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APPLIED GENERAL EQUILIBRIUM MODELS: THE MEXICAN EXPERIENCE OF NAFTA

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DOCUMENTO DE TRABAJO

Núm. I - 1998

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The Mexican Experience of NAFTA*

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*Seminar on Migration, Free Trade and Regional Integration in North America, organised by the OECD and the Mexican authorities with the support of Canada and the United States, Mexico City, 15-16 January 1998.

SUMMARY

This paper reviews the use of the applied general equilibrium (AGE) approach to evaluate economic integration, in particular the recent use of AGE models to analyse the likely impacts of NAFTA on the Mexican economy. Although references to specific results are made, the object of the paper is to offer general comments concerning the main characteristics of these models, pointing out both their merits and their weaknesses.

An obvious strength of general equilibrium models over partial equilibrium models is their ability to incorporate interactions between all the main markets and agents in the economy. In addition, it is argued that the dynamic nature of these models also provides additional insights.

However, the results that emerge from these models are heavily dependent on the model's behavioural assumptions as well as the parameterisation of the model. The sensitivity of the models to variations in specification may not only produce quantitatively different results but also conflicting conclusions.

One important implication of this and other weaknesses of the AGE technique is the issue of what these models are designed to achieve. The question is important because in policy debate the results of this kind of model are sometimes wrongly seen as forecasts. The models should instead be seen as an additional tool for policymakers who need to evaluate policy options.

Despite these difficulties, the paper points out that there is one area in which the AGE models for Mexico agree: the Mexican economy would benefit the most from the rationalisation process that NAFTA would in the long term produce. This consensus should be taken seriously by policymakers because it implies that the Mexican economy will experience a profound process of adjustment, particularly in the labour market. Whether or not these processes will occur is something that the models do not address and so, therefore, none of them model explicitly the possible adjustment paths. To do so would require a *fully* dynamic model. As has been suggested elsewhere and is assented to here, much of the future research work on AGE modelling should take this line of research as central.

APPLIED GENERAL EQUILIBRIUM MODELS
THE MEXICAN EXPERIENCE OF NAFTA

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1. Introduction

1. This paper presents some reflections on the use of the applied general equilibrium (AGE) approach to evaluate economic integration, taking as a point of reference the Mexican experience prior to the approval of NAFTA. Although some reference to specific results will be made, the intention is to offer some general comments about the main characteristics of AGE models, emphasising both their weaknesses as well as their merits. The document is structured as follows: section 2 outlines the basic principles of these models and their resolution; section 3 discusses very briefly the main applications as well as the main limitations of the approach and compares them with other models, such as macroeconometric models; section 4 outlines the main results of the models elaborated around the NAFTA experience; finally, section 5 presents the main conclusions and some implications for the modelling of economic integration.

2. Applied general equilibrium models

2. AGE models can be traced back to the work of Leontief based on fixed input-output coefficients. Unlike input-output models, however, AGE models allow for substitution both on the consumption and the production sides. The most well known analytical application in a two sector model was developed by Harberger (1962) to analyse issues related with fiscal incidence. In 1967 Scarf (1967) developed a computer algorithm which subsequently permitted a much detailed desegregation of these models. The work by Shoven and Whalley (1973) is perhaps the first example of a highly disaggregated AGE model dealing with tax reform.

3. During the 1970s and 1980s, a large number of models were developed for different countries, most of them focusing on tax and trade reforms.[1] In particular, numerous AGE models were built to analyse the effects of trade and tax reforms in developing countries, introducing great detail regarding the structure of income distribution and rigidities, presumed characteristic to these countries.[2] More recently, this kind of model has been used to explore the effects of ecological taxes.[3]

4. The structure of AGE models is very well documented elsewhere and therefore we will not go into the details of specific models. For the purposes of this document it will suffice to outline the underlying basic principles, regardless of the many different ways in which an AGE model can be specified.

5. The essence of these models consists in simulating together both supply and demands for every market and the solution of the model occurs when a vector of prices that clears all markets is found. Both

supply and demand are modelled through behavioural assumption of producers and consumers. Producers are normally modelled using a constant returns scale technology, sometimes allowing for some input substitution, mostly between domestic and imported commodities. Consumers have a initial endowment and demand functions for each of N commodities. These demands are a function of prices and income, and satisfy Walras' Law. Finally, producers are assumed to maximise profits whereas consumers are assumed to maximise utility.

