A GENERAL EQUILIBRIUM ANALSIS OF THE WELFARE AND EMPLOYMENT EFFECTS OF US QUOTAS IN TEXTILES, AUTOS AND STEEL

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A GENERAL EQUILIBRIUM ANALYSIS OF THE WELFARE AND EMPLOYMENT EFFECTS OF US QUOTAS IN TEXTILES, AUTOS AND STEEL

by

David Tarr

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The usual caveat, that any errors that may remain are the responsibility of the author, applies.

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EXECUTIVE SUMMARY

The postwar period has witnessed two conflicting trends in U.S. policy toward imports. On the one hand, the U.S. has been a vigorous supporter of multilateral efforts through the General Agreement on Tariffs and Trade (GATT) to lower tariff rates. On the other hand, the U.S. has imposed nontariff barriers such as quantitative restraints (QRs) on selected products that limit the amount of imports from particular countries, part of the so-called "New Protectionism." This report concludes that this new protectionism has completely reversed the progress towards free trade made under the GATT, resulting in substantial costs to consumers.

Using an approach that encompasses the economy-wide impacts of trade restrictions, this report assesses the effects on consumers and workers of the QRs granted to the domestic automobile, steel, and textile and apparel industries.[1] As a result of imposing QRs in these industries, imported car prices are estimated to increase by 23 percent, steel prices by 7 percent, and textile and apparel prices by more than 40 percent. The total costs to consumers of these restrictions are estimated to be $20.9 billion per year, equivalent to an overall tariff rate of 25 percent. That is, the report estimates that if the QRs on automobiles, steel, and textiles and apparel were removed and replaced by an average tariff rate of 25 percent on all imports, there would be no net effect on U.S. consumers. By contrast, the average tariff rate on all imports has declined between 1946 and 1987 from 10.3 percent to 3.5 percent. Indeed, the last time the average tariff rate in

[1] The approach used in this report is based on conditions that prevailed in the year 1984. Our estimates of the effects of the QRs are therefore expressed in terms of 1984 values.

the U.S. was at least 25 percent occurred prior to the Second World War. Thus, the rise of nontariff protection has negated the various rounds of multilateral tariff reduction advocated by the U.S. through the GATT.

The primary reason the QRs are so costly is because the U.S. government unilaterally gives away a valuable right to foreign countries--the right to export a quota-restricted product to the United States. The QR supply restrictions cause import prices to increase, and through these higher prices foreigners capture higher profits. These profits, which are estimated to equal $14.21 billion per year for autos, steel, and textiles and apparel combined, represent more than two-thirds of the total costs of the QRs to U.S. consumers. Since the profits are income transfers from the U.S. to foreign countries, the U.S. could maintain the same degree of protection for these industries and reduce the overall costs of the QRs if it adopted a policy of auctioning the quota rights. By adopting such a policy, the U.S. government would realize additional revenue of $14.21 billion annually (and thus reduce the costs of the QRs to U.S. consumers by a corresponding amount).

The QRs also distort the flow of U.S. exports and imports. At the same time that the QRs curb imports of automobiles, steel, and textiles and apparel, they also reduce U.S. exports. The export industries that are the major losers are general manufacturing, agriculture, and traded services. We estimate that the QRs reduced general manufacturing exports by $4.45 billion per year, agricultural exports by $1.12 billion per year, and traded services exports by $1.08 billion per year.

The approach used in the report provides an opportunity to assess the industry-specific employment effects of the QRs under the alternative assumptions of fixed and varying total employment. Under both assumptions, the estimated number of jobs protected by the QRs in automobiles, steel, and textiles and apparel is about 172,000.[2] However, the higher prices of goods in the protected industries generate reductions in jobs and output in the unprotected sectors, the main losers being general manufacturing, services, consumer goods, and agriculture. Assuming a fixed total level of employment, it is estimated that general manufacturing loses 79,000 jobs, service industries lose 56,000 jobs, consumer goods industries lose 17,000 jobs, and agriculture loses 14,000 jobs. With varying total employment, general manufacturing loses 74,000 jobs, service industries lose 40,000 jobs, consumer goods industries lose 16,000 jobs, and agriculture loses 13,000 jobs.

This study also assesses the argument advanced by some that in addition to preserving jobs in the protected industries, QRs have a substantial positive effect on overall employment in the economy. Permitting the total level of employment to vary, the QRs are estimated to result in a maximum overall employment gain of 44,000 jobs, which is less than one-half of one percent of the total work force.[3]

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[2] The overall protective effect of the three QRs combined is to raise net employment in the auto, steel, and textile industries by 172,000 workers. Employment in the steel and textile industries is higher, by 16,000 and 158,000 workers respectively. But employment in the automobile industry is lower, by 2,000 workers. The reason auto employment is lower is due primarily to the fact that the QRs on steel and textiles increase raw materials costs to automakers, which forces them to curb domestic auto production.

[3] If this were not the case, the number of jobs preserved in the protected industries by the QRs would be exactly offset by the number of job reductions in other economic sectors. The total number of job reductions in the unprotected industries would rise from 129,000 to 172,000.

The reason why aggregate employment increases with the QRs is that QRs reduce the average real income of workers who now have to work more than before to purchase more expensive automobiles, steel, textiles and apparel, and other goods that use these products as inputs. Some individuals who initially choose not to work would find it necessary to join the work force; others who are already working would put in longer hours -- working overtime or taking a second job. The annual consumer costs of each one of these additional full-time equivalent economy-wide jobs (brought about through the sacrifice of leisure) is estimated to equal approximately $800,000.

This report finds no support for the argument that protection of high wage industries, such as autos and steel, increases the average wage in the economy as a whole. The contention is that in the absence of special protection to high wage industries, workers would have to shift to low paying jobs, e.g., in the service sector, what the report refers to as the "McDonalds" effect. This report finds no support for the McDonalds effect. Indeed, if the QRs were removed, the average wage rate in the economy would increase slightly, by 0.04 percent.

Removing the QRs would cause adjustment costs for those workers who were displaced from their former jobs. These adjustment costs can be measured by the earnings lost by displaced workers. Over a six year period the present value of these losses totals $1.64 billion. But the present value over six years of the gains to consumers of removing the QRs is $106.6 billion. The consumer benefits of removing the QRs far exceed the losses incurred by displaced workers.

The methodology used in this study makes it possible to trace the full effects of QRs throughout the entire economy by accounting for the interdependence among various industries.[4] A number of previous studies of QRs were not designed to trace the effects of QRs so broadly. Instead, the task of these earlier studies was to estimate the direct costs to consumers and benefits to workers from the imposition of QRs in particular industries. As valuable as these studies are, they ignored the indirect effects of the QRs on workers in other, related industries, and on consumers of the products of them. For example, the direct effect of a QR on steel is to raise prices of steel in the U.S. The higher prices impose added costs on U.S. industries that use steel as a raw material. The indirect effects of the QR on steel include the effect of these higher costs on the ability of U.S. producers using steel (say automakers) to sell in competition with imports (imported autos). As U.S. producers lose sales, they not only buy less steel, they also buy less from a wide variety of other domestic industries, such as glass, paper products, plastics, and textiles. In turn, these other industries reduce their orders for the raw materials they require, which may also include adverse feedback effects on the domestic steel industry. By not taking into account these indirect and feedback effects, the increase in output and employment in the domestic steel industry from the imposition of a QR on steel could be overstated. The present study takes into account both the direct effects of the QRs as well as the indirect and possible feedback effects of the QRs in autos, steel, and textiles and apparel.

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[4] The methodology uses a Computable General Equilibrium (CGE) model for the U.S. economy. This is a relatively new methodology in contrast to the older partial equilibrium methodology, which typically focusses narrowly on a particular industry or market.

CHAPTER 1

SUMMARY OF RESULTS

1.1 Introduction

With the rise in the trade deficit of the United States (US), issues related to protecting US markets have risen in importance. Traditionally, protection has been viewed as a concession to a particular industry that benefits at the expense of the rest of the economy. This view is now being challenged. Widespread protection is now being considered as a vehicle for increasing US welfare, employment and real wages.

The method that economists normally employ to analyze protection in a particular industry (partial equilibrium (PE) analysis) is not well suited for analyzing changes over a wide range of industries. Moreover, PE analysis cannot provide estimates of the impact of quota removal on many variables of interest to policymakers, such as employment by industry or the real wage. Thus, this study develops a computable general equilibrium model (CGE) of the US economy to analyze trade policy. We name this model the US General Equilibrium Trade Model (USGETM). All of the trading partners of the US are aggregated into a single region called the rest of the world (ROW).

In recent years several economists have constructed CGE models to study particular policy issues in the US or other countries.1/ Our USGETM builds on these earlier models, and is a fairly standard application of existing CGE methodology. It is, however, particularly well suited to

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1/ See for example, Ballard, Fullerton, Shoven, and Whalley (1985), Deardorff and Stern (1983), Dervis, de Melo and Robinson (1982), Harris (1984) and Whalley (1985).

handle the full array of international trade policy issues relevant to the US, especially when nontariff barriers generate quota rents captured by foreigners.

The three most significant industries in which the US has maintained quantitative restaints (QRs) on imports in recent years are: textiles and apparel, automobiles and steel. In 1984, the year for which the data set of the model was developed, QRs on textiles and apparel and autos were in effect, and those on steel were being negotiated. In order to assess the effects of a widespread change in quotas, we ask what would be the welfare and employment effects to the US, if it removed QRs on all three industries simultaneously. We also analyze the welfare and employment effects of QR removal in the three industries separately.2/

The method by which the US administers the QRs is very important in assessing their welfare impact. In the three industries mentioned, the US has allowed foreign governments the right to administer the quota. This has allowed foreigners to capture higher prices and profits on their allowed sales in the US. These higher profits on sales in the US are known as quota rents. The effects of maintaining the QRs, but with US residents capturing the quota rents are also estimated.

1.2 Welfare Effects

All welfare estimates were derived for a range of elasticities (low, central and high). In this summary, we only report the results based on the central, or best estimate, elasticity case. These are presented in

2/ The welfare changes are assessed through the Hicksian equivalent variation. See chapter 8 for an intuitive explanation of this measure, and chapter 3 for its formal derivation.

table 1.1. The annual benefits to the US of removing QRs in all three industries simultaneously is $20.9 billion. Thus, the US would gain an amount slightly greater than one-half of one percent of its gross national product from quota removal in these three industries.

An alternate policy that we consider is where the US retains QRs in all three industries, but administers the quotas such that it captures the quota rents. Auctioning of the rights to import the product into the US, with proceeds going to the US Treasury, would be one way to transfer the quota rents to the US. (See, Elliot et al., 1987.) This policy amounts to roughly equivalent protection for the three industries; imports are limited by a quota to the same amount in each industry. Thus, the industry receiving protection should not be significantly affected by allowing the quota rents to be captured by the US. Yet, a policy of capturing the quota rents makes an enormous difference in the welfare results. The US gains $14.21 billion, if it captured the quota rents in the three industries.3/ That is, the US can dramatically reduce the costs it imposes on itself by the QRs, while retaining protection of the industries, if it captures the quota rents from foreigners.4/

3/ The reader should consult chapter 7 for a discussion of how these estimates vary as a result of different elasticities. Details of all of the estimates discussed in this summary are provided in chapters 7, 8 and 9.

4/ The quota rents that are captured by foreigners are, in some sense, compensation to foreigners for their acceptance of the quotas. If the US moved to a system of capturing the quota rents, it may well become more difficult to obtain agreement on a system of quotas, without facing retaliation. Thus, the US consumer is asked to pay three times over for the system of quotas that keeps all producers happy. Once for the inefficient production and consumption pattern (distortion costs) induced by the quotas and, according to the above estimates, twice that amount to foreigners in quota rents.

TABLE 1.1

WELFARE AND REAL WAGE EFFECTS OF QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES AND STEEL: SIMULTANEOUSLY AND SEPARATELY
(central elasticity case)

(in billions of 1984 US dollars)

Sector and Policy	Gains to the US	% Change in the Real Wage
<u>All 3 Sectors</u>		
Remove QRs	20.90	+0.04
Maintain QRs but Capture Rents from Foreigners	14.21	-0.04
Remove Tariffs after QRs are Removed	0.94	+0.28
<u>Textiles and Apparel</u>		
Remove QRs	13.06	+0.04
Maintain QRs but Capture Rents from Foreigners	7.07	0.00
<u>Automobiles</u>		
Remove QRs	6.9	+0.01
Maintain QRs but Capture Rents from Foreigners	6.2	0.00
<u>Steel</u>		
Remove QRs	0.91	+0.04
Maintain QRs but Capture Rents from Foreigners	0.78	-0.04

* The gains are the value of the Hicksian equivalent variation (EV). the EV measure is explained in chapter 3, section 6.

Source: Estimates from USGETM.

