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Applied Methods for Trade Policy Analysis: An Overview

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After receiving their respective Ph.D.s, the authors of this chapter both set off to work at the U.S. International Trade Commission (USITC) in Washington. In our graduate studies, we had been steeped in mainstream international economics and, consequently, naively thought of ourselves as knowing at least the basics of what was necessary for working in an applied policy environment. Our delusions proved to be short-lived. Within a few weeks of our arrival at the USITC, it became apparent that there was a broad set of tools required for our jobs that were rather different from those emphasized in academia. There was also a need to temper these tools with a sense of policy relevance. Within months of our arrival, we needed to become versed in the nuances of imperfect substitutes models, trade data nomenclature, social accounting matrices, computable general equilibrium modeling, and a host of other concepts and methods. While the standard trade models continued to provide intuition in many areas, our day-to-day professional work was often in another realm entirely. In many cases, the applied work provided new and useful insight into the significance of various theoretical issues.

The purpose of this book is to assist others in their own professional journey from standard trade theory to applied trade analysis in a policy environment. Our objective is to make life easier for the graduate student working on an applied trade topic, the government or international organization economist engaged in the quantitative analysis of trade policy, or the policy analyst trying to understand what in the world trade economists are talking about in their reports. Our success in assisting such individuals in this bridging process will justify the book's existence.

The objective of this chapter is to provide a detailed overview of the objectives of the book, and a suggested strategy for its use. Our first task is to give the reader an idea of what it is that distinguishes applied trade policy analysis from theoretical trade policy analysis. We do not mean to convey the notion that the two types are unconnected, nor even that the delineation between the two is clear-cut. It can be difficult to tell when one has moved from "numbers with theory" to "theory with numbers." However, we recommend that you keep such a delineation in mind. This is discussed in Section I of the chapter. Our second task is to identify and describe some of the basic frameworks of applied trade policy analysis, the foundation concepts of the field. We take up this task in Section II. Building on these basic frameworks, we move on to a set of standard applications to which these methods can be applied; the description of these applications is provided in Section III. Section IV delves into a number of important extensions to the standard applications, all of which are important and active areas of research in their own right. Finally, in Section V we turn briefly to the issue of behavioral parameters. This book is devoted to applied analysis, centred on the collection, organization, and analysis of data through the construction of applied static and dynamic models. Such research depends not only on available production and trade statistics, but also on available parameter estimates. In our view, the econometric estimation of behavioral elasticities is a very important but relatively undervalued area of study. We conclude in Section VI with some final comments on model transparency.

I What Is Applied Trade Policy Analysis?

What distinguishes applied trade policy analysis from theoretical trade policy analysis? There is no clear line of division between theoretical and applied models, but rather a continuum from "theory" to "theory with numbers" to "numbers with theory." Nevertheless, we feel that there are a set of characteristics that *tend* to distinguish applied trade policy analysis from theoretical trade policy analysis. These include (i) a *detailed policy orientation*; (ii) the formulation of models that are not merely local approximations from non-distorted base equilibria but that, in contrast, provide sensible results for *nonlocal changes in policy parameters from distorted base equilibria*; (iii) a concern for *accurate and current data* as the foundation of the modeling exercise; and (iv) *model structure determined by the data*, rather than selective use of data to fit a theoretical structure. For example, data on two-way trade often precludes homogeneous goods models, dictating instead the inclusion of *product differentiation* at the country and/or firm level in the formulation of the model.

I.1 Detailed Policy Orientation

First, let us say a few words about what we mean by "detailed policy orientation." Many theoretical models consider trade policies, especially *ad valorem* tariffs, in the process of considering the properties of the model. The term "detailed policy orientation" as we use it here means more than a simple, theoretical consideration of *ad valorem* tariffs. It involves an analytical commitment to the sectoral and institutional details of a policy as well as a commitment to be engaged in the policymaking process with all the inherent frustrations. A concern for sectoral detail forces the researcher into the realms of trade data nomenclatures, input–output relationships, and industrial classification schemes. A concern for institutional detail requires attention to the way in which a trade measure is implemented. How are quotas allocated? Is there evidence of quota rent sharing? How do quotas and tariffs interact? Are there supporting domestic policies which must be addressed? Finally, engagement in a policymaking process requires a sensitivity to the types of information that are relevant to policymakers, a willingness to engage the public in lay explanations of models and results, and the patience to endure what often appear to the economist as mundane concerns of policymakers and the public.[1] The move from theoretical analysis to applied analysis often involves a change of professional mode from economist to public servant. The applied trade policy economist must wear more than one hat. Occasionally, when wearing the public service hat, we are asked to go beyond (or even contradict) the insights offered by formal analysis and condone purely political judgements on matters of policy. At this point, the hat should be hung back up on the rack.[2]