6. Equilibrium is characterised by a set of prices and production levels such that demand equals supply in every market. It is therefore necessary to construct a initial or base equilibrium which is done by calibrating, for any year, a data base from national accounts, which normally include an input-output matrix describing the inter-industry transactions. To put all of the data base into a consistent framework requires a good deal of effort, particularly if the model is to incorporate a detailed production and consumption structure. Once the model reproducing the base equilibrium is calibrated, the experiments consist in changing the value of certain exogenous variables (for instance tariff rates), and finding the new vector of prices which clears every market. The resolution of the model is an iterative process where both producers and consumers react to prices until both find a vector such that profits and utility levels are maximised given the technological and income restrictions.

7. The description provided above is of course very simple. In practice the results depend on the behavioural assumptions of the model (such as functional forms) as well as the parameters (elasticities) chosen. For instance, one critical behavioural assumption is the choice of the so called closure rule. Another, is whether or not factor are mobile between sectors or whether factors are fully employed or not. The decisions concerning these behavioural assumptions can lead to very different, even opposite results. It is therefore important to bear in mind that the results of AGE models should be interpreted carefully, because their reliability is ultimately dependent on the choice of a reasonable set of assumptions. For instance, suppose that we have two models that are identical in every aspect except in their closure rule. If model A assumes a fixed exchange rate and a variable current account balance, while model B assumes a variable exchange rate and a fixed current account balance, and we remove tariffs as part of our experiment, the results will produce a very different allocation of resources. The reason is simple, in model A we assume that there is no foreign exchange restriction and therefore the adjustment of the economy is "easier" than the economy in model B where prices have to adjust assuming a foreign exchange restriction. Naturally, the welfare results in model A are not very useful because we are implicitly assuming that the economy can borrow abroad to cover any trade imbalance and the model does not tell us anything as to how this economy is to pay this debt in the future, which would surely reduce welfare. To fully address this issue a dynamic AGE model is required.

8. Finally, to complete this section two points should be mentioned. First, in general, most models explicitly incorporate the following economic agents: producers, consumers, a government and a foreign sector, often referred to as rest of the world. The common practice is to assume that governments collect taxes and then redistribute the resulting revenue in a lump-sum fashion. This is because of the difficulty of modelling public goods. Second, while most models built in the 1970s and 1980s were static and assumed perfect competition, in recent years there has been a growing number of models which incorporate some form of imperfect competition and/or some form of dynamic behaviour. It has to be said, however, that whereas static models are in some sense standard, when it comes to introducing dynamics and imperfect competition, a great number of behavioural assumptions are added and therefore is more difficult to get some kind of consensus regarding the results. Nevertheless, static models although very useful, do not answer such important questions as the mechanics of transition between equilibria, which are essential to understand, for instance, how labour markets adjust in a trade liberalisation process.

3. Main applications and limitations

9. As mentioned in the previous section, AGE models have traditionally been used to analyse trade and tax reforms and, more recently ecological tax reforms. Additionally, it is common to add some elements typical of a trade liberalisation process, such as capital flows. In general, however, AGE models address such issues as fiscal incidence, or more generally, incidence on real incomes. This is in fact the main attractiveness of this kind of model because, given that they incorporate dynamic effects, the resulting welfare change is in fact a measure of the changes in real income of economic agents. In other words, to the extent that these models explicitly incorporate the production and consumption structure and therefore the interaction of economic agents, the solution equilibrium, unlike partial equilibrium models, incorporates all effects. A simple example of this is in the literature of tax reform. Indeed, in a partial equilibrium model one normally has to assume, a priori, whether a particular tax is shifted forwards or backwards. This choice will crucially determine the results of the model. In AGE models, rather than being an assumption, this is a result.

10. While this characteristic is perhaps the main asset in favour of these models, it is perhaps also their main weakness given that the results are heavily dependent on the assumptions adopted by the modeller, beyond the problems of choosing a specific value for some parameters that normally are not empirically estimated. Yet partial equilibrium models implicitly assume certain economic behaviours; the famous "ceteris paribus" clause ultimately means that the modeller has also made a decision on behavioural assumptions, although these assumptions are not explicit. In that sense, the results of AGE models are very interesting because they are the outcome of a complete and explicit set of assumptions.