The difference between the total gains from QR removal and the gains from capturing the quota rents are unrecoverable inefficiency or waste costs due to the QR, known as distortion costs. We note that the proportion of the costs of the QRs that are due to distortion costs are higher in textiles and apparel than in the other sectors. This is primarily due to the fact that estimates of the elasticity of demand for imported textiles and apparel products are high relative to other products. This means that the higher prices caused by the quotas induce a relatively large switch by consumers out of imported textile and apparel products. This in turn implies that the distortion costs will be relatively high, since consumers are departing by greater amounts from their desired optimum choice without quotas. Also explaining the higher distortion costs, is the fact that textiles and apparel have a much higher tariff rate (about 17.3 percent) than the auto (about 3 percent) or steel (about 5 percent) sectors; and the estimated quota premium rate paid on imported goods (the percentage increase in price paid by US consumers on the imported articles due to the quota) is also higher in textiles and apparel (about 40.5 percent). Thus, textiles and apparel is a highly distorted sector. Due to the combination of tariffs and quotas, US consumers of textiles and apparel are paying, on average, about 58 percent more than they would have to, were it not for the US government imposed restraints on these imports. As the economy moves away from free trade, the distortion costs increase more than proportionately with the rate of the distortion (the tariff plus premia rate).

If, after removing all QRs, the US then reduced all tariffs to zero, the additional gains to the US would be $0.94 billion. Evidently, relative to QRs, tariffs are a much less serious impediment to trade, as measured by the costs they impose on the US economy. Interestingly, if the US were to move to a uniform tariff structure (all sectors have an identical tariff rate), but retain the same overall average tariff rate, the US would gain $0.6 billion. Thus, about two-thirds of the costs of the tariff system derives from the dispersion of the tariff structure. This again emphasizes the point that the distortion costs of protection increase more than proportionately with the departure from free trade.

There are two important policy experiments that we do not report in table 1.1. In chaper 8, we extend the model to consider the effects of allowing workers the choice of varying their supply of labor, known as allowing a labor-leisure choice. The total supply of labor will then be affected by the policy experiments that we simulate. When workers have a labor-leisure choice, the gains to the economy of removing the restrictions are about 6 percent lower in the central labor supply elasticity case. For example, the gains from removing quotas in all three industries, in the central elasticity case, are 19.74 billion.

It is quite probable that the US is large enough in relation to the world market that it has the ability to influence the price of its agriculture exports (known as monopoly power), and the price of its automobile imports (known as monopsony power). Some small departure from a regime of no import restraints is optimal in the event that the US has any monopoly or monopsony power. If the US has monopoly power in agriculture and monopsony power in autos (at the levels at which we simulate it), the welfare gains from removing QRs in all three industries are reduced to $19.8 billion.

1.3 Employment and Wage Effects

Employment Effects

Removing protection for a particular sector can generally be expected to reduce employment in that sector. However, after full adjustment occurs, there is no increase in aggregate employment and other sectors will gain employment. The effects will depend on how the other sectors of the economy are linked to the sector under consideration: for example, is a given sector a major buyer from, or a major seller to, the protected sector.

In table 1.2, the estimates of the employment effects by industry are presented for the cases of QR removal for the three sectors combined, and for the case of each of them separately. The QRs shift employment around, but do not increase it (except as noted below). It is interesting to note that the steel and textiles and apparel sectors will lose almost as many jobs when QRs are removed in all three sectors as they would when QRs are removed in their sector alone. The auto sector, however, gains 1,950 jobs when QRs are removed concurrently in all three sectors. This is because steel, an input into auto production, is cheaper, and because the demand for autos increases more than proportionately when income increases (it is income elastic). Both effects benefit the domestic auto industry, which expands when QRs for all three sectors are removed.

As mentioned above, we have extended the model to the situation where the worker-consumer chooses between labor and leisure, and where employment of labor will thus be dependent on the level of income, wages and prices in the economy. It turns out that in this case, the primary determinant of the change in equilibrium employment is the level of income in the economy. That is, when individuals are wealthier, they choose to

TABLE 1.2

EMPLOYMENT EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL, AUTOS AND STEEL: SIMULTANEOUSLY AND SEPARATELY

(change in employment by industry in thousands of jobs)*
(central elasticity case)

	Remove Quotas on:			
Sector	All three sectors Simultaneously	Textiles & Apparel Only	Autos Only	Steel Only
Agriculture	14.26	12.33	0.18	1.75
Food	1.64	1.28	- 0.07	0.29
Mining	3.99	4.27	0.01	-0.30
Textiles	-157.56	-158.26	-.13	0.80
Automobiles	1.95	2.68	-1.14	0.41
Steel	-16.22	4.48	0.00	-20.70
Nontraded Services	21.60	22.42	0.50	-1.30
Traded Services	34.28	33.15	0.18	0.95
Consumer Goods	17.45	14.15	0.21	3.09
Manufactured Goods	78.62	63.50	0.12	15.01
Total for Economy	0.0	0.0	0.0	0.0
Total for Economy with Labor-Leisure Choice**	-23.11	-22.39	-0.79	-0.92

* A positive (negative) number indicates an increase (decrease) in employment for the industry.

** The changes for the sectors correspond to the fixed labor supply case.

SOURCE: Estimates from USGETM.

consume part of their additional real income in the form of additional leisure. Since quota removal results in an increased level of real income, individuals choose to work less. We present, in the last row of table 1.2, the estimates of the aggregate employment effects of quota removal when there is a labor-leisure choice. For example, when quotas are removed in all three industries, in the medium labor supply elasticity case, in the aggregate individuals choose to reduce their labor supplied by an amount equivalent to two-tenths of one percent of the labor force, or a reduction of 23 thousand jobs. The reader must go to tables in chapter 8 to determine the sectoral employment effects of quota removal in the presence of a labor-leisure choice. We observe that aggregate employment increases when welfare (or real income) decreases (as in the case of the imposition of the steel quotas), and aggregate employment decreases when welfare (or real income) increases. This very small change, reflects the long term trend of the US economy since the turn of the 20th century. As the per capita income of the economy has increased, this has allowed workers to reduce their hours worked per week.

Wage Effects

Data in table 2.2 (in chapter 2) reveal that as the US trade deficit has grown during the 1980s, the rate of unemployment has declined. Economists would not suggest that the trade deficit caused the decline in the unemployment rate. Awareness of these numbers, however, has caused some who favor protection to shift their argument. The claim is that protection can protect high wage jobs; it is argued that without protection, employment will shift to low wage jobs such as those provided by McDonalds restaurants. This we call the "McDonalds" effect. Our results, such as those in table 1.1, strongly reject the "McDonalds" effect. The real wage is not significantly affected by quota or tariff removal; but to the extent that the real wage changes, it tends to increase. In the majority of cases of QR removal, the real wage increases, but by at most four-tenths of one percent. The positive effect is relatively larger (+0.28 percent) if all tariffs are removed (see chapter 7 for explanation).

1.4 Costs Per Job

Protection does not increase employment in the aggregate. Rather it shifts employment around among industries. Moreover, we have shown that protection does not increase the economy-wide real wage.

In view of the fact that protection is obtained through the political process, some might argue that Congress has decided to value a job in the protected sectors more highly than jobs elsewhere in the economy. In that case, however, we can ask what is the cost per job protected in the quota protected sectors, knowing that overall employment is not increased.

We consider the case of simultaneous removal of quotas on textiles and apparel, autos and steel, with central elasticities. Our estimate is that removal of these quotas would result in the US economy gaining $20.9 billion in 1984 dollars. The three sectors subject to quotas would collectively lose 174 thousand jobs to sectors in the rest of the economy. Thus, the annual cost per job protected in these three sectors is about $120 thousand per year. This is approximately 8 (3) times the annual total compensation of workers in the textile and apparel (steel) sector.5/

5/ Our estimates are that auto workers do not lose employment in the case of simultaneous removal of QRs in all three industries.

1.5 Adjustment Costs

If quotas are removed, displaced workers will incur search, relocation and retraining costs. These real resource costs due to quota removal must be subtracted from the benefits of quota removal to obtain the net benefits of quota removal. A proxy for these costs is the displaced worker's earnings losses (discounted value) over his lifetime. That is, we compare the lifetime earnings stream of the worker who has been displaced with the earnings stream of workers who were not displaced. This measure has the advantage that it allows us to estimate how much gainers from a trade liberalization will have left after compensating displaced workers for their earnings losses. The present value of the earnings losses (or adjustment costs of workers) are $1.64 billion, whereas the present value of the benefits of quota removal are $106.6 billion. Thus, the net benefits from removal of the quotas in these three industries is $105 billion. The associated benefit-cost ratio is 65. That is, for every dollar of earnings losses of displaced workers, the economy gains $65 from quota removal in the three industries.

1.6 Tariff Equivalent of the Quotas

Another way of evaluating the quotas is to ask what tariff structure would be required to impose the same costs on the economy as the quotas in the three sectors. Return to the case of quota removal on all three industries. The total welfare costs are estimated at $20.9 billion. Of this $20.9 billion, $6.7 billion are distortion costs and $14.2 billion are rent transfers to foreigners. To impose costs on the economy equal to the distortion costs alone of the quotas, would require raising all tariffs by 3.8 times their rates in 1984. This would amount to an average (import weighted) tariff of 15%. To impose costs on the economy equal to the total costs of the quotas, would require multiplying all tariffs by 6.9 times their 1984 level, to an average level of tariff protection of 25%. Since we have estimated the costs of quotas in only three sectors, the costs of quotas in all sectors of the US is greater than the estimates we have provided. The average tariff rates on manufactured goods pre-Kennedy round, post-Kennedy round, and post-Tokyo round were 10, 7, and 5 percent, respectively (Balassa and Balassa, 1984). Thus, in terms of the welfare costs of quotas, it is not an exaggeration to conclude that quotas have taken us back to the early days of multilateral tariff reduction.

1.7 Outline of the Study

In chapter 2, the issues perceived to be important in the policy debate on protectionism are discussed. The reader will also find a brief review of the existing PE literature on the welfare estimates of protection, and a discussion of the advantages of the CGE approach.

The goal of this study has been to make the results replicable by an independent researcher. Hence, considerable detail in explanation has been provided in chapters 3 through 6, so that all of the assumptions and data are specified. Similarly, considerable detail in explanation of the results has been provided in chapters 7, 8, and 9. As a result, all the results are interpretable and explainable from basic economic principles and the model is not a "black box."

Technical aspects of the model, its parameter specification and the data are discussed in chapters 3 through 6 and the appendix. The reader who is only interested in the policy issues and the results should, for the most part, be able to comprehend the results chapters without a detailed reading of chapters 3 through 6. The model itself is presented in chapter 3. The first part of the chapter (sections 3.1 to 3.4) provides a general overview of the model. This overview explains how we choose to specify production of domestic indutries (including level of aggregation), spending by consumers, activities of the government, market competition (including market structure) and trade with other countries. This overview also briefly considers alternative specifications to the ones we adopt. The remaining sections of chapter 3 (sections 3.4 and 3.5) are designed for the reader who wishes to understand the model in detail. These sections present and explain all of the equations in the model. How the model is benchmarked is discussed in chapter 4. Elasticity specifications are discussed in chapter 5. In chapter 6, we discuss how we calculate the quota premia on textiles and apparel and on automobiles. This is an important chapter for interpreting results, and some readers may be interested in the techniques and data used to calculate the quota premia (that existed in the base year of the model) in textiles and apparel and autos.

The results for the core model are presented in chapter 7. In order to determine how sensitive the results are to the elasticities, estimates are obtained under a range of elasticities, which we call the low, medium (or best or central) and high elasticity cases. We also assess the impact of terms-of-trade effects in this chapter. In chapter 8, the impact of varying a number of the assumptions in the model are examined, such as intersectoral capital mobility. One of the more important of these is the impact of the presence of wage distortions in the automobile and steel industries. It is also in this chapter that we extend the model to include a labor-leisure choice. Thus, aggregate labor supply and employment are influenced by the policy variables of the model. Chapter 9 provides an overall assessment of our results. It gives estimates of adjustment costs for displaced workers and also provides a comparison of the welfare results of our model with those of previous studies, both partial and general equilibrium. The construction of the data set is discussed in the appendix.

CHAPTER 2

POLICY ISSUES

2.1 Introduction

Given the large increase in the US trade deficit in recent years, many observers have suggested that the US should increase its protectionism.1/ Other observers have been alarmed by the protectionism and suggest it should be lowered. Although the debacle of the Smoot-Hawley tariff gave protectionism a bad name, the benefits of free trade are now being seriously questioned.2/ A number of the questions raised in this debate relate to economy-wide effects of protectionism. These economy-wide questions cannot be satisfactorily answered by the methods economists normally use to assess protectionism. Consequently, this study assesses the consequences of protectionism using a computable general equilibrium model (CGE) with a trade policy focus for the US economy. This model is referred to as the USGETM for US General Equilibrium Trade Model.