I.2 Nonlocal Changes from Distorted Base Equilibria

Most static applied trade policy analysis makes use of a procedure of economic analysis known as *comparative statics*. Even "dynamic" models often involve either the comparison of steady-state equilibria (comparative statics with time subscripts) or fake dynamics involving a sequence of static

1 An applied trade policy modeller was presenting the basic features of a sectorally detailed CGE trade model to a top trade official. The official's first question was "Does the model have an orange sector in it?" Reply: "I am afraid not, sir, oranges are included in the fruit sector." The official was disappointed.

2 An academic trade economist was presenting the basic features of a partial-equilibrium trade policy model for use in import relief cases to a senior U.S. trade official. At the conclusion of the presentation, the official commented, "That is all well and good, and I will certainly use it as long as it will allow me to vote the way I want to."

equilibria. Under this approach, an initial or base equilibrium is compared to an equilibrium in which some exogenous variable, such as a trade policy variable, has been changed. In most theoretical models, the economy starts off in a nondistorted state with no tariffs, quotas, or other taxes present. From this initial, nondistorted equilibrium, an infinitesimal tariff is introduced and a new, counterfactual equilibrium is solved for using the linear approximation of differential calculus. In applied trade policy analysis, the comparative static framework is used with two differences. First, the initial or base equilibrium has built into it the relevant set of distortions due to trade policy or other government interventions. This allows for second-best welfare effects of changes in trade policies. Second, changes in trade policies are those actually under consideration. They are, therefore, nonlocal.

As a consequence of the presence of distortions in the base equilibrium, the removal of small tariffs can reduce rather than improve welfare by reallocating economic activity into other distorted sectors. Since the model is analysing a second-best world, it is not always the case that trade liberalization improves welfare. As a consequence of the nonlocal policy parameters introduced into the analysis, the functional forms chosen to describe economic behaviour matter. The economy moves far enough away from the initial equilibrium for the functional forms used to determine where the economy lands. For example, in partial equilibrium models, linear versus constant elasticity functional forms can make a big difference when considering the effects of large tariffs or quotas.

I.3 Accurate and Current Data

In trade policy analysis based on the comparative static procedure described, three things determine the result of a policy simulation: the functional forms used to describe the behaviour of the model (model structure), the base data used to describe the initial equilibrium, and the behavioural elasticities used in the functional forms. Even if the analyst chooses functional forms with care, the share and elasticity parameters of these functional forms must be filled in accurately. The share parameters are calibrated from a data set describing the initial equilibrium. In a partial equilibrium model, this data set may be quite simple. In a general equilibrium model, it may be quite complex. In either case, if we want to provide results of some merit, care must be taken to make the base data accurate. That said, policymakers are often very much concerned with the currency of model results. It will be of little use to have a base data set a decade old, ideally, it will be up to date. Unfortunately, there is sometimes a trade-off between accuracy and currency of data. When there is, professional judgement must be used. The last elements of the model, behavioural elasticities, are also important. Their magnitude will determine both qualitative and quantitative results of models. Unfortunately, in our view, while the field of economics is obsessed with functional forms, it does not reward research into either the estimation of base data sets or behavioral elasticities for trade policy modeling. This is part of our field's bias toward theoretical as opposed to applied modeling.

Model Structure and Data Structure Finally, we turn to the trade-off between data structure and model structure. Consider product differentiation. The classical theoretical trade models assume that imports and domestic competing goods are *perfect* substitutes in demand. In this case, the model (i) describes interindustry trade only and (ii) cannot support a number of goods that exceed the number of factors.[3] Both of these characteristics prove to be severe limitations for applied work. To get around the second limitation, it is possible to specify a specific factor for each sector. With the additional factor of labour, then the number of factors exceeds the number of sectors by one, and ten, twenty, or thirty sector models become a possibility. This, however, still does not address the first limitation. Even at high levels of disaggregation, there are both imports *and* exports in the trade data for most sectors of any economy; intraindustry trade is a widespread phenomenon. A perfect substitutes model cannot explain this and therefore resorts to explaining net imports or net exports in any sector. In essence, this sweeps the two-way trade observed in the trade data under an analytical rug, in both partial and general equilibrium frameworks. Applied homogeneous goods models, while consistent with theory, are usually inconsistent with the observed world.