11. Having said that, it is important to make clear the main weaknesses of these models. The following are some of the most well known. First, the difficulties of choosing appropriate elasticities and other parameter values. Normally the values of these parameters are not available and therefore the modeller has to use estimated values that correspond to different levels of aggregation. This problem is perhaps less severe when a sensitivity analysis with different values is carried out.

12. A second difficulty arises because detailed micro-data sets are difficult to incorporate. In tax reforms models, for instance, this difficulty leads to problems when determining average and marginal tax rates, which are essential in the analysis of distributional effects.

13. A third problem is present to the extent that these models do not normally fully incorporate a financial framework, essential for saving decisions. Moreover, is common to treat savings as an aggregate while, in practice, it is very likely that the economy and agents are not neutral to the different savings instruments.

14. Finally, in models that incorporate dynamics and/or imperfect competition their resolution very quickly becomes complicated, resulting in much less desegregated models. More importantly, in these attempts to incorporate dynamics and imperfect competition there is far less agreement as to how sensible are the assumptions adopted. The result is that, in general, the economic processes of intertemporal behaviour, for instance, are still areas where economic theory provides insufficient explanations. The best example is perhaps endogenous growth theory which, although very appealing, still has a long way to go in explaining the mechanisms at work, not to mention to difficulty in measuring them.

15. One important implication not only of these weaknesses but more generally of the AGE technique is the issue of what these models are good for. The question is important because in the policymaking debate the results of this kind of model are sometimes wrongly seen as forecasts.

16. Indeed, AGE models are structural models, useful for policy analysis but should not be used for forecasting. The reason is that although they incorporate the whole structure of the economy they do not, unlike macroeconomic forecasting models, incorporate lagged processes of behaviour capturing expectations. In AGE models the focus is on the structure of the economy and the mechanisms at work. In other words, AGE are simulation models and therefore, their main attractiveness is that they provide a detailed description of adjustments resulting from economic changes. A good example of that are, for instance, models designed to analyse trade liberalisation. In this case, the results should not be seen as forecasts of trade deficits, for instance, but instead, the way to "read" these results is how resources have to be allocated to reach certain level of trade deficit. More generally, AGE models are good for describing adjustment processes resulting from determined economic changes. As such, they provide the policymaker with a general idea of how feasible some processes are.

17. While there seems to be general agreement on this point, in an interesting exercise Kehoe, Polo, and Sancho (1995) compared the results generated by an AGE model with the changes that actually occurred in Spain during the period 1985-86 and concluded that the model performed well in predicting the changes that actually occurred. They argue that AGE models can be used to make conditional forecasts with some accuracy. Perhaps this argument should be interpreted as saying that, provided AGE models are built with realistic assumptions, their simulations are also realistic and therefore it should not be surprising that they may be useful to make conditional forecasts. To be certain of the accuracy of the forecasts, however, one should be certain as to how realistic the set of assumptions adopted are. This is not always easy.

18. In summary, despite the weaknesses of AGE models and the questionable realism of their underlying behavioural assumptions, the central issue should not be whether they are right or wrong. Instead, they should be seen as an additional tool for policymakers who need to evaluate policy options.

4. The Mexican experience with NAFTA

19. In this section I would like to make a brief summary of the experimental use of AGE models to analyse the impacts of NAFTA, in particular as they concern Mexico. The models and their results have already been analysed and surveyed with great detail[4] and we shall therefore avoid repetition. Instead we will try to summarise the main findings and suggest how these simulations can be of some help in the debate on economic integration.

20. Prior to the approval of NAFTA, several models were built to evaluate the possible economic impacts. All of them were AGE models although each model focused on different aspects. Tables 1.1, 1.2 and 1.3, describe the main characteristics of these models, as reported by Francois and Shiells (1994).[5]

21. As can be seen, four models are multi-sector,[6] two of which are multi-country, whereas the other two refer to Mexico and Canada. Another four models are sector focused, and two more are dynamic models. In turn, of the four multi-sector models, three of them incorporate some form of imperfect competition.

22. In general, all of the models predict welfare gains for the three countries and it is also true that all of the models predict that Mexico will be the country that benefits the most. This last result should not be surprising for at least two reasons. First, of the three countries Mexico is the smallest and therefore opening up to trade means that Mexico benefits disproportionally from access to the common market. Second, according to these models the removal of distortions leads to more efficiency; prior to NAFTA, of the three countries Mexico was the most protected economy, especially if we consider that Canada and

the U.S. already had a free trade agreement. In numbers, the welfare gains for Mexico range from 1 to 5 per cent of GDP whereas United States would gain, according to these models, by no more that 0.1 per cent of GDP. Moreover, according to the results of these models, labour disruption in the United States does not seem to be important.