Because our approach relies on assessing the costs of protection in an economy-wide context, we are able to better address the debate on the costs of protection and on the employment effects of protection. For example, two of the sectors which have been the recipients of special

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1/ The balance on the US current account has shifted from a surplus of $7 billion in 1981 to a deficit of $141 billion in 1986. (Economic Report of the President, February 1988, p. 364.)

2/ See, for example, the polls reported in The Washington Post, March 6, 1988, pp. H1, H8.

protection are the steel and automobile sectors. Removing protection in the steel industry will cause a loss of jobs in the steel industry. But the automobile industry will be able to purchase steel at a lower price than previously. This will allow the automobile industry to expand. Our economy-wide approach emphasizes these interindustry linkages. As such, it is particularly well-suited to examine the total effects of protection. As will be shown throughout the study, the economy-wide simulation approach is also particularly well-suited for extensive counterfactual analysis. For example, we can estimate the average economy-wide tariff protection which would yield the same welfare loss to the US as the existing quotas in selected sectors.

Due to successive rounds of multilateral trade negotiations since World War II, tariff rates have been substantially reduced. It is the view of many that tariffs are no longer a serious impediment to international trade among the developed countries. For example, in the US, average tariff protection was 3.5% in 1984. On the other hand, nontariff barriers have been growing in importance.3/ The three most significant industries in which the US has imposed special protection in the 1980s are: textiles and apparel, automobiles and steel. The US imposes (or imposed) quantitative restictions (QRs) on the imports of all three of these products during the 1980s. Textiles and apparel and steel restraints are currently in effect. Bilaterally negotiated automobile restraints were in effect for four years, until April 1985, after which Japan unilaterally restrained its exports to the US.

3/ See Balassa and Balassa (1984) for an assessment of protection in developed countries.

Given the relative importance of these industries in US trade policy, this study will focus on these three industries. We will also assess the additional gains from removing the remaining tariff protection.

2.2 Previous Cost of Protection Studies

In view of the concerns about the costs of protection, it would be useful to know the costs of protection in each of these industries separately, and the combined costs of protection of all three. There have been a number of studies that have analyzed the effects of quotas on these three industries separately. Efforts to estimate the effects of the quotas on textiles and apparel include Tarr and Morkre (1984), Hickock (1985), Hufbauer et al. (1986) and Cline (1987). In steel, the effects of the VERs have been estimated for the US alone by Tarr and Morkre (1984), Hufbauer et al. (1986), and for the US, Korea and the rest of the world in Tarr (1987). The welfare effects of the automobile VER have been estimated by Tarr and Morkre (1984), Feenstra (1984, 1985b), Hickock (1985), Hufbauer et al. (1986), Winston and Associates (1987) and Dinopoulos and Kreinin (1988).

Table 2.1 surveys the results of previous studies. Many of the differences in results among industries are explained by differences in coverage and years of the estimates.

First consider autos: 1981 was a recession year. Consequently in autos, Tarr and Morkre and Feenstra obtain low estimates. We regard the higher estimates of Dinopoulos and Kreinin as more reliable, both because they are for 1984, a more normal year in the business cycle, and because they recognize and estimate the impact of the VER with Japan on European prices. (This is discussed in detail in chapter 6). Yet another source of difference in estimates comes from underlying model assumptions. For

TABLE 2.1

PARTIAL EQUILIBRIUM ESTIMATES OF THE COSTS OF PROTECTION IN TEXTILES AND APPAREL, AUTOS AND STEEL

Industry and Author	Year of Estimate	Welfare Costs (in billions of dollars)	Consumer *** Costs (in billions of dollars)	Jobs Protected (in thousands)	Welfare Costs per Job (in thousands of dollars)
I. Textiles and Apparel					
1. Tarr and Morkre (1984)	1980	0.37	0.38	8.9	43
2. Hickock (1985)	1984	NA	8.5-12.0	NA	NA
3. Hufbauer et al. (1986)	1984	6.65	27.0	640	42 *
4. Cline (1987)	1986	8.128	20.344	234.9	87 *
II. Autos					
5. Feenstra (1984)	1981	0.33	NA	11	30
6. Tarr and Morkre (1984)	1981	0.99	1.1	4.6	216
7. Hickock (1985)	1984	NA	4.5	NA	NA
8. Hufbauer et al. (1986)	1984	2.4	5.8	55	105 *
9. Winston and Associates (1987)	1984	5.0	14.0	-31.7	NR
10. Dinopolous and Kreinin (1988)	1984	5.861	NA	22 **	181
III. Steel					
11. Tarr and Morkre (1984)	1985	0.80	1.1	10.0	81
12. Hickock (1985)	1985	NA	2.0	NA	NA
13. Hufbauer et al. (1986)	1985	2.3	6.8	9.0	750 *

NA Not available from study.

NR Not relevant because domestic employment in autos was estimated to decline when quota imposed.

* Indicates consumer costs per job.

** Job estimates are for 1982.

*** Estimates of costs to consumers exceed welfare cost estimates because initial equilibrium estimates are based on assumption that consumers do not receive payments from firms or the government. In the context of consideration of the full economy, i.e., general equilibrium, this assumption is inappropriate. Thus, the column "welfare costs" is the relevant column of reference for the estimates of this study. See Chapter 9, section 3 for further explanation.

SOURCE: Compiled by the author.

example, Winston and associates estimate that, because it has monopoly power, the domestic auto industry restricted output and employment following the VER.

In textiles and apparel, Tarr and Morkre estimated the costs of quotas only for imports from Hong Kong. The other studies estimated the costs of quotas and tariffs on all countries.

These studies are all partial equilibrium studies. They were fine efforts at estimating the costs of the restrictions in particular industries. Partial equilibrium studies often are able to more readily model detailed features of an industry. As partial equilibrium studies, however, they could not (endogenously) determine feedback effects of the change in policy on the sector under consideration from the rest of the economy. This study will employ a general equilibrium approach. We would argue that there are a number of important advantages in the general equilibrium approach. First, and perhaps foremost, the partial equilibrium approach is unable to assess employment impacts across other sectors of the economy. Thus, none of the studies mentioned attempted to estimate the employment effects in an unprotected sector resulting from the protection. Because the employment effects of protection are such an important issue (which we discuss further below), we have come to the point where we need to have economy-wide and individual sector estimates of the employment effects of protection.

Second, partial equilibrium studies misestimate the effects of protection because the balance of trade constraint is not properly accounted for. 4/ Our experiments indicate that the failure to incorporate the balance of trade constraint can result in a very significant exaggeration of the costs or benefits of protection. Third, income transfers to, or from, the rest of the world are more properly accounted for in our model than in partial equilibrium estimates. Thus, a trade policy that has an income effect on the US will induce shifts in demand curves that are accounted for in our model, but which are ignored in partial equilibrium analysis. An example of this is the partial equilibrium result that capturing quota rents has no resource allocation effect. In general equilibrium, however, it will have resource allocation effects. We estimate these effects. Moreover, protection can affect the real exchange rate. The change in the real exchange rate will, in turn, affect all sectors, including the sector receiving protection.

To the extent that other things which are changing are being held constant in a partial equilibrium model, inaccuracy develops. As the magnitude of the policy changes become large, so does the inaccuracy. Partly for this reason, most of the above-mentioned studies have not attempted to aggregate the costs to the economy of the trade restrictions.5/ Whereas these studies are generally reliable estimates of the effects of trade policy changes in individual industries, they are not reliable

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4/ The balance of trade constraint fixes the difference between the value of total exports and imports (in foreign currency units), to the value recorded in the benchmark year (in our case 1984). See the appendix, section 7 for the data and further explanation.

5/ Tarr and Morkre (1984) attempted an aggregation based, in part, on general equilibrium estimates.

economy-wide estimates. Thus, adding up separate partial equilibrium estimates does not yield reliable global estimates. We provide an example of this kind of aggregation bias in chapter 9.

2.3 Policy Issues Addressed in this Study

Welfare Effects

(a) Effects of Removing Quotas

As mentioned above, the first issue on which we shall focus is the costs to the US of the quotas on the three mentioned industries. The costs to the US of each of the three restraints considered separately will be assessed, as well as the combined costs to the US of the quotas on all three industries. Welfare effects will be measured using the Hicksian equivalent variation, which is explained in chapter 3. Given the increased interest in protectionism, a fresh round of estimates, previously unavailable from a CGE approach, should be very welcome. We believe this to be especially valuable with respect to the aggregate estimate.

Moreover, our methodology will allow us to assess the relative importance of tariffs versus quotas. Given our estimate of the costs to the US of the quotas, we estimate the level of tariff protection that would be required to impose the same costs on the US, if there were no quotas. That is, how far back in the multilateral tariff negotiations would the US have to go, if it were to abandon nontariff barriers (NTBs), and were to impose the same costs on its consumers.

(b) Capturing the Quota Rents

The US method of allocating quota rights allows foreign countries to capture the quota rents. That is, the higher price of the imported articles under the quota accrues to the exporting nation. There are alternate methods of allocating the quota rights that would allow the US to capture the quota rents. These include raising the tariff rate, allocating quota rights to domestic citizens or auctioning the quota rights.6/ Auctioning of the quota rights has been tried in Australia and New Zealand, and recently the US International Trade Commission recommended to the President that he impose an auction quota in the footwear industry.7/ We

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6/ See Morkre and Tarr (1980, chapter 3) for a general discussion of these issues.

7/ See Elliot *et al*. (1987) for a thorough discussion of auction quotas. Recent theoretical work by Krishna (1988a, 1988b) indicates that in the case where imports are supplied monopolistically, auction quotas will not capture rents from foreigners. There is little monopoly power, however, in the import supply of the three industries we are considering; thus, Krishna's interesting theoretical results do not significantly alter our policy conclusions regarding capturing quota rents. In particular, there are thousands of suppliers of imported textile and apparel products, so we can perceive of the sale of these products as competitive. Moreover, over one hundred cases have been filed at the US International Trade Commission and the Department of Commerce regarding steel, for the purpose of determining if many of the suppliers of imported steel have been supplying steel at prices less than costs; see Tarr (1988a). (If prices are not above marginal costs, there is no monopolistic pricing, and auction quotas will capture the rents.) Finally, automobiles are supplied from many countries including Italy, France, Germany, the United Kingdom, Sweden, Japan, South Korea and Yugoslavia. Most of these countries have multiple suppliers to the United States, so that there are over fifteen competing suppliers of imported automobiles. Empirical evidence suggests that markets with this many suppliers, generally exhibit very little monopoly power. Moreover, Dixit's (1988) tests reveal little evidence of monopoly pricing in the automobile industry, prior to the introduction of quotas.

The domestic industry, however, has far fewer firms, and other work by Krishna (1983) has shown that quotas can act as a "facilitating practice" regarding the achievement of monopoly power. The presence of domestic market power (induced by the quotas) can affect the value of the import quota licenses when the imported product is supplied competitively (increasing the value in the normal case of when an import good substitutes for the domestic good), but does not affect the basic quota rent capture story.

estimate the effects on welfare and employment of the US changing its quota allocation policy so as to capture the quota rents.8/

Employment and Wage Effects

(a) Employment

We shall be concerned with the effect of protection on employment. Protection is often regarded as a mechanism for preserving jobs in industries that receive protection. But what is the impact on jobs in industries that are not receiving protection? We shall estimate the change in employment across all sectors of the economy as a result of changes in protection.

Although many economists do not believe that protection is capable of generating employment (e.g. Krueger, 1969), the large rise in the US trade deficit has generated fears of widespread unemployment. The data in table 2.2 reveal, however, that the large increase in the US trade deficit has been associated with a decline in the unemployment rate. Although economists would not suggest a causal relationship, awareness of these numbers has given pause to those who would argue that protection is needed to preserve US jobs. It is therefore important to estimate the distribution of employment effects throughout the economy, resulting from protection. We address this issue in chapters 7 and 8.

8/ Given that there is a quota, the auction quota is more efficient, because it reduces rent-seeking activity. That is, if the government gives away the quota through a quota allocation scheme, citizens will devote resources to acquire the quota rights. This is wasteful activity. See Krueger (1974).

TABLE 2.2

UNEMPLOYMENT RATE AND THE US TRADE DEFICIT: 1982-1987

Year	Trade Deficit (in billions of dollars)	Unemployment Rate (percent)	Average Weekly Earnings (index in 1977 dollars)
1982	-8.7	9.5	168.09
1983	-46.2	9.5	171.26
1984	-107.0	7.4	172.78
1985	-116.4	7.1	170.42
1986	-141.4	6.9	171.07
1987	-161.9	6.1	169.28
LATE 1987 (annualized rate)	-173.51	5.7	168.41

* The late 1987 unemployment rate and average weekly earnings is for December 1987; the trade deficit number is four times the trade deficit for the third quarter of 1987.