One alternative to all of these difficulties is simply to recognize that imports and domestic competing goods are *imperfect* substitutes in demand. This represents product differentiation by country of origin. This idea was originally proposed by Armington (1969), who used a constant elasticity of substitution (CES) functional form to describe preferences among imports from various countries. Consequently, the combination of product differentiation by country of origin and a CES functional form for preferences has become known as the *Armington assumption*. Product differentiation by country of origin has been incorporated into both partial and general equilibrium frameworks. In the partial equilibrium framework, this assumption

3 This result goes back to Samuelson (1953).

was utilized early on by Baldwin and Lewis (1978) and Baldwin, Mutti, and Richardson (1980). It was incorporated into a U.S. International Trade Commission Staff Study by Rousslang and Suomela (1985) which was widely circulated. In general equilibrium frameworks, the Armington assumption was used by Dervis, de Melo, and Robinson (1982); Whalley (1985); and de Melo and Robinson (1989).

The Armington assumption has been the centre of controversy.[4] Out of this controversy, a second alternative to the perfect substitutes assumption that recognizes the existence of product differentiation at the level of the firm has emerged. Appropriately, this approach is known as firm-level product differentiation. This approach has at least two origins. The first of these is the introduction of monopolistic competition into international trade theory, beginning with Krugman (1979, 1980) and Ethier (1979, 1982). The second is the incorporation of firm-level product differentiation into a model of the Canada–United States free trade agreement (CAFTA) by Brown and Stern (1989). The motivation of Brown and Stern was to minimize terms-of-trade effects inherent in the Armington structure. Norman (1990) has argued that the firm-level product differentiation approach is preferable to the country of origin or Armington approach because it locates product differentiation on the supply side. The limitation of the firm-level product differentiation approach is that the absence of firm-level data makes econometric estimation of elasticities difficult. This point has been emphasized by Winters (1990). Another limitation is that, as in the case of homogeneous goods models, models of pure firm-level product differentiation can yield indeterminate production patterns, when the number of goods exceeds the number of factors. In practice, therefore, models with firm-level product differentiation often incorporate product weights that are sector- and region-specific (see Brown, 1994). The result is that the spirit of Armington is often preserved in imperfect competition models, even when the formal Armington assumption is dropped.[5]

II Getting Started: Basic Frameworks

Suppose that you have been recently hired as an economist in the Trade Ministry of your country. Suppose further that your supervisor has given you a few weeks to sharpen your skills in the field of applied trade policy analysis

4 An overview of this controversy is provided in Francois and Shiells (1994).

5 It is possible to calibrate the demand elasticity for firm-level product differentiation from an elasticity of scale for the sector in question. The latter, though, are in short supply. For more on this see Chapter 11.

in preparation for an upcoming project. Where should you begin? We want to suggest that you put aside for these few weeks your trade textbooks and take a look at Part II of this book. Here we cover a number of subjects which we think will be of more immediate use to you.[6]

In the classroom, we use a policy parameter t, an *ad valorem* tariff, to introduce commercial policies into our models. In your Trade Ministry, however, when you begin your first project, you will in all probability encounter a proliferation of commercial policies structured according to, perhaps, a number of different nomenclatures. No doubt, when mired in the intricacies of these commercial policies, you will long for the simple t parameter of the graduate texts. To ease the difficulty, Chapter 2 takes up the subject of quantifying commercial policies. It is only appropriate that a volume on trade policy analysis begin with the policies themselves.

Chapter 2 considers tariffs, sometimes referred to as nominal protection. The bulk of the chapter, though, deals with nontariff measures or NTMs. The chapter analyses the qualitative effects of these trade measures and their measurement. It also identifies sources of data on trade measures. Appendix 2.1 presents the UNCTAD nomenclature of trade control measures, and Appendix 2.2 provides a glossary of NTMs. The chapter is not exhaustive; if it were, it would fill the entire volume. Therefore, the reader must utilize it, and its excellent set of references, as an *entrée* into the literature on commercial policies.

In standard trade theory, we consider a move from autarky to free trade and, under certain conditions, show that welfare under free trade must be at least as great as welfare under autarky.[7] In your new role as trade economist, this will be unsatisfactory for two reasons. First, second-best considerations and terms of trade effects make welfare declines as a result of movements toward free trade a logical possibility. Second, even if welfare increases as a result of a movement towards free trade, the burning question will be, How much? In one way or another, you will have to quantify welfare effects. This brings us to Chapter 3.