23. Another important point is that according to the models that incorporate some form of imperfect competition, welfare gains to the three countries are greater than those predicted by models assuming perfect competition. Again, this result assumes that countries -especially Mexico- can exploit scale economies. This contrasts with the results of traditional models where welfare gains from trade liberalisation are normally inferior to one percent of GDP, even in countries like Mexico.

24. Turning to the sector focused models, perhaps the principal suggestion of the models focusing on agriculture is that the effects on labour migration may be large, which would suggest to policymakers that some form of adjustment program may be necessary. The study of the auto sector suggests that the Mexican industry may be in need of an deep process of restructuring. Finally, the model on textiles indicates that the United States could lose unless this country relaxes its quotas.

25. The results of the dynamic models indicate that welfare gains could be larger than those predicted by static models. These gains could come from a liberalisation of the capital goods sector, which in turn would increase investment. Moreover, while the empirical evidence is much weaker, Kehoe argues that if there is learning by doing, welfare gains could be substantially larger than those predicted by conventional static AGE models.

26. Beyond the quantitative results of the AGE models, which depend on the assumptions adopted by the modellers, there would appear to be agreement on the fact that the Mexican economy would benefit the most from the rationalisation process that NAFTA would in the long term produce. This consensus should be taken seriously by policymakers because it implies that the Mexican economy will experience a profound process of adjustments, particularly in the labour market.

27. Considering the point made above in relation to the way to "read" these models, my own experience leads me to argue that the lesson from this modelling experience is not so much to maintain that, as a result of NAFTA, Mexico will automatically obtain welfare gains from 1 to 5 per cent of GDP. Rather, the results suggest that if Mexico wants to have a substantial welfare gain from NAFTA, it has to go through a process of labour market reform, among other reallocation processes. Whether or not these processes will occur, is something that the models do not address.

28. Two final points are in order. First, very often in the political debate it is argued that the AGE models were perhaps too optimistic, especially if Mexico's present economic situation is considered. Such line of argument, however, is, in my opinion, "unfair", because the models were built to answer a very specific scenario. Moreover, the results of these models should be seen as taking place in the long run, which should be at least as long as the duration of the implementation of NAFTA, which is between 10 to 15 years. In this respect, it is perhaps convenient to remember the point made by Francois and Shiells (1994):

> *"Canadian public perception of CAFTA suggests strongly that NAFTA will be blamed, at least in some circles, for most -if not all- negative economic shocks experienced during or following implementation. Because this 'scapegoat' effect is not necessarily linked to real effects or developments, governments in all three countries need to be prepared to deal with pressure for adjustment assistance and related trade remedies, not only for NAFTA-induced structural adjustment, but also for those blamed erroneously on NAFTA. To support this point, one only*

needs to look to Canada, where mainstream parties have blamed the global recession on CAFTA. In a similar vein, structural adjustments in the United States associated with micro-imbalances are often attributed to 'unfair trade' in individual sectors, rather than to the broader macro-environment."

29. The second point to mention is that although the models suggest strong adjustment processes in the Mexican labour market, none of them modelled explicitly the possible adjustment paths. To do that requires a fully dynamic model. Indeed, as Kehoe (1995) suggested, much of the future research work on AGE modelling should take this line of research as central.

5. Conclusions

30. Perhaps the main conclusion of this document is that despite their weaknesses, AGE models are a very useful instrument for policymakers to the extent that provide them with an extra tool with which to evaluate policy options. This tool should no be seen as alternative to macroeconometric models but rather, as a good complement. The purpose of macroeconometric models is to make forecasts based on lagged processes of behaviour whereas AGE models try to describe the adjustment of the economy resulting from a particular change(es). To the extent that AGE models are reasonably built, with realistic assumptions, their results should be seen only as conditional forecasts. Only in this very narrow sense do both approaches coincide.

31. The recent development of numerical algorithms and the rapid increase in computer power now permit the resolution of large and sophisticated models. Yet, when it comes to modelling dynamic behaviour a very wide range of modelling possibilities are opened and there seems to be an ongoing discussion as to which modelling strategy is best. This situation can perhaps be explained by the fact that economic theory itself is still relatively undeveloped in this area.