SOURCE: Economic Report of the President, 1988, pp.292, 299, 364.

(b) The "McDonalds" Effect

Perhaps, as a result of awareness of the numbers in the first two columns of table 2.2, those who argue for protection have proposed a new argument, which we call the "McDonalds" effect. Faced with the fact that huge increases in the US trade deficit have not resulted in increased unemployment in the aggregate, the argument for more protection has shifted. The claim is that protection can preserve high wage jobs, i.e., that without protection, the US will shift to low wage jobs, such as those provided by McDonalds restaurants. The data in table 2.2 do not reveal any significant relationship between the real wage (measured as average weekly earnings in constant dollars) and the trade deficit. But with the USGETM, we can test the McDonalds effect by determining the change in the real wage as a result of protection.

(c) Wage Distortions in Automobiles and Steel

Wages in the steel and automobile sectors are considerably higher than the average for US manufacturing. Many have argued that because of the high wages, it is difficult for the automobile and steel sectors to compete with foreign competition (see chapter 6). Others have estimated the amount of additional employment in the steel (Webbink, 1985) and automobile (Munger, 1985) industries, if their respective wages were lowered to competitive levels. We assess in chapter 6, whether the wages in these sectors are competitive or are above competitive levels due to the combination of protection and monopoly power on the part of the United Autoworkers and the United Steelworkers. Most of the simulations we perform are under the assumption that wages in these sectors are competitive. In chapter 8, we estimate how the welfare results change if wages in these sectors are not competitive, but at a distortionary high level. We also estimate the benefits to the US, if any such distortions were removed.

Effects on Exports, Imports and the Real Exchange Rate

If a sector or group of sectors in the economy is protected, imports of the protected sector may be expected to decline, but the real exchange rate is likely to appreciate as a result of protection.9/ If protection is being considered in order to assist an industry that has "been injured" by imports, such as is done by the US International Trade

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9/ For a discussion of the real exchange rate in our model see appendix 3A.

Commission (USITC), should protection be granted to an industry because of an appreciation of the US exchange rate? This was an important issue in 1984, when a number of major industries petitioned the USITC for protection.

Grossman (1986) has argued that granting protection to an industry will cause the real exchange rate to appreciate. Thus, the burden of adjustment to the appreciated exchange rate will fall on the export sectors and those import competing sectors that are not protected. He concludes that the USITC should not grant protection on the basis of an appreciation of the real exchange rate, because exchange rate appreciation is not sector specific in its effects. Through the USGETM, we assess the impact of granting quotas to each of the three industries separately, and in the aggregate, on the real exchange rate, as well as on exports and imports of each sector. We also assess which sectors bear the burden of adjustment when protection is granted to the three sectors subject to QRs.

CHAPTER 3

THE UNITED STATES GENERAL EQUILIBRIUM TRADE MODEL

3.1 Introduction

The USGETM is a comparative statics computable general equilibrium (CGE) model of the United States (US) economy implemented for 1984. We carefully model the behavior of agents in the US, but treat the rest of the world parametrically. That is, no country in the rest of the world (ROW) is singled out for special modeling. The ROW is aggregated into a single region in the model. However, we allow for the possibility that the US is large in relation to the supply of imports from the ROW, as well as in the demand for its exports. Thus, terms-of-trade effects are explicitly incorporated. However, our treatment of the ROW implies that we cannot directly assess the impact of a VER between say the US and Japan on third country exports to the U.S.

Below we describe the main assumptions underlying the model. To simplify the description, we carry out the presentation for the "core" model. By the "core" model, we mean the basic specification of behavior where all agents are assumed to be price takers and production is characterized by constant returns to scale (CRTS). In some sectors, we could allow for increasing returns to scale (IRTS) and a departure from average cost pricing when there are barriers to entry. An important example is the model by Harris (1984) for the Canadian economy. He finds that the costs of import protection can be substantially higher with IRTS and noncompetitive pricing. However, because the evidence for IRTS and noncompetitive pricing is still a subject of controversy, we shall report all results from experiments with a CRTS perfect competition model and structure our presentation of the model accordingly.

The reader not interested in the details of the model, should read sections 2 and 3 which provide an overview of the properties of the model and of the selected functional forms. The reader unfamiliar with CGE models, who wishes to follow the details of the model, should also read the remaining sections of the chapter where the complete structure of the model is laid out.

3.2 Overview of the Model

Since we are interested in estimating the effects of trade policies, and are not concerned with policy issues related to investment decisions, we avoid unnecessary complication by not modeling the investment decision. Similarly, we do not model consumption decisions by the US government. Thus, we treat all final domestic demand for the output of a sector as private consumption demand. Total demand for the output of a sector from domestic sources alone is the sum of domestic intermediate demand plus domestic consumption demand. We assume that all consumers have identical preferences and that their behavior can be modelled by a "representative" consumer.

The government collects tariffs and taxes (and possibly quota rents at auction); it can subsidize exports or the production of a sector in various ways. Given our interest is limited to trade policy experiments, we confine the government's role to collection and distribution of trade related revenues. The government's budget surplus (deficit), however, is distributed to (taken from) the consumer as a lump sum payment. Thus, the government is treated as though it operates under a balanced budget, where lump sum distributions or taxes compensate for any residual of taxes over spending.

We do not attempt to assess the impact of costly rent-seeking activities associated with efforts to erect or preserve barriers to imports. See Krueger (1974). Nor do we address political economy of protection issues. That is, why one industry achieves protection from the government over another, is not explained. See Baldwin (1984).

The real exchange rate is assumed to adjust to keep the current account deficit, expressed in foreign currency units, unchanged as a result of a policy simulation. Thus, whatever exogenously given current account deficit exists in the year for which the model is benchmarked will continue to prevail after the policy simulation. This guarantees that there will be no permanent free lunches, either taken from or given to the ROW in the policy simulations. This assumption makes welfare analysis of changes in restrictions more meaningful and transparent. In chapter 9, we show the magnitude of the bias one introduces by dropping this assumption.

The model is designed for a range of trade policy experiments. In some cases, we analyze a standard tariff or subsidy rate change, or the imposition of a quota. In other cases, we analyze the effects of the existence of a preexisting quota in the base year data, given exogenous estimates of the preexisting quota premium rate. Given the importance of quota rent capture, we generally assume that foreign firms capture the rents from quotas or voluntary export restraints (VERs). In some cases, however, we also simulate the effects of the US recapturing these rents through an auction quota or similar mechanism. There is a short run and a long run version of the model. In the short run, capital stocks are fixed in each sector; in the long run, they are mobile across sectors. Moreover, if there is a preexisting wage distortion in a given sector, the model is used to simulate the effects of removing that wage distortion, as well as considering the second-best effects of removing a quota or tariff in a sector with distorted wages. Finally, we generalize the model to incorporate a labor-leisure choice tradeoff. In this version of the model, the labor supply is endogenous.

As mentioned above, we also use the model to assess the empirical importance of terms-of-trade effects for welfare cost estimates. To the extent that evidence suggests that there are sectors in the US that have productive capacity that is large in relation to world demand, we have incorporated this market power. Similarly, if for a given sector, there is evidence that US demand is large in relation to the rest of world supply, we incorporate this assumption by specifying an upward sloping world supply curve. Either of these two considerations imply that policy changes will result in terms-of-trade effects in the model. When such effects are present, there will be a positive optimal import tariff or export tax. We will not, however, be concerned with determining that optimal tariff.

The model is a general equilibrium model in the sense characterized by Arrow and Debreu (1954). Shoven and Whalley (1984) survey these models as applied to international trade issues. Consumer demand functions are continuous, nonnegative, homogeneous of degree zero (in absolute prices) and, at any set of prices, consumer expenditures on commodities equal consumer money income inclusive of transfers. The latter property means the model satisfies Walras Law. Producers maximize profits subject to CRTS production functions. Given technology, output and input prices, the representative firm in each industry purchases primary factors, domestic and foreign intermediate inputs so as to minimize the costs of producing any level of output. The single representative consumer purchases domestic and foreign goods and consumes leisure in a manner that maximizes utility given income (both labor and nonlabor income) and prices. The consumer's income is determined endogenously. Given the prices that firms face in the export and domestic markets and their production transformation possibilities, firms allocate their output between the domestic and foreign markets so as to maximize profits. This, together with the homogeneity of degree zero of the demand functions, implies that only relative prices are of significance. We choose a numeraire to determine absolute prices. But the selection of the numeraire is arbitrary, since relative prices are independent of its value.

A general equilibrium results when all industries are in equilibrium, all product and factor markets clear, and the balance of trade equals its initial value. Given the properties discussed in the previous paragraph, a general equilibrium is known to exist. Because preferences are reduced to a single representative consumer, the resulting equilibrium is unique. (See, for example, Arrow and Hahn, 1971.) Finally, the model is required to replicate an historical data set (in our case 1984) as an equilibrium. Determining parameter values such that the observed data set is an equilibrium of the model, is known as benchmarking (or calibrating) the model. How this is done is described in chapter 4.

3.3 Aggregation and Elasticity Specification

Aggregation

For analyzing the costs of protection, the economy is aggregated into 10 sectors: (1) agriculture; (2) food; (3) mining; (4) textiles and apparel; (5) autos; (6) iron and steel; (7) other consumer goods; (8) other manufacturing; (9) traded services; and (10) construction and nontraded services. We choose to aggregate in this manner because most of the significant industries that frequently petition and obtain trade protection in the US are isolated as separate industries in the model, while other industries are treated in a more aggregegated manner.1/ Further disaggregation of our sectors would be useful for obtaining estimates of effects on subsectors of our sectors. In so far as there has been strong sector-wide pressures for protection from textiles and apparel, autos and steel, we are interested in estimates of the sector-wide effects of protection. Thus, our aggregation is appropriate for our purpose.

Elasticity Specification

Figure 3.1 summarizes the model structure for the USGETM. Starting with foreign trade, we treat the products produced by the US and the ROW as differentiated. If products were not differentiated then, in the absence of nontariff barriers, prices in the US, net of tariffs and transportation costs, would have to equal prices in the ROW. That is, US prices of traded goods would be determined in a rather simple manner from ROW prices. The problem with a homogeneous product and Hecksher-Ohlin based trade model is that it cannot explain the significant amount of two-way (or cross-hauled) trade that occurs. Thus, a significant advance in the modern theory of applied trade models is the assumption that products are differentiated by country of origin. This is often called the "Armington"

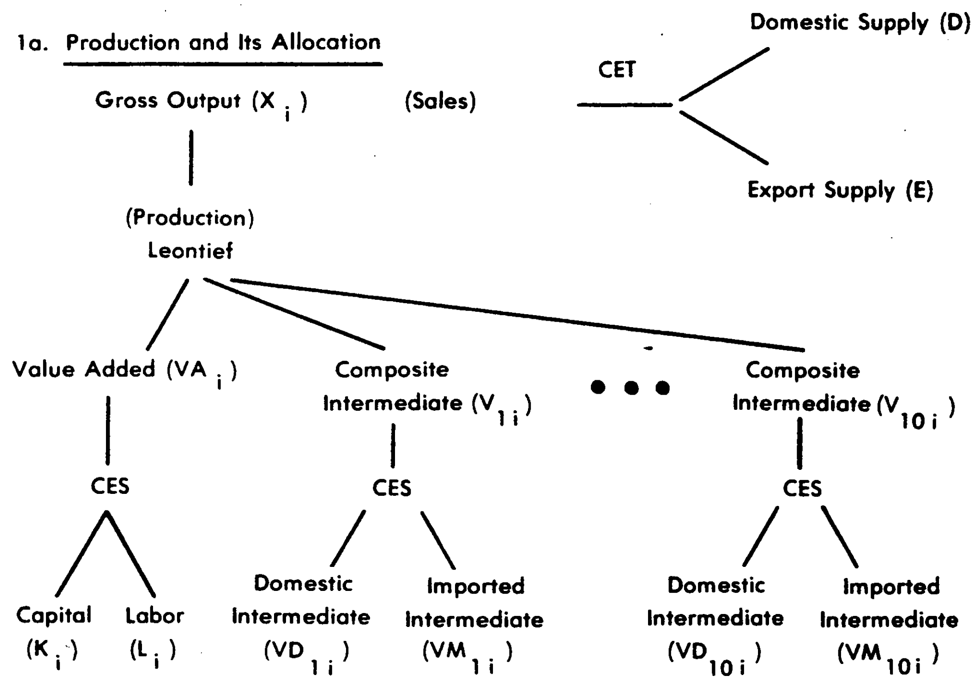
1/ The data set has been constructed (see appendix) for 12 sectors, where two additional policy relevant sectors (crude oil and natural gas and petroleum related products) are included.

