensities of the two industries and cannot be analyzed simply by the same diagram. A proposition from the literature on the Harberger model (see Mieszkowski [1969]) is that the factor which is relatively intensively used in the taxed industry will bear some of the burden of the tax; whether it will fully bear the tax burden, however, depends on the parameters of demand and production functions.

The two sector framework represented in Figure I.1 is not confined to analyzing tax distortions of choices by consum-

FIGURE I-1

Simple Analysis of a Distorting Consumer Tax on Good X



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