NOTES

1 See Shoven and Whalley (1984) for a very detailed survey on these models.

2 Dervis, de Melo y Robinson (1982) provide a very rich discussion on the use of AGE models in developing countries.

3 See, for instance, Whalley and Wigle (1991).

4 See Francois and Shiells (1994) and Kehoe and Kehoe (1995).

5 For a model focused on agricultural policies and migration see Robinson and Hinojosa (1991). More generally, a good description of modelling results on labour market effects is on Hinojosa and Robinson (1993).

6 The number of sectors are from 12 to 27.

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Table 1.1. Summary of Demand and Production Structure

Model	Country (ies)	Demand Side		Production Side	
		Demand Functions	Disaggregation	Production Functions	Disaggregation
Multisector Models					
Brown	Home and Foreign	2-level utility functions: 1-Cobb-Douglas between composite goods 2-CES between firm varieties	1 consumer in each country	CES function of capital and labor for fixed and variable inputs	2 composite goods
Cox	Canada	Domestic final demand: 2-level utility functions 1-Cobb-Douglas between composite goods. 2-CES between national varieties Foreign final demand: Derived from CES utility functions between national varieties	1 consumer in each region (Canada, U.S., Mexico, and ROW) buys goods from each region	Fixed costs in imperfectly competitive industries are linear functions of labor and capital input prices. Unit variable costs are Cobb- Douglas functions of labor, capital, and intermedite inputs	19 production sectors in Canada
Roland-Holst, and Shiells	Canada Mexico U.S.	2-level utility functions 1-LES between composite goods 2-CES between national varieties	1 consumer in each country	CES value-added functions of labor and capital inputs; gross output is a CET function of domestic sales and exports to each region; fixed coefficient use of intermediate goods	26 production sectors in each country
Sobarzo	Mexico	2-level utility functions 1-Cobb-Douglas between composite goods 2-CES between national varieties (Mexico, other North America, and ROW)	1 consumer	Cobb-Douglas value-added functions of labor and capital inputs; fixed coefficient use of intermediate goods; fixed coefficients between intermediate inputs and value added	27 production sectors in Mexico
Young and Romero	Mexico	Cobb-Douglas preferences between consumption goods sectors; imports and domestic products are perfect substitutes	1 consumer	2-level cost functions 1-traslog functions of prices of labor and composite intermediate goods and rental fee on composite capital 2-composite capital price is a translog function of capital goods prices; composite intermediate price is a Cobb- Douglas function of intermediate goods prices	9 consumption goods and 3 capital goods sectors
Sector-Focused Models					
Burfisher, Robinson and Thierfelder	Mexico U.S.	2-level utility functions 1-Cobb-Douglas between composite goods 2-Almost ideal demand system between national varieties (Mexico, U.S., and ROW)	1 consumer in each country	CES value-added functions of primary factors (4 labor types, capital, and agricultural land); domestic outputs is a CET function of domestic sales and exports to each region; fixed coefficient use of intermediate goods	11 production sectors (4 farm and 1 food processing) in each country
Levy and van Wijnbergen	Mexico	3-level utility functions 1-Cobb-Douglas between 3 goods (industry, services, and a composite agricultural good) 2-CES between 5 rural goods 3-CES between raw corn and tortillas Imports and domestic goods are perfect substitutes	6 household types	Cobb-Douglas value-added functions of primary factors (2 labor types, 2 capital types, and 3 land types); mostly fixed coefficient use of intermediate goods; exogenous rate of Hicks-neutral technical change	7 production sectors (5 agricultural)

Table 1.1 (continued)