FIGURE 3.1

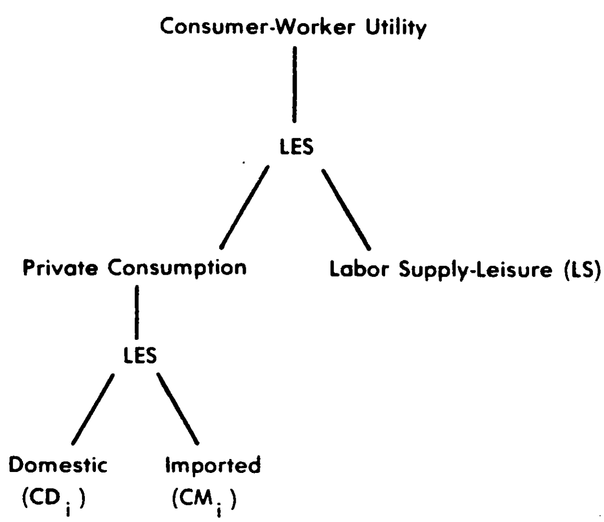
MODEL STRUCTURE

1. Substitution in production and demand

1a. Production and Its Allocation



1b. Consumer Demand and Labor-Leisure Choice



2. Import Supply and Foreign Export Demand

Import Supply: infinitely elastic (except autos).

Foreign Export Demand: infinitely elastic (except agriculture) assumption, even when Armington's specific functional form is not employed. As explained below, we retain the Armington (1969) constant elasticity of substitution (CES) formulation for intermediate products, but use a different functional form for final goods. This allows for a greater degree of flexibility in elasticity specification, while retaining the product differentiation assumption. The assumption of product differentiation on the import side is also extended symmetrically to the export side where the corresponding specification is the constant elasticity of transformation (CET) function. 2/

Figure 3.1 indicates that we parametrize production substitution possibilities by assuming CES functions for value-added and Leontief functions between intermediates and value-added and between intermediates. However, within each intermediate sector, a CES function is postulated between the domestically produced intermediate and the competing foreign-produced intermediate. To give an example, no substitution is allowed between steel and other manufacturing, but substitution is allowed between domestically-produced and foreign-produced steel. The substitution possibilities are given by a CES function. As explained above, the same specification is adopted for the supply of exports. The allocation of sales between the domestic and export markets is given by a CET function. The CES and CET functional specifications could, of course, be relaxed to include second-order approximations as in the flexible functional forms proposed in the production and consumer choice literature (e.g. translog functions). However, such specifications would unnecessarily complicate our parametrization of the model as many more cross-elasticities (that are

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2/ The CET was introduced by Powell and Gruen (1968).

difficult to estimate precisely) would be needed. These, second-order approximations would not add any further insight into our analysis of the welfare costs of protection.

For consumption demand, we allow for nonzero cross-price elasticities of demand between domestically and foreign produced consumer goods of the same category, e.g., between domestic and foreign vehicles. As discussed in chapter 5 on elasticity specification, fairly detailed estimates exist that can easily be incorporated into the linear expenditure system (LES) demand system which is also convenient for welfare analysis (see below). Finally, we also use an LES specification for determining the labor-leisure choice and resulting supply of labor, with, as a special case, a fixed labor supply.

3.4 Model Equations

The list of independent equations and unknowns of the model is provided in table 3.1. Endogenous variables, exogenous variables and parameters are defined in table 3.2. Variable subscripts denote sectors. If double subscripts are employed, the first subscript denotes the sector of origin, and the second, the sector of destination. For example, the Leontief input-output coefficient, a_{ij}, denotes the amount spent on inputs from sector i to produce one dollar of output in sector j. Exogenous variables have an overbar; parameters are symbolized by Greek or lower case Latin letters. Endogenous variables are written in upper case Latin letters.

Equations in table 3.1 are numbered 1 through 33. These are the equations describing the model. We shall refer to them throughout the

TABLE 3.1

MODEL EQUATIONS

Variable subscripts denote sectors. If double subscripts are employed, the first subscript denotes the origin sector and the second the destination sector. For example, the Leontief input-output coeficient, a_{ij} denotes the amount spent on inputs from sector i to produce one dollar of output in sector j. Exogenous variables have an overbar. Parameters are symbolized by Greek or lower case Latin letters. Endogeneous variables are written in upper case Latin letters. T is the subset of traded sectors; NT the subset of nontraded sectors; T U NT=N where N is the set of all sectors.

1. Technology

Value Added:
Cobb-Douglas Technology

(1a) $$X_i = \overline{AD}_i \, L_i^{\alpha_i} K_i^{(1-\alpha_i)} \qquad i = 1, \ldots, n$$

CES Technology:

(1b) $$X_i = \overline{AD}_i \, [\alpha_i L_i^{\rho_i} + (1-\alpha_i) \, K_i^{\rho_i}]^{1/\rho_i} \qquad \rho_i < 1 \qquad i = 1, \ldots, n$$

2. Primary Factor Markets

Weighted Average Wage:

(2) $$WG = \sum_{j=1}^{n} W\phi_i L_i / LS.$$

Aggregate Labor Supply:

(3) $$LS = \overline{MAXHOURS} - (\beta_o / WG) \, [(Y - P_C \lambda_C)/(1-\beta_o)].$$

Sectoral Labor Demand (Cobb-Douglas)

(4a) $$L_i = \alpha_i X_i PN_i / W\phi_i \qquad i = 1, \ldots, n$$

Sectoral Labor Demand (CES)

(4b) $$L_i = X_i \, [\overline{AD}_i^{\rho_i} \, \alpha_i \, (PN_i / W\phi_i)]^{[1/(1-\rho_i)]} \qquad \rho_i<1 \qquad i = 1, \ldots, n$$

TABLE 3.1 (continued)

Sectoral Capital Demand

(5a) $K_i = (1-\alpha_i)\ X_i\ PN_i/R$ $\quad i = 1, \ldots, n$

(5b) $K_i = X_i [\overline{AD}_i^{\rho_i} (1-\alpha_i)\ (PN_i/R)]^{[1/(1-\rho_i)]}$ $\quad i = 1, \ldots, n$

Short-run model: replace R with $RENT_i$ in (5a) and (5b).

Capital Supply Constraint:

(6) $\sum_{i=1}^{n} K_i = \overline{KS}$ $\quad i = 1, \ldots, n$

Labor Market Equilibrium:

(7) $\sum_{i=1}^{n} L_i = LS$ $\quad i = 1, \ldots, n$

3. Intermediate Product Demands

Aggregation of Imported and Domestic Intermediates:

(8) $V_{ji} = \overline{AC}_{ji} [\delta_j VM_{ji}^{\rho c_j} + (1-\delta_j) VD_{ji}^{\rho c_j}]^{1/\rho c_j}$ $\quad \rho c_j < 1,\ i = 1, \ldots, n,\ j \in T$

Cost Minimizing Use of Imported and Domestic Intermediates:

(9a) $VD_{ji}/VM_{ji} = [(1-\delta_j)/\delta_j]^{[1/(1-\rho c_j)]} [PD_j/PMI^{v}_{ji}]^{[1/(\rho c_j - 1)]}$ $\quad i = 1, \ldots, n \quad j \in T$

(9b) $VM_{ji} = 0$ $\quad j \in NT$

Leontief Production Function in Intermediates:

(10) $V_{ji} = a_{ji} X_i$ $\quad i, j = 1, \ldots, n$

4. Output Allocation

Production Transformation Possibilities:

(11) $X_i = \overline{AT}_i [\gamma_i E_i^{\rho t_i} + (1-\gamma_i) D_i^{\rho t_i}]^{1/\rho t_i}$ $\quad \rho t_i > 1, \quad i = 1, \ldots, n$

TABLE 3.1 (continued)

Allocation to Domestic and Foreign Sales:

(12a) $$D_i/E_i = [(1-\gamma_i)/\gamma_i]^{[1/(1-\rho t_i)]}[PD_i/PE_i]^{[1/(\rho t_i-1)]} \qquad i \in T$$

(12b) $$X_i = D_i \quad \text{or} \quad E_i = 0 \qquad i \in NT$$

5. Cost-Determined Prices

Composite Output Price:

(13) $$PS_i = \overline{AT}_i^{-1} [\gamma_i^{1/(1-\rho t_i)} PE_i^{\rho t_i/(\rho t_i-1)} + (1-p_i)^{1/(1-pt_i)} PD_i^{\rho t_i/(\rho t_i-1)}]^{(\rho t_i-1)/\rho t_i} \qquad i \epsilon T$$

Composite Price of Intermediates:

(14) $$PC_{ij} = \overline{AC}_{ij}^{-1}[\delta_i^{1/(1-\rho c_i)} PMI_{ij}^{v\ \rho c_i/(\rho c_i-1)} + (1-\delta_i)^{1/(1-\rho c_i)} PD_i^{\rho c_i/(\rho c_i-1)}]^{(\rho c_i-1)/\rho c_i} \qquad i \in T$$

Net Unit (or Value Added) Price:

(15) $$PN_i = PS_i - \sum_{j=1}^{n} a_{ji}PC_{ji} \qquad i = 1, \ldots, n$$

6. Definition and Determination of Import and Export Prices

Supply Price of Imported Consumer Goods

(a) Perfectly Elastic Supply

(16a) $$PWM_i = \overline{PWM}_i$$

(b) Upward Sloping Supply

(16b) $$C_i^m = \bar{C}_i \, PWM_i^{\Omega_i} \qquad \Omega_i > 0, \ i \in T$$

TABLE 3.1 (continued)

Import Prices Adjusted by Tariffs and Preexisting Quota Premia

(a) For final goods:

(17) $PM_i = PWM_i(1 + tm_i)\ (1 + prc_i)\ ER \qquad i \in T$

(b) For intermediate goods:

(18) $PMI_i = PWI_i(1 + tim_i)\ (1 + pri_i)\ ER \qquad i \in T$

Price Determination of Imported Consumer Goods:

(a) Preexisting quotas:

(19a) $PM_i^v = PM_i$

(b) With quotas:

(19b) $C_i^m = \overline{C}_i^m;\ PM_i^v > PM_i \qquad i \in T$

Price Determination of Imported Intermediate Goods:

(a) Preexisting quotas:

(20a) $PMI_i^v = PMI_i \qquad i \in T$

(b) Quotas rationed by destination sector:

(20b) $VM_{ij} = \overline{VM}_{ij}\ ;\ PMI_{ij}^v > PMI_i \qquad i \in T$

(c) With quotas rationed in the aggregate:

(20c) $VTM_i = \overline{VTM}_i \qquad i \in T$

Equal premia determination on (PHI_i) imported intermediates, when rationed in the aggregate

(20d) $PMI_{ij}^v = PMI_i\ (1 + PHI_i) \qquad i \in T,\ j = 1, \ldots, n$

Domestic Price of Export Goods:

(21) $PE_i = PWE_i\ (1 + te_i)\ ER \qquad i \in T$

TABLE 3.1 (continued)

Price of Export Goods on World Markets:

(a) Perfectly elastic demand for exports:

(22a) $PWE_i = \overline{PWE}_i$ $\quad i \in T$

(b) Downward sloping foreign demand for exports:

(22b) $E_i = \bar{E}_i(PWE_i)^{-\pi_i}$ $\quad \pi_i > 0 \quad i \in T$

7. Consumer and Domestic Supply Demand Balances

Consumption Demand for Domestic Goods

(23) $$C_i^d = \lambda_i^d + (\beta_i^d/PD_i)\ [Y - \sum_{j=1}^{n} (\lambda_j^d\ PD_j + \lambda_j^m\ PM_j^v)] \qquad i = 1, \ldots, n$$

subject to: $\beta_i^d > 0$; $C_i^d > \lambda_i^d$. $\quad i \in T$

Consumption Demand for Imported Goods:

(24) $$C_i^m = \lambda_i^m + (\beta_i^m/PM_i)\ [Y - \sum_{j=1}^{n} (\lambda_j^d\ PD_j + \lambda_j^m\ PM_j^v)] \qquad i \in T$$

subject to: $\beta_i^i > 0$; $C_i^m > \lambda_i^m$

and $C_i^m = 0 \quad i \in NT$

(23) and (24) must also satisfy: $\sum_{j=1}^{n} (\beta_j^d + \beta_j^m) = 1.$

Total Demand for Domestic Intermediates Originating in Sector i:

(25) $$VTD_i = \sum_{j=1}^{n} VD_{ij} \qquad i = 1, \ldots, n$$

Total Demand for Imported Intermediates Originating in Sector i:

(26) $$VTM_i = \sum_{j=1}^{n} VM_{ij} \qquad i \in T$$

TABLE 3.1 (continued)

Domestic Supply-Demand Balances:

(27) $D_i = VTD_i + C_i^d$ $\qquad i = 1, \ldots, n$

8. Income, Trade Balance, Rents, and Numeraire

Income:

(28)
$$Y = W \sum_{j=1}^{n} (L_i \phi_i) + R\,\overline{KS} + GR + \sum_{j=1}^{n} (1-\theta_i)\,(RENTC_i + RENTI_i) - \overline{B}\,ER$$

In the short-run model, with fixed capital, replace $R*\overline{KS}$ in 28 with $\sum_{j=1}^{n}$ $RENT_i\,K_i$

Government Revenue:

(29)
$$GR = \sum_{j=1}^{n} [PWI_i\,VTM_i\,tim_i + PWM_i\,C_i^m\,tm_i - PWE_i\,te_i]\,ER$$

Trade Balance:

(30)
$$\overline{B} = \sum_{j=1}^{n} [PWE_i\,E_i - PWM_i\,C_i^m - PWI_i\,VTM_i] - \sum_{j=1}^{n} \theta_i\,(RENTC_i + RENTI_i)\,/\,ER$$

Sectoral Rents:

Consumption Goods:

(31)
$$RENTC_i = (PM_i^v - PM_i)\,C_i^m + prc_i PWM_i\,C_i^m\,(1+tm_i)\,ER$$

Intermediate Goods i:

(32)
$$RENTI_i = \sum_{j=1}^{n} (PMV_{ij}^v - PMI_i)\,VM_{ij} + \sum_{j=1}^{n} VM_{ij} PWI_i (1+tim_i) pri_i ER$$

TABLE 3.1 (continued)

Numeraire:

(33) $$1 = [\sum_{j=1}^{n} PD_i \, X_i^o] \; / \; [\sum_{j=1}^{n} PD_i^o X_i^o],$$

where the superscript ^{o} denotes the value in the initial equilibrium, or base year data.