Chapter 3 identifies three commonly used approaches to general equilibrium welfare evaluation in distorted open economies. These are the balance of trade function approach based on compensation measures, the direct evaluation approach using a money metric, and Marshallian surplus measures. The balance of trade function yields measures of the compensation required to maintain utility at a specified level. The equivalent variation

6 Other useful references which address commercial policy *theory* are Vousden (1990) and Helpman and Krugman (1989).
7 Dixit and Norman (1980, Chapter 3).

version of this measure provides a money metric of welfare change. The money metric approach is different from the compensation approach in the presence of distortions and is shown to be identical with a modified version of the balance of trade function derived from the public finance literature. Diagrammatic surplus measures are derived by using Taylor series expansions to provide intuition about the source of welfare gains or losses from changes in trade policies or terms of trade.

In trade theory, once we have shown that the movement from autarky to trade cannot reduce welfare, we then turn to a set of comparative static experiments in which we consider the effects of transfers, factor supply changes, technological change, and trade policies on the endogenous variables of the system.[8] When using the linear approximation of total differentiation, there appear in the system a number of parameters that reflect the initial values of variables. The size of these initial values determines the quantitative and sometimes the qualitative results of the comparative static exercises. In applied trade models, we usually solve models in level form rather than using linearization methods.[9] Nevertheless, the system still has a (large) number of parameters reflecting initial values of variables. Since we are very concerned with the quality of both qualitative and quantitative results in applied trade policy modeling, establishing these initial values is of prime importance. In the literature on computable or applied general equilibrium modeling, these initial values are entered into the model by *calibrating* the model to what is known as a *benchmark equilibrium dataset.*[10] The benchmark equilibrium dataset serves as a description of the economy in the initial equilibrium before any policy changes have been made. How does one construct such a dataset? Recently, it has become standard practice to construct them in the form of a *social accounting matrix* or SAM, originally developed to analyze income distribution issues in developing counties.[11] Chapter 4 of this volume is an introduction to the concept of SAMs and their use as benchmark equilibrium datasets. It has circulated in recent years through a number of international organizations and has proved helpful in a number of applications.

Chapter 4 begins in a very straightforward way with simple macroeconomic SAMs which are related to familiar macroeconomic accounting identities. It then moves, step by step, to more complicated SAMs by adding institutional accounts and sectoral detail. The chapter lays out a basic meth-

8 Dixit and Norman (1980, Chapter 5).
9 On the issue of linearization versus level solution, see Hertel, Horride, and Pearson (1992).
10 On calibration and benchmark equilibrium datasets, see Shoven and Whalley (1984) and Shoven and Whalley (1992, Chapter 5).
11 See Pyatt and Round (1985).

odology for SAM construction and consolidation which should help to simplify this tedious process for you. It then begins to describe the relationship between SAMs and general equilibrium analysis of trade policy by addressing three topics: flexible aggregation, calibration, and closure. In the case of flexible aggregation, the authors make a case for maintaining a sectorally detailed SAM which is aggregated in a different fashion for each trade policy that comes under scrutiny. This methodology is taken up in Chapter 7 (discussed later).

While international trade theory is fundamentally a general equilibrium affair, there are many circumstances in which single market or partial equilibrium modeling is both appropriate and desirable. For example, there are many highly detailed trade policies applying to specific products which will be a small portion of standard industrial classifications of the economy in question. In this case, it is simply not possible to construct a SAM for a general equilibrium model. An antidumping case on Chinese candles or Korean baseball uniforms is best addressed in a partial equilibrium framework. The partial equilibrium models of trade that we learned as undergraduates are only the starting point for the models used by applied trade policy analysts today, not in the least because of their perfect substitutes assumption. A whole menu of alternative models, solvable on spreadsheets, are utilized on a daily basis around the world. Chapter 5 provides an introduction to such models.

Chapter 5 outlines, in detail, methodological approaches for constructing simple partial equilibrium trade models. Emphasis is placed on quantifying the effects of tariffs and nontariff measures on trade, production, and national income. The chapter begins with perfect substitute models and then continues with imperfect substitute models. It takes you through the modeling of both tariffs and quotas and numerically illustrates several important concepts, including linearization errors and the implications of underlying distortions for second-best policy options. Despite its partial equilibrium emphasis, welfare measures are explicitly linked to their general equilibrium counterparts, making clear what assumptions are being made when measuring welfare in partial equilibrium. Importantly, the chapter introduces you to the implementation of applied models using spreadsheet software.

As stated in Section I, product differentiation plays an important role in distinguishing applied trade policy analysis from its theoretical counterpart. For many years, a barrier to making the intellectual transition from theoretical to applied models has been the complex model structure introduced by incorporating product differentiation in applied general equilibrium trade models. It is a long leap from a simple Jones or Dixit–Norman style model to the blizzard of goods and prices within a computable general equilibrium (CGE) model. How can you make this leap in the few weeks you have at your Ministry? The answer to this question is, by focusing on a model with a minimum of sectoral detail. This is exactly what is done in Chapter 6.