Model	Country (ies)	Demand Side		Production Side	
		Demand Functions	Disaggregation	Production Functions	Disaggregation
Multisector Models					
Lopez-de-Silanes, Markusen, and Rutherford	Canada Mexico U.S. ROW	3-level utility functions 1-Cobb-Douglas between composite autos and a composite of other goods 2-CES between composites of autos produced by different firm types (U.S. and ROW ownership) 3-CES between varieties of autos produced by different firms of each type	1 consumer in each region (Canada, Mexico, U.S., and ROW)	Final assembly of autos: Multinational producers; fixed cost plus constant marginal cost Auto parts: 2-level CES 1-CES production function between national composites 2-CES production function between firm varieties; fixed cost plus constant marginal cost Engines: One engine per car; engines are produced using capital and labor at constant cost	4 production sectors (Final assembly, parts, engines, and other goods) in each of 4 regions (Canada, Mexico, U.S., and ROW)
Trela and Whalley: Steel	Canada Mexico U.S. ROA	CES utility function between 3 goods (steel producing sector, steel consuming sector, and all other goods); domestic production and imports from each of 3 regions (Canada, Mexico, and ROA, a 22-country aggregate of other non-VRA countries) are perfect substitutes	1 consumer for each region (Canada, Mexico, U.S. and ROA)	Domestic production: CES value-added functions of labor and capital inputs; fixed coefficients between intermediate inputs and value added Foreign production: CET function between output of 3 production sectors	3 production sectors (steel producing, steel consuming, and other) in each region.
Trela and Whalley: Textiles and Apparel	Canada Mexico U.S. ROA	3-level utility functions 1-CES between a composite of all textile and apparel products and a composite of all other goods 2-CES between a composite of all textile goods and a composite of all apparel goods 3-CES between MFA-restricted and unrestricted goods Domestic production and imports from each of 3 regions (Canada, Mexico, and ROA, a 33-country aggregate of other supplying MFA countries) are perfect substitutes	1 consumer for each region (Canada, Mexico, U.S., and ROA)	3-level production possibilities frontiers 1-CET between a composite of all textile and apparel products and a composite of all other goods 2-CET between a composite of all textile goods and a compsite of all apparel goods 3-CET between MFA-restricted and unrestricted goods	4 production sectors in each region

Source: Joseph P. Francois and Clinton R. Shields, *Modeling Trade Policy*, Cambridge University Press, 1994, pp.16-19, Table 1.1.

Table 1.2 Summary of Market Structure and Model Closure

Model	Market Structure		Model Closure		
	Firm Behavior	**Entry and Exit**	**Balance of Payments**	**Capital Market**	**Labor Market**
Multisector Models					
Brown	Monopolistic competition with Berthand pricing	Free	Walras'Law implies the current account is in equilibrum	Fixed aggregate capital stock: perfectly mobile between sectors; immobile internationally	Fixed aggregate labor supply; perfectly mobile between sectors; immobile internationally
Cox	Imperfectly competitive industries use a weighted average of Eastman- Stykolt and monopolisticall- competitive pricing	Free	Walras'Law implies the current account is in equilibrum	Fixed rental rate on capital services; perfectly mobile between sectors and internationally	Fixed aggregate labor supply; perfectly mobile between sectors; immobile internationally
Roland-Holst,Reinert and Shiells	Perfect competition, average cost pricing due to constable markets, or cournot markup pricing	Free under Cournot	Trade balance is equal to net foreign borrowing	Fixed aggregate capital stock; perfectly mobile between sectors; immobile internationally	Fixed wage rate; perfectly mobile between sectors; immobile internationally
Sobarzo	Imperfectly competitive industries use monopolisticall y-competitive pricing	Free	Variable trade balance and fixed real exchange rate	Fixed world rental rate on capital services: perfectly mobile between sectors and internationally	Fixed aggregate labor supply; perfectly mobile between sectors; immobile internationally
Young and Romero	Perfect competition	Free	Walra's Law implies the current account is in equilibrium	Exogenous world prices of machines and vehicles, use transferable between sectors and internationally; exogenous supply of building, use transferable between sectors but not internationally	Exogenous aggregate labor supply; mobile between sectors within specified bounds; immobile internationally

Table 1.2 (continued.)

Model	Market Structure		Model Closure		
	Firm Behavior	Entry and Exit	Balance of Payments	Capital Market	Labor Market
Sector- Focused Models					
Burfisher, Robinson, and Thierfelder	Perfect competition	Free	Current account balance is equal to net foreign savings	Fixed aggregate capital stock; perfectly mobile between sectors; immobile internationally	Fixed aggregate supply of each labor type; perfectly mobile between sectors; labor markets are segmented and linked through migration
Lwvy and van Wijnbergen	Perfect competition	Free	Walra's law implies that trade is balanced in equilibrium	Exogenous rate of growth of sector-specific capital;immobile internationally	Exogenous rate of growth of rural and urban labor types; labor markets are segmented and linked trough migration
Lopez-de-Silanes, Markusssen and Rutherford	Final assembly: Multinational firms employ a Cournot markup rule Parts: Monopolistic competition with Berthand pricing Engines: Intra-firm production under constant cost	Free	Walra's law implies that trade is balanced in equilibrium	Capital used in parts and other goods differs from capital used in auto assembly and engine production Capital is perfectly mobile between parts and other goods but immobile internationally Capital used in auto assembly and engines has some mobility between sectors and internationally	"Labor" is a composite of all factors that are perfectly mobile between sectors and immobile internationally
Trela and Whalley: Steel	Perfect competition	Free	Trade balance is Zero and steel exports to the U.S. are quota- constrained	Fixed aggregate capital stock; perfectly mobile between sectors; immobile internationally	Fixed aggregate labor supply; partially mobile between sectors, with external adjustment costs of moving between sectors; immobile internationally
Trela and Whalley: Textiles and Apparel	Perfect competition	Free	Trade balance is zero and some categories of textile and apparel trade are quota- constrained	Capital market is implicit only, due to use of the CET production possibilities frontier	Labor market is implicit only, due to use of the CET production possibilities frontier