TABLE 3.2

LIST OF VARIABLES

		Number of Variables
Endogenous Variables		
C_i^d	final domestic demand for the output of sector i	n
C_i^m	final demand for imports of sector i	(n-1)
D_i	output of sector i supplied to the domestic market i	n
E_i	output of sector i supplied to the export market i	(n-1)
ER	real exchange rate	1
GR	government revenue	1
K_i	demand for capital from sector i	n
L_i	demand for labor from sector i	n
LS	aggregate supply of labor	1
P_C	price of composite final good	1
PC_{ij}	composite costs of inputs from sector i paid by sector j	n^2
PD_i	price of domestic goods, sector i	n
PE_i	domestic price of export goods, sector i	(n-1)
PHI_i	equal premia rate across intermediate sectors with new QRs	(n-1)
PM_i, PM_i^v	domestic price of consumption goods imports without new QRs (PM_i) and with QRs (PM_i^v)	2(n-1)
PMI_i, PMI_i^v	domestic price of intermediate imports without QRs (PMI_i) and with QRs (PMI_i^v)	2(n-1)
PMI_{ij}^v	domestic price of intermediate imports with QRs and rationing by individual sectors	

TABLE 3.2 (continued)

		Number of Variables
PN_i	unit value added (net) price of sector i	n
PS_i	composite price of output of sector i	(n-1)
PWE_i, PWM_i (PWI)	world price of exports and imports (final and intermediate) respectively (mostly exogenous)	
R	rental rate on capital	1
$RENT_i$	rent on capital in sector i when capital is immobile	
$RENTC_i$	quota rents on imports of final consumption goods of sector i	(n-1)
$RENTI_i$	quota rents on imports of intermediate products from sector i	(n-1)
V_{ji}	composite use by sector i of intermediates, inputs from sector j	n^2
VD_{ji}	use by sector i of domestic inputs from sector j	n^2
VM_{ji}	use by sector i of imported inputs from sector j	n(n-1)
VTD_i	total demand for domestic intermediates from sector i	n
VTM_i	total demand for imported intermediates from sector i	(n-1)
W	undistorted average wage rate	1
WG	weighted average wage rate across sectors	1
X_i	gross output of sector i	n
Y	consumer income (net of transfers)	1
	TOTAL	$3n^2$+n(n-1)+8n+12(n-1)+7=585

Note: Number of endogenous variables depends on model closure. See chapter 4.

Exogenous Variables

$\overline{B}$	balance of trade (in foreign currency units)
$\overline{FK}$	net remittances from abroad
$\overline{KS}$	economy-wide endowment of capital

TABLE 3.2 (continued)

$\overline{\text{MAXHOURS}}$	maximum hours available for work after minimum leisure requirement
prc_i, pri_i	preexisting quota premia rate on consumption and intermediate goods, respectively
tim_i, tm_i, te_i	ad valorem tariffs for intermediates and consumer goods and subsidies on exports, respectively
PWE_i, PWM_i; PWI_i	world price of exports, imports of consumption goods and imports of intermediate goods, respectively, in foreign currency units
λ_i^d, λ_i^m	minimum consumption of the ith domestic and imported final good, respectively.

Elasticities and Share Parameters

θ_i	share of quota rents in sector i captured by foreigners
$-\pi_i$	elasticity of demand by the rest of the world for the exports of sector i
ψ_i	parameter reflecting the premium earned by workers in industry i
Ω_i	elasticity of supply by the rest of the world for final goods of sector i
$\sigma c_i = 1/(1-\rho c_i)$	elasticity of substitution in use between domestic and imported intermediates
$\sigma t_i = 1/(\rho t_i-1)$	elasticity of transformation in allocation between domestic and export sales
$\sigma_i = 1/(1-\rho_i)$	elasticity of substitution between capital and labor

Shift Parameters

$\overline{AC}_{ij}$, $\overline{AD}_i$, $\overline{AT}_i$	shift parameters in intermediate demand, value added and output transformation, respectively.

study by the equation number appearing in table 3.1. Equations written within the text of chapters, have a chapter number preceeding them.

Technology

Production is characterized by two level nesting. At the first level, there is a Leontief input-output production function. At this level, firms use a composite of primary factors of production, and n composite intermediate products (one for each sector). Since the firms cannot substitute the composite primary factor of production for intermediates, or intermediates of one sector for intermediates from another, the production function at level one is strongly separable.3/ At the second level, the composite functions are defined. The composite primary factor of production is a composite of two primary factors, capital and labor. These primary factors of production substitute smoothly for each other through CES value added functions (or as a special case, Cobb-Douglas). The parameters of the CES vary across sectors. Each sector uses intermediate inputs, and, except for nontraded goods, these inputs come from both domestic and foreign sources. Intermediate inputs from a given sector are a composite of domestic and foreign intermediate inputs. Firms smoothly substitute domestic and foreign intermediate inputs in a given sector through a CES aggregator function defined by equation (8). These assumptions are reflected in the first level Leontief production function:

(3.1) $$X_i = \min \{F_i(K_i, L_i), V_{1i}/a_{1i}, \ldots, V_{ni}/a_{ni}\},$$

3/ See Blackorby et al. (1978) or Phlips (1974).

where X_i is gross output of sector i. The functions $F_i(K_i, L_i)$ are the value added functions in labor and capital. When these are Cobb-Douglas, we utilize equation (1a); when they are constant elasticity of substitution, we utilize equation (1b).

Primary Factor Markets

Equation (2) defines the weighted average wage rate when there are labor market distortions. It is the weighted average of the wage rates in the individual sectors. If there are no distortions across sectors, that is if ϕ_i equals unity for all sectors, then WG reduces to W, a common undistorted wage rate for similarly skilled workers across sectors.4/

Equation (3) is the aggregate supply of labor equation. The detailed derivation and explanation of equation (3) is explained below in section 3.5, where we discuss the utility function giving rise to equation (3). In equation (3), $\overline{\text{MAXHOURS}}$ is the maximum available hours for work, defined to be the total time available less the minimum subsistence amount of leisure. The worker-consumer supplies more labor as the wage rate increases. Analogously to the econometric treatment of Abbot and Ashenfelter (1978), we have eliminated the somewhat arbitrary variable "time" from the labor supply equation.5/ This is an advantage over Ballard et al. (1985) who report that the choice of the value for time has a surprising effect on the welfare results.

4/ The wage distortion issue is discussed in more detail in the calibration chapter.

5/ We explain in chapter 5 how $\overline{\text{MAXHOURS}}$ is determined by other variables or parameters in the model.

Equation (4) is the demand for labor by industry. We use either (4a) or (4b) depending on whether technology is Cobb-Douglas or CES. Labor demand follows from the first-order conditions for profit maximization. The inclusion of the exogenous parameter ϕ_i denotes wage differentials across industries. As discussed in more detail in chapter 4, we treat ϕ_i as a wage distortion. This allows us to model the effects of wage distortions due to unionization in the steel and automobile sectors. Equations (5a) and (5b) are the analogous demand for capital equations. Equations (6) and (7) are the market equilibrium equations for capital and labor. These equations determine the economy-wide wage and rental rates. In the short run model, capital is immobile. Then sectoral rental rates are determined residually. Thus, in the short-run model, we replace R with $RENT_i$ in equations (5). An alternative to equation (6) would be to assume perfect capital mobility across international borders. In that case, a unique rental rate on capital would be exogenously given to the model and equation (6) would be dropped from the model.

<u>Intermediate Product Demand</u>

V_{ji} is the amount of good j used by industry i. It is a composite variable, reflecting an aggregation of the differentiated domestic and imported components in sector j. Firms in sector i use both imported (VM_{ji}) and domestic (VD_{ji}) intermediates from sector j so as to minimize the costs of producing any output level (9a, 9b). Substitution possibilities between domestic and imported intermediates are given by (8). The elasticity of substitution between domestic and imported intermediates in a given sector is defined as:

$$\sigma c_i = [\partial(VD_{ji}/VM_{ji})/\partial(PMI_{ji}/PD_j)]\ (PMI_{ji}/PD_j)/(VD_{ji}/VM_{ji}) \qquad i\epsilon T$$

Differentiation of equation (9a) yields $\sigma c_i = 1/(1-\rho c_i)$. Given the restraints on ρc_i, the elasticity of substitution is positive, and imported and domestic goods approach perfect substitutes as ρc_i approaches 1.

For example, consider the use of steel by various industries. Typically, different industries will use imported and domestic steel in different proportions. For this reason, it would be more general to write the share coefficient as δ_{ji}, so that it is indexed across the industry of destination. In practice, however, there are no data available for the US that would allow us to calibrate δ_{ji}. In particular, the US input-output tables are presented in a manner that combines the domestic and imported use of intermediate inputs. What is required, and some countries such as Korea publish such data, is a separate input-output table for imported and domestic intermediate inputs. Lacking these data, we assume that the domestic to imported use ratio of an input is the same regardless of the destination industry. Thus, we will assume $\delta_{ji} = \delta_j$ for all i. This means that if automobiles use 75 percent domestic steel and 25 percent imported steel, then all other sectors use domestic and imported steel in the same proportions.

Equation (9a) is the cost minimizing ratio of domestic to imported intermediates, given the substitution possibilities presented by equation (8). Figure 3.2(a) shows the cost minimizing use of imported and domestic intermediates. By definition, there are no imports of nontraded services; hence equation (9a) does not apply since nontraded services is not an element of the set T, where the set T denotes traded sectors. In that event equation (9b) applies, where NT denotes nontraded sectors.

Equation (10) is the Leontief assumption regarding intermediate requirements from different sectors.

The assumption of product differentiation on the import side is extended to the export side. By the same logic, exports and domestic products are treated as differentiated products. An intuitive example is that of Mercedes-Benz. The car it exports to the US is much more luxurious and expensive to produce than the model of the same name produced for its domestic European market. Contrary to the European version, the US vehicle has leather upholestry and air conditioning as standard equipment; and Mercedes must make the vehicle so that it conforms to US environmental and safety regulations. Thus, it cannot transform a domestic unit of production into an export costlessly.