Chapter 6 introduces a basic applied trade policy model with one country, two producing sectors, and three goods, a model the authors therefore call the 1–2–3 model. The chapter begins with a simple analytical version of the model and relates it to the seminal papers of Salter (1959) and Swan (1960) and the whole issue of nontradables. As you will see, however, from an empirical point of view, their approach to nontradables is more satisfactory than the standard theoretical approach of Komiya (1967) and Ethier (1972) since it does not define nontradability on a sectoral basis. The importance of this approach is obvious when you examine trade data that includes service sectors: There are few sectors which do not show at least some amount of trade. The chapter uses the analytical model to assess the impacts of a number of economic changes which will help give you some intuition for its properties. Next, it adds a government and investment sector to the model to bring it closer to models actually used in trade policy analysis. It then explains how to implement this more realistic model in a spreadsheet framework and conducts a revenue-neutral tariff reform experiment as an illustrative policy experiment. Along the way, you will be introduced to the constant elasticity of substitution and constant elasticity of transformation functional forms widely used in CGE modeling.

Your first few weeks of orientation in your new position have passed. Having assimilated the material of Part II, you will face your first trade policy assignment. However, you now have a number of basic analytical frameworks from which to draw, and you will not be at a loss in making the transition from theory-based analysis to applied policy analysis. What might your first application of these frameworks look like? Part III provides a few alternatives.

III Putting the Basics to Work: Standard Applications

You have just returned from a meeting with your supervisor and other Ministry colleagues, and at this meeting you were given your first assignment. It is likely that you will be working on a project involving a specific set of policies in a specific set of products or sectors. Perhaps a trade delegate is considering offering a specific tariff concession at the World Trade Organization (WTO), or perhaps a domestic industry has successfully lobbied for a quota in a particular sector. Chapter 7 will lead you through an approach to your assignment in a general equilibrium context. In the chapter, the flexible aggregation approach advocated in Chapter 4 is utilized. The chapter makes use of a 487-sector SAM of the United States, using three different aggregations of it to analyze a sectoral tariff, domestic and foreign allocated quotas, and an import prohibition. Along the way, the chapter will introduce you to the specification of a CGE model and describe the modeling of tariffs and quotas. The simulations described will give you an idea of the types of results that can be obtained from general equilibrium models and some of the general equilibrium considerations involved. An Appendix will introduce you to the linear expenditure system which is often used to model household demand in CGE models.

It is possible that your first assignment concerns commodities so narrowly defined that it will not be possible for you to utilize a general equilibrium framework. Or it may be that the time frame of your assignment precludes the construction of a CGE model. Then you may need to resort to partial equilibrium analysis. This does not prevent you from accounting for some basic interactions among the markets or regions involved. Building on Chapter 5, Chapter 8 will introduce you to the procedures involved in specifying and solving multiproduct, multiregion partial equilibrium models. Such models have proved particularly relevant for modeling agricultural policies.

In some instances, your assignment will not only require a general equilibrium point of view, but will be inherently global. For instance, you might be asked to assess the impact of a round of global trade negotiations on developing countries. Since the policy involved is both multisectoral and multilateral, proper analysis requires global modeling. Not long ago, the limits of computer technology would effectively prevent such an endeavour. With current computing technology, however, it is now possible to construct and solve large global general equilibrium models on a personal computer. Chapter 9 of this volume describes the process involved in global modeling. Emphasis is placed on the important differences between macro closure rules employed in single-region models and multiregion models.

Standard trade theory, via the Stolper–Samuelson (1941) Theorem and its Ricardo–Viner equivalents (Ruffin and Jones, 1977), provides information on the effects of tariffs on the returns to primary factors. In most applied general equilibrium trade models, changes in primary factor returns then help to determine the welfare of a single, representative household. Ironically, one early strand of CGE models (e.g., Adelman and Robinson, 1978) as well as the early SAM literature (e.g., Stone, 1985) was developed precisely to analyze income distribution in *multihousehold* contexts. With few exceptions, multihousehold concerns have not been a priority in applied policy research. While this might be appropriate in many developed country applications, it is hardly appropriate in many developing country applications, especially given the present concerns with the impacts of structural adjustment policies on poverty. In light of the above, Chapter 10 takes up the question of household disaggregation in applied general equilibrium trade models. Following a survey of the literature on income distribution and trade policy analysis, the chapter turns to two methodological issues: household classification and measurement of distributional impacts. A CGE trade model for Bangladesh is specified, and the model is used to assess the impacts of trade liberalization on income distribution. Appendix 10.3 provides a brief guide to various income distribution measures.