Source: Joseph P. Francois and Dlinton R. Shielda, ***Modeling Trade Policy***, Cambridge University Press, 1994, pp. 22-24, Table 1.2.

Table 1.3. Sources of Data and Elasticities in the Models

Model	Year(s) Replicated	Extraneous Use of Elasticities	Production Data	Demand Data	Trade data
Multisector model					
Cox	1981	Elasticities of substitution between national varities (4 spefifications for sensitivity analysis), and inverse scale elasticities	Statistics Canada input- output tables, Statitics Canada data on number of firms, capital stocks, and non-capital variable costs	Input-output tables	Input- output tables
Roland-Holst, Reinert, and Shiells	1988	Elasticities of substitution between national varieties (own estimates), elasticities of substitution between capital and labor, elasticities of transformation between domestic supply and exports, and cost disadvantage ratios	Social accounting matrix (own construction)	Social accounting matrix	Social accounting matrix
Sobarzo	1985	Elasticities of substitution between national varieties, export demand elasticities, and inverse scale elasticities	Social accounting matrix (own construction)	Social accounting matrix	Social accounting matrix
Young and Romero	1992- 2002	Translog cost function parameters (own estimates)	INEGI National Accounts and input-output tables, banco de Mexico capital stocks	National Accounts	National Accounts
Sector Focused Models					
Burfisher, Robinson, and Thierfelder	1988 (Mexico) 1987 (U.S.)	Almost ideal import demand system calibrated based on expediture and substitution elasticities, elasticities of transformation between domestic supply and exports, export demand elasticitires for the rest of the world	Social Accounting matrices (own construction)	Social Accounting matrices	Social Accounting matrices
Levy and van Wijnbergen	1991- 2000	Elasticity of substitution between corn and basic grain in livestock production, aggregate supply elasticity for maize, elasticities of substitution between 5 rural goods in household demand, elasticities of substitution between raw corn and tortillas in household demand, rural-urban migration elasticities, inter-temporal substitution elasticity	Social Accounting matrix (own construction)	1984 Income-Expenditure Survey and social accounting matrix	Social accounting matrix
Lopez-de-Silanes, Markussen, and Rutherford	1989	Elasticities of labor supply to firms, elasticities of scale (from engineering studies)	Labor shares of value-addeed, production of autos, engines, and parts by region, and GDP	Consumer auto price indices	Matrix of trade flows between regions in autos, engines, and parts

Table 1.3 (continued)

Model	Year(s) Replicated	Extraneous Use of Elasticities	Production Data	Demand Data	Trade data
Multisector Models					
Trela and Whalley: Steel	1986	Elasticities of substitution between labor and capital are based on a literature search, CES and CET parameters are set to 1 (6 specifications for sensitivity analysis)	UN, U.S. Department of Commerce, UNIDO, USITC	Consumption is determined as a residual, from production and net trade data	U.S. Department of Commerce, USITC
Trela and Whaley: Textiles and Apparel	1986	Elasticities of substitution and transformation at each of 3 levels (7 specifications for sensitivity analysis)	UN, U.S. Department of Commerce, World Bank	Consumption is determined as a residual, from production and net trade data	U.S. Department of Commerce and Canadian Department of External Affairs

Source: Joseph P. Francois and Clinton R: Shields, *Modeling Trade Policy*, Cambridge University Press, 1994, pp. 25-27, Table 1.3

Note: Brown's model is not included in this table because it is not calibrated to the actual world economy.