Accordingly, the model assumes that firms can transform domestic production into exports according to a constant elasticity of transformation (CET) frontier represented by equation (11). The elasticity of transformation of this frontier is defined as:

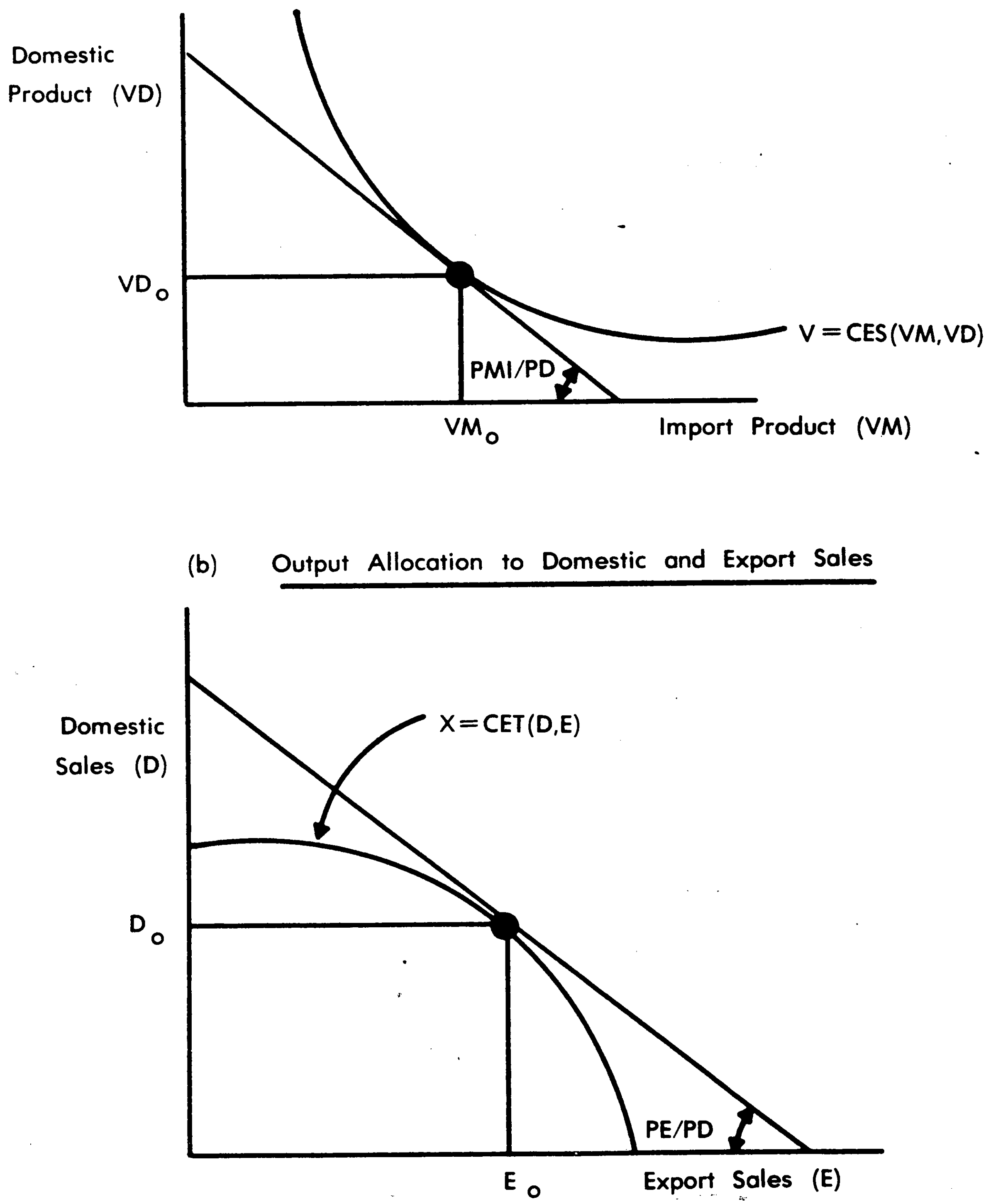
$$\sigma t_i = [\partial(D_i/E_i)/\partial(PD_i/PE_i)]\ (PD_i/PE_i)\ /\ (D_i/E_i) \qquad i \in T.$$

Differentiation of equation (12a) yields $\sigma t_i = 1/(\rho t_i - 1)$; the elasticity of transformation is nonnegative for acceptable values of ρt_i. A special case of the model is the one in which the elasticity of transformation approaches infinity; the frontier approaches a downward sloping straight line and reduces to the case of costless or perfect substitution between exports and

FIGURE 3.2

SUBSTITUTION ELASTICITIES

(a) Substitution in Intermediate Demand



domestic products. Thus, our model is clearly a generalization of the usual approach with an undifferentiated domestically produced good.

Because of the assumption of product differentiation on the export side, the variable X_i is a composite product, analogous to the composite intermediate V_{ji}. The firm produces for domestic sales, D_i, and for export sales, E_i. The firm desires to maximize revenues for any given level of composite output production. Alternatively expressed, given that the firm must operate on its production transformation frontier, the firm attempts to maximize revenues. Maximization occurs when domestic and export sales conform to the ratio given by equation (12a). As shown graphically in figure 3.2(b), the profit maximizing ratio of exports to domestic sales in sector i occurs when the absolute value of the slope of the production transformation frontier equals the relative price between sales on the domestic and export markets.

As before, we assume that the nontraded good is neither imported nor exported. Thus, equation (12b), rather than (12a) applies for the nontraded sector.

Cost-Determined Prices

Since the representative firm in each sector maximizes profits (minimizes costs) and technology is CRTS, the composite price of domestic and export sales of each sector is determined solely by the prices of the domestic and export goods, and composite costs of intermediate inputs (of sector i into sector j) are determined solely by the costs of imported and domestic intermediate inputs (of sector i into sector j). Equations (13)-(15) give the unit prices that correspond to the selected functional forms for technology. For example, PS_i is the unit price of output produced in sector i when output is sold to the domestic market at unit price PD_i and to the export market at the unit domestic currency price, PE_i. Equation (13) is obtained by substituting equation (12a) into equation $PS_iX_i = PD_iD_i + PE_iE_i$, which defines total sales of domestic output in terms of each component sale. 6/ Likewise equation (14) is obtained by substituting equation (9) into the definition of total purchases in terms of its domestic and imported components, $PC_{ji}V_{ji} = PD_jVD_{ji} + PMI^v_i VM_{ji}$. Finally, in equation (15), equilibrium net price or value added per unit of output, PN_j, is obtained via profit maximization given PS_j.

6/ Alternatively, equation (13) can be obtained directly from profit maximization. Temporarily drop sector subscripts. A sector wishes to maximize revenues for any given output level. The Lagrangian is:

$$(3.2) \qquad L = PD*D + PE*E + \lambda[\bar{X} - X(D, E)],$$

where X(D ,E) is equation (11), and $\bar{X}$ is the fixed level of composite output. The first order conditions are:

$$(3.3) \qquad PD = \lambda*X_D \quad \text{and} \quad PE = \lambda*X_E$$

where X_D and X_E are partial derivatives. From (3.3) we get:

$$(3.4) \qquad PD*D + PE*E = \lambda[D*X_D + E*X_E] = \lambda X(D,E).$$

The equality on the rhs of (3.4) follows from Euler's Theorem, since X is homogeneous of degree one. In the lhs of (3.4), we have the optimum quantities of D and E. Therefore, the lhs is the maximum revenue obtainable from the composite output level X. Since λX equals this value, λ must be the average price of the output level X. Substitute into equation (11) the optimum values of D and E obtained from 3.3, and solve for λ. This yields equation (13).

An entirely analogous argument gives the price of the composite intermediate V_{ij}. Its price is expressed in equation (14).

<u>Definition and Determination of Import and Export Prices</u>

This block of equations translates prices expressed in foreign currency units into prices perceived by domestic users. For exports and both categories of imports, it is necessary to add the ad-valorem border tax rates (te_i, tm_i, tim_i) to the corresponding world prices after having expressed these prices in domestic currency units by multiplying these prices by the exchange rate, ER. (ER is the scalar that can be thought of as translating world prices into domestic currency units.)7/ This is done in equation (17), (18), and (21).

Next, a distinction must be made between sectors where import supply is infinitely elastic (equation 16a) and sectors where import supply is upward sloping (equation 16b). In our application, we will occasionally assume that (16b) applies for the supply of imported motor vehicles. Likewise, we will usually assume that the foreign export demand is infinitely elastic (equation 22a). Sometimes, however, we will assume a downward sloping foreign export demand for agricultural exports (equation 22b).

Finally we have to deal with QRs. Two cases occur. In textiles and apparel and autos, QRs existed in the base year. Figure 3.3(a) shows how the premium inclusive price is determined under the assumption of an infinitely elastic import supply for the case of autos. Here import demand is assumed to be entirely for final demand. As discussed in chapter 6, we have an estimate of the premium rate prc_i due to imports of autos being restricted to CM_i^o by the VER in the base year. By choice of units (see

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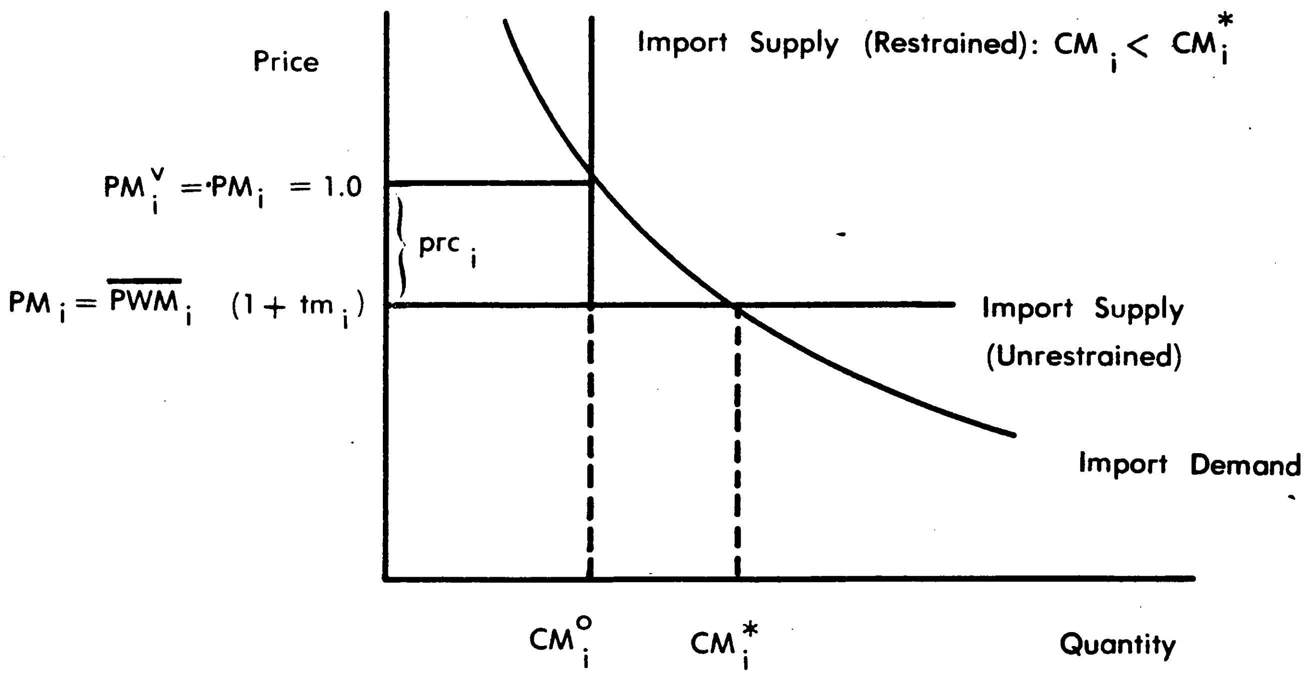
7/ Strictly speaking, since the model only determines relative prices, it is inappropriate to speak of "currency." However, given our numéraire selection (see below), ER can be considered the real exchange rate which is an endogenously determined variable in the model when there is a balance of trade constraint. See Appendix 3A.

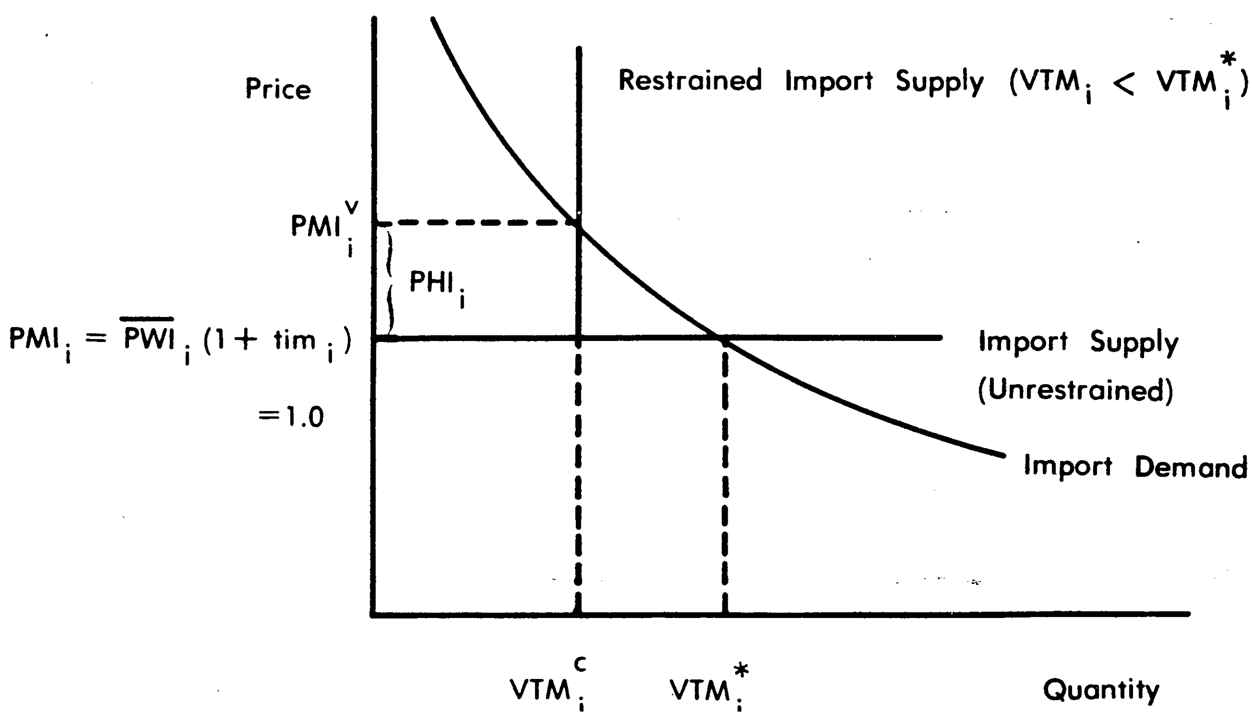
FIGURE 3.3

IMPORT PRICE DETERMINATION WITH RATIONING

(a) Pre-Existing Rationing: Consumer Good Example



(b) Restraining Supply from Quota-Free Equilibrium: Intermediate Good Example



chapter 4) we choose the premium inclusive price in the base year to be equal to 1. Thus, in this case the premium rate is exogenously given, and abolishing the VER consists of setting $prc_i = 0$. The case of preexisting quotas is covered in equations (17), (18) and equations (19a) and (20a).