IV Getting Fancy: Extensions

Imagine now that you have been in your position at the Ministry for a year or two. You are now very comfortable with both the foundation methods of applied trade policy analysis and their application. Most likely, somewhere in your work you have been struck by a problem that lies beyond the standard applications of your models. Perhaps this concerned an issue of labour markets, imperfect competition, or an externality question. Part IV takes up some of these matters. This last section of the book goes significantly beyond Parts II and III in its level of difficulty. The material of this section is also currently under discussion in both academic and policy communities. Finally, these extensions are more information-intensive than the standard applications. For these reasons, you should proceed cautiously when incorporating the material of Part IV into your policy analysis at the Trade Ministry.

In the last decade, international trade theory has incorporated a number of elements from industrial organization to analyze the determinants of trade under imperfect competition. Sometimes referred to as the new international trade theory, these developments have contributed to the understanding of intraindustry trade and multinational corporations.[12] In the applied trade policy literature, there simultaneously developed a concern for the role of economies of scale in measuring the cost of protection (e.g., Dixon, 1978). These two sets of concerns came together in a paper by Harris (1984), who argued that the inclusion of scale economies in a general equilibrium model of trade liberalization can substantially affect the quantitative

12 Grossman (1992) collects a number of key papers in this area.

results of liberalization experiments.[13] These matters are taken up in Chapter 11.

Chapter 11 takes a broad view of alternatives available in specifying applied trade policy models with imperfect competition. Beginning with a brief explanation of the potential procompetitive effects of trade policy reform, the chapter then considers alternative approaches to specifying and calibrating firm-level costs. It considers market power in both homogeneous goods models and heterogeneous goods models. In the latter case, it contrasts country-level (Armington) and firm-level product differentiation. Some of the key concepts are illustrated with a multiregion CGE model focused on Korea. This model is an extension of the one used in Chapter 9.

As indicated in Section II, most of international trade theory employs the comparative static framework. The term "static" in this context generally refers to the fact that no attention is given to the path along which the economy travels from one equilibrium to another. The term, however, has at least two other meanings. First, by static we might indicate that economic or policy changes have no effect on the accumulation of capital and the associated change in production possibilities. Second, static might mean that economic or policy changes have no effect on the *rate* of growth. A sizable theoretical literature exists on trade and capital accumulation (e.g., Smith, 1976, 1977; Baldwin, 1992). With regard to the impacts of economic and policy changes on growth rates, a relatively recent branch of trade theory has grown from the contributions of Romer (1987) and Lucas (1988).[14] The incorporation of capital accumulation and growth effects into numerical models is relatively new.[15] However, numerical models in which trade policy affects capital accumulation and production possibilities do exist.

Chapter 12 is devoted to the analysis of trade and investment linkages in steady state. Emphasis is placed on capital market closure rules that relate trade policy to investment effects. Following a brief overview of theoretical linkages between trade and investment, an application that examines the investment-related effects of the Uruguay Round is offered. Chapter 12 is devoted to steady-state comparisons (comparative statics with time subscripts) and ignores the explicit modeling of adjustment paths. In contrast, Chapter 13 provides an introduction to the issues surrounding the dynamic effects of commercial policy, including time paths. It shows that incorporating intertemporal optimization into applied general equilibrium trade models can allow one to describe the growth effects often attributed to liberali-

13 See, however, the concerns raised in Section V.
14 For a review of this literature, see Francois and Shiells (1993).
15 For a review of the issues involved, see Kehoe (1994).

zation efforts and to evaluate them in welfare terms. The chapter develops a dynamic general equilibrium model calibrated to Austrian data. The model features overlapping generations with lifetime uncertainty. Investment and savings are determined by intertemporal optimization under perfect foresight. The chapter discusses the calibration of dynamic parameters and applies the model to a number of trade policy exercises.

In your experience at the Trade Ministry, it probably will have become apparent that a primary concern of both trade policy officials and the public is employment. It is often a long distance from such concerns to standard trade theory. Most trade theory models specify labour markets that operate in a perfectly functioning manner with no institutional rigidities. Traditionally, labour market rigidities have been brought into trade theory via wage differentials (e.g., Bhagwati and Srinivasan, 1971), generalized sticky wages (e.g., Brecher, 1974), and sector-specific sticky wages (e.g., Harris and Todaro, 1970). More recently, a number of new approaches to the labour market have been generated from the macroeconomic field of New Keynesian Economics. Efficiency wage, insider–outsider, and implicit contract models are but a few of the new ideas of this literature.[16] At a more basic level, employment data often preclude the treatment of labour as homogeneous. Like trade data, employment data also raise the issue of heterogeneity in relevant markets. Chapters 14 and 15 are devoted to modeling employment in general equilibrium. The chapters will introduce you to some of the possibilities for and implications of incorporating these New Keynesian ideas about labour markets into general equilibrium trade models.

While the relation of trade to employment is a concern with a long history, that of trade and the environment is a concern both recent and intense. When the employment and environment issues coalesce on a particular trade matter, such as the North American Free Trade Area, policy analysis becomes highly politicized. Politics aside, though, the microeconomics of trade and the microeconomics of externalities and depletable resources are fully compatible.[17] It is, for example, quite clear that environmental externalities can yield consequences for the efficiency gains from trade.

Chapter 16 begins with the recognition that the transfer of environmental effects among countries is embodied in trade patterns. It takes up the case of the trade relationship between Japan and Indonesia. In this chapter, you will see how it is possible to make use of environmental satellite accounts, in

16 For a collection of central articles in this field, see Mankiw and Romer (1991).
17 For a collection of papers on the analysis of trade and the environment, see Anderson and Blackhurst (1992).

addition to the SAM framework developed in Chapter 4, in calibrating a general equilibrium trade model with multieffluent components. You will also be introduced to a measure of embodied effluent trade, which can help to establish the extent to which environmental costs have been transferred from one country to another. In this particular case, there is a negative link between trade and the environment for Indonesia, and a variety of policies are examined for mitigation of the pollution intensity of Indonesian production.

Our hope is that Part IV will have, at the least, demonstrated to you the wide array of extensions to standard trade policy modeling which are possible. This should allow you to develop your own research program at the Trade Ministry in light of the issues that appear to be most important in that context.

V Parameterization

Over a decade ago, Dale Jorgenson (1984) made the following statement:

> The development of computational methods for solving nonlinear general equilibrium models . . . has been the focus of much recent research. By comparison the development of econometric methods for estimating the unknown parameters describing technology and preferences in such models has been neglected. (p. 139)

In our view, the state of affairs described by Jorgenson is as much a reality today as it was a decade ago. Our own explanation for this phenomenon is that the profession of economics in general and international trade in particular does not value "nut and bolt" empirical work to the extent it values new twists on old theoretical insights. That said, we do want to familiarize you with the econometric literature that does exist and is most relevant to your mission at the Ministry.

To begin, we will describe the ideal approach, represented by Jorgenson's modeling efforts. Jorgenson has constructed a dynamic model of the United States economy which has been applied to trade as well as other issues (Ho and Jorgenson, 1994). The methodology used for estimating the behavioural parameters of this model is presented in Jorgenson (1984). Jorgenson develops a time series of SAMs and then estimates the behavioural parameters of his model from them on the basis of translog functional forms. Without commenting on the translog function itself, it is clear that the time series of SAMs approach has advantages. It represents a consistency extended across time which the single SAM imposes across sectors and institutions. One drawback to the approach is that it is intensive in research resources. A second drawback is that it locks in a particular sectoring scheme, precluding the flexible aggregation approach described in Section II. For these reasons, most trade policy analysts have chosen to focus on the most crucial components of their model for econometric estimation, taking the remainder of their behavioral parameters from the literature. Further, in the estimation of the crucial parameters, the analysts typically construct time series of the relevant variables only, rather than of the entire SAM.

What is the most crucial parameter for trade policy modeling? If a small sample of available studies reveals a preference of modellers, it seems that emphasis is placed on the magnitude of elasticities of substitution between imports and domestic competing goods. This is because these elasticities are the nexus between trade policies on the import side and the domestic economy; an early study that estimated these elasticities was Alaouze, Marsden, and Zeitsch (1977). A more recent series of studies began with Shiells, Stern, and Deardorff (1986); these authors estimated the elasticity of substitution or Armington elasticity between imports and domestic competing goods for the United States, accounting for the simultaneity of the import demand and supply. Reinert and Roland-Holst (1992) also focused on the United States and explicitly utilized the CES functional form for preferences, the Armington assumption. This was also done in the context of the North American Free Trade Area by Shiells and Reinert (1993) and Reinert and Shiells (1992). These authors also employed the Armington assumption but disaggregated U.S. imports into those from Canada, Mexico, and the rest of the world. A summary table of Armington elasticities from Reinert and Roland-Holst is provided in the Appendix to Chapter 5.