The other case is steel, an intermediate product. In this case, there were no restrictions in the base year so $VTM_i^o = VTM_i^*$, i.e., actual total steel imports in the base year (VTM_i^o) equal desired imports (VTM_i^*) where i here refers to steel. Let VTM_i^c equal the quota restrained amount of steel imports allowed in the new equilibrium. Estimating the cost of the VERs in steel consists of setting $VTM_i^c < VTM_i^o$ and computing the premium inclusive price PMI_i^v at which VTM_i^c will be actually demanded. This case is shown in figure 3.3(b). Thus, whenever $VTM_i^c < VTM_i^o$, then $PMI_i^v > PMI_i$ and the premium rate PHI_i is endogenously determined. This case is covered by equations (20c) and (20d). Note that the constraint is on the aggregate imports of steel rather than on imports demanded by individual sectors. Thus, the quota restrained steel goes to the highest bidder, which leads to an equal premia rate PHI_i.

Premium inclusive import prices are denoted with a superscript v. This superscript denotes the "virtual" price that sector i must pay for imported intermediates from sector j. Double subscripts allow for the possibility that not all sectors are treated equally under a quota or rationing scheme. In particular, we allow for the possibility that each sector is rationed separately.

The concept of a virtual price was developed by Neary and Roberts (1980). Using duality theory, they show how we may derive constrained demands, when the quota is allocated or rationed in some way other than by market clearing prices. An obvious reason for nonclearing prices would be government price controls. Neary and Roberts call the price that would result in an unrationed user purchasing the same amounts as when he is rationed, the virtual price. Although not uncommon in developing countries, the US generally allows market clearing prices of goods imported under a quota. Thus, in our simulations, the virtual price reduces to the ordinary market price under a quota. Our specification, however, allows for a generalization to the situation where the market does not clear.

Returning to the description of equations, equation (17) defines the tariff and preexisting premia inclusive price of final goods, in home currency, without the effect of any new quotas. Thus, if textiles and apparel are imported in the base period under a preexisting quota, PM_i would be calculated as follows: PWM_i is the price (in foreign currency units) at which the rest of the world is willing to supply the product in the US. ER times PWM_i converts the price charged by the rest of the world to US dollars. This we refer to as the border price. When the border price is multiplied by $(1+tm_i)$, where tm_i is the tariff rate, we obtain the tariff inclusive border price. Finally, if there is a US quota in the initial equilibrium that induces the price to be higher than the tariff inclusive border price, then we multiply this latter value by $(1+prc_i)$ to obtain the price in the domestic market without the influence of any new quotas. Here prc_i is defined as the premium US consumers pay above the tariff inclusive border price, as a result of preexisting quotas. The value of prc_i is important in our textiles and apparel, and motor vehicle experiments; it must be obtained from data sources outside the model.

Equation (18) is directly analogous to equation (17) for intermediate products. If imports of final goods of sector i are subject to new binding quotas, then the price of final imports of sector i would be determined by equation (19b). Equation (19a) would not apply as the price determining equation. If, however, there are no new quotas imposed in the sector, then equation (19a) applies.

Equations (20a) and (20b) are analogous to equations (19a) and (19b). Equation (20b) applies, if and only if, there is a binding quota on sector j's imports from sector i. As mentioned in the discussion of equation (9), we allow for the possibility of each sector being individually rationed. If the quota on imports from sector i is not distinguished by destination sector, but is simply an aggregate quota on intermediate products, then equation (20c) would apply. This is the case described in figure 3.2(b). In that event the premia rate will be equalized across sectors and equation (20d) will also apply.

Equation (21) defines the price, in US dollars, that US firms obtain for their exports. PWE_i is the price, in foreign currency units, that US firms obtain for their products. Multiplication by ER converts it to domestic currency units. If there is an export subsidy (or tax), at te_i*100 percent per unit, then firms receive the amount reflected by the export subsidy (or tax). Equations (22) tell us how the export price of US exports is determined. If the US is too small in relation to world markets to influence the price, then (22a) applies, and PWE_i is treated parametrically. If US firms face a downward sloping demand for their exports, then equation (22b) applies. This is a constant elasticity of demand function, with elasticity $-\pi_i$.

Consumer Demand and Domestic Supply-Demand Balances

Equations (23) and (24) are the demand functions of US residents for final consumption of domestic and imported goods, respectively. The form of these functions is the "linear expenditure system," that is derived from a Stone-Geary utility function. Subject to the restrictions on the parameters that are specified, these functions satisfy the usual and desired properties of demand functions. In particular, they satisfy the adding-up, symmetry of the cross-substitution effects, negativity of the direct substitution effects and homogeneity conditions. (See Phlips, 1974 for a further description of these well-known properties.) Due to the fact that we have generalized the utility function to include a labor-leisure tradeoff, our Stone-Geary utility function for commodities is part of a nested Stone-Geary utility function for leisure and commodities. This is explained in the welfare section 3.5 below.

We now turn to the demand-supply balances. First, we obtain total intermediate demand for domestic and imported goods by sector of origin in equations (25) and (26). Then, the supply-demand balance is given by equation (27). In equilibrium, total domestic supply to the domestic market, D_i, must equal total demand, i.e. consumption demand plus intermediate demand. Although all endogenous variables in the model are determined simultaneously, we can think of equation (27) as determining the price of domestic goods in sector i, PD_i.

Income, Trade Balance, Rents and Numeraire

Equation (28) defines consumer income. The consumer earns income through the sale of his labor and capital. All labor and capital income goes to the representative consumer. The government returns to the representative consumer the proceeds from tax collection. This implies that, in effect, the government maintains a balanced budget. Government revenue is defined in equation (29). In this model government revenue is obtained from tariffs on intermediate and final goods imports; the government's expenditures are on subsidies for exports. However, in our application to the US, there are no export subsidies.

It is preferable to treat the government in this manner for two reasons. First, it is the economically appropriate way to model the process, because without government production activity, government deficits need to ultimately be paid for through the tax obligations of citizens. Second, otherwise there will be a grossly exaggerated picture of the effect of government policy changes. Consumer welfare comes from consumption, which is dependent on income. If the government budget surplus were not part of income, then an increase in taxes would, in addition to the distortionary costs, have a more significant effect on lowering income. For example, suppose the government increases subsidies to an industry. There will be distortion or inefficiency costs associated with the subsidy. These will be measured by our model, regardless of whether the government surplus is part of consumer income. If the government surplus is not part of consumer income, however, then consumer income will rise due to the increase in profits and labor income in the subsidized industry. This income effect is likely to dominate the distortion or inefficiency costs of the subsidy, resulting in the conclusion that the subsidy is beneficial. If instead, we recognize that the subsidy imposes budgetary costs on the government that will ultimately result in tax obligations of the citizens, then we should include the reduced government surplus (or increased deficit) in the consumer's income. With this reduction in income taken into account, we derive sensible estimates of the welfare costs of distortions.

The surplus in the balance of payments, defined in domestic currency units, is a reduction from consumer income. This reflects the fact that whatever is exported cannot be consumed, and conversely for imports.

θ_i is defined as the share of rents on quota restrained imports of sector i (either preexisting or new) that are captured by foreigners. If the US captures the rents, then it is paying less for the imports to foreigners, and has more income to spend on other goods. Thus, we substract from income, the share of rents paid to foreigners.

The balance of trade constraint is defined by equation (30). The first term is the value of exports minus imports at border prices. The second term reflects the outflow of payments to foreigners resulting from premia obtained on quota rights. These premia or rents are obtained either through preexisting quotas or new quotas.8/ The balance of trade is defined in foreign currency units.

Rents on final goods in sector i are defined by equation (31). The rent in sector i, measures the excess paid by consumers over the tariff inclusive border price of the import. If there is a preexisting quota only, the second term captures the rent, and the first term is zero. If there is a new quota only the first term captures the rent, and the second term is zero. If there are both, the first term will measure the additional rents generated by the new quota. Equation (32) is directly analogous to (31) for intermediate products.

8/ We do not explicitly include in the trade balance equation a variable for remittances. Remittances are exogenous to the model. They reflect flows such as interest payments from foreigners on capital invested abroad, and analogous payments by US residents to foreigners. As discussed in the data chapter, net remittances were $16.2 billion in 1984. Thus, the actual trade deficit is $16.2 billion less than that calibrated by equation (30).

As was discussed above, only relative prices matter in this model. To determine relative prices, we must choose a numeraire. We are free to choose any price, or index of prices as our numeraire. The solution, in terms of relative prices, will be independent of the choice or value of the numeraire. As has been shown by de Melo and Robinson (1988), it is convenient to take a weighted average of all domestic prices as our numeraire, and to fix this value at unity, because then the change in the endogenously determined value of ER is the change in the real exchange rate.

3.5 <u>Welfare Measure and Labor-Leisure Trade-Off</u>

<u>Weakly Separable Utility</u>

Equations (3), (23) and (24) were derived via nested Stone-Geary utility functions. In order to simplify notation, for the purpose of this section, delete superscripts in equations (23) and (24); instead let domestic products be numbers 1 through n and imported products be numbered n+1 through (2n-1) = m. Let P_i denote the price of the respective final consumption products, i = 1 through m, and treat the parameters similarly. Finally, denote $\sum_{j=1}^{m} \lambda_j P_j$ by μ.

We define the extended utility function of the consumer-worker as:

$$(3.5) \qquad U(C_o, C_1, \ldots, C_m) = (C_o - \lambda_o)^{\beta_o} \left[\prod_{i=1}^{m} (C_i - \lambda_i)^{\beta_i} \right]^{\beta_C}$$

subject to: $\beta_o, \beta_C \geq 0$; $\beta_o + \beta_C = 1$; $C_o - \lambda_o > 0$; where C_o is leisure. The consumer earns the wage rate WG for every hour worked, and must allocate his total time between labor supply and leisure.

Define the aggregate commodity C as:

$$(3.6) \qquad C - \lambda_C = \prod_{i=1}^{m} (C_i - \lambda_i)^{\beta_i}$$

where $C - \lambda_C > 0$ and C is an aggregate of all commodities.

Equations (3.5) and (3.6) imply that the utility function is weakly separable between leisure and commodities. Thus, the consumer-worker's decision problem can be viewed as a two-stage maximization procedure. In the first stage, we substitute the lhs of (3.6) into (3.5) and maximize utility subject to "full income." This stage, which is discussed below, determines the allocation of time to work and leisure, and the money income to spend on commodities. Having determined the money income to spend on commodities, the consumer then maximizes her branch utility function (3.6) subject to money income. Due to weakly separable utility, the influence of the wage rate is limited to its effect on money income.9/ It has been shown (Samuelson, 1947-48) that equations (23) and (24) result from maximization of 3.6 subject to money income.10/

9/ See Phlips (1974), Blackorby, Primont and Russell (1978) and Green (1964) for derivations of the results of weakly separable utility.

10/ Readers familiar with the Abbot and Ashenfelter (1976) treatment of the choice of leisure and commodities, may question the need for a two-level nested Stone-Geary utility function. That is, Abbot and Ashenfelter employ a single level Stone-Geary utility function, by defining utility as:

$$U = \sum_{i=0}^{m} (C_i - \lambda_i)^{\beta_i} \quad \text{with} \quad \sum_{i=0}^{m} \beta_i = 1$$

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Welfare with No Labor-Leisure Tradeoff

In order to understand the welfare concepts, first