Alston et al. (1990) compared the CES functional form with the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980). In the context of some specific agricultural commodities, these authors found that the elasticity of substitution between imports and domestic competing goods in the United States was substantially higher in the AIDS estimation. Shiells, Roland-Holst, and Reinert (1993) estimated an AIDS system for U.S. imports from Canada, Mexico, and the rest of the world but encountered regularity problems. A general equilibrium trade model of United States–Mexico free trade which employs the AIDS import demand formulation can be found in Burfisher et al. (1994).

As stated in Section IV, trade under imperfect competition has become increasingly important during the last decade or so. A part of this importance reflects a concern for the role of scale economies in determining the effects of trade policies. In calibrating a trade model with scale economies, it is necessary to incorporate some information on the extent to which scale economies actually exist. Failure to incorporate high-quality information on scale economies can lead to misleading policy simulations.

Scale economies are typically measured by using what are known as cost disadvantage ratios. The cost disadvantage ratio is related to the scale efficiency parameter, S, which measures the extent to which the average cost (AC) curve lies above the marginal cost (MC) curve: $S = AC/MC$. The cost disadvantage ratio is then defined as $CDR = 1-(1/S) = 1-(MC/AC)$. If MC is assumed to be constant, $CDR = FC/TC$, where FC denotes fixed cost and TC denotes total costs. De Melo and Tarr (1992) discuss the means by which the CDR is used to calibrate a general equilibrium trade model with scale economies; their estimates of CDRs for the U.S. automobile and steel industries are based on selected industry studies.

For more sectorally comprehensive models, Harris (1986) reports scale efficiency parameters for Canada "based on reported econometric values from the literature" (p. 236). Sobarzo (1994) reports scale efficiency parameters for Mexico. Haaland and Tollefsen (1994) report information on returns to scale for a four-region (European Union, European Free Trade Agency [EFTA], United States, Japan) trade model. Pratten (1988) conducts a survey of engineering estimates of minimum efficient scale by industry for the European Union. Francois, McDonald, and Nordström (1995) and Harrison, Rutherford, and Tarr (1995) utilize figures from Pratten to calibrate CDRs in models of the Uruguay Round. Francois et al. also provide sensitivity testing of their results for both Armington and scale elasticities. In models of trade based on monopolistic competition, the scale elasticity plays a similar theoretical role to the substitution elasticity in Armington models. Not surprisingly, therefore, depending on model specification, the range of numerical results is highly sensitive to both sets of parameters. If one follows the chain of references in various studies, it turns out that most scale elasticity estimates can be traced to a small family of engineering studies centred on the 1960s and 1970s. This leaves us somewhat uneasy about the robustness of scale-based estimates.

A further elaboration on the theme of scale economies is based on the new growth theories, which emphasize trade- and production-based dynamic externalities. Yang (1993) has examined the Uruguay Round in a model of trade-based externalities, while Keuschnigg (1995) emphasizes innovation-based externalities. The literature on imperfect competition points, in reduced form, to factors that suggest static, external scale economies on a regional and global basis. The new growth literature highlights a number of factors that, in reduced form, point to a similar set of dynamic externalities. As for static scale effects, the incorporation of dynamic scale effects in numerical models, in a credible matter, must be built on solid empirical evidence of such dynamic externalities. In our view, recent advances in trade theory, related to both imperfect competition and trade-related growth mechanisms, strengthen the need for empirical research aimed at parameter estimation.

VI Some Final Comments on Transparency

It is important to keep in mind that the methods covered in this book are not economic forecast tools. Rather, they represent extensions of other forms of economic analysis, including theory, statistical description, qualitative analysis, and even simple insight. All models, applied and theoretical, are incomplete by definition. They are deliberately simple representations of a complex world, designed to let us focus on possible interactions in a subset of important elements. The advantage applied modeling offers is that we are able to combine real world data with formal theory as part of the mix of inductive and deductive reasoning that makes up economic analysis. In the process of policy analysis, the construction and use of models will both influence, and be influenced by, these other approaches to economic method. Having said this, the reader should also be aware that the results of numerical analysis can take on a life of their own when released into a policy environment. Very rough guesses can be marketed as precise estimates, packaged with interpretations unanticipated or unintended by the original analysts. In such a situation, the limitations of the original analysis are easily (and sometimes deliberately) forgotten. For this reason, it is very important that the nature of the analytic exercise be kept in mind, and be transmitted (as often as necessary) to the relevant policy audience. Transparency is critical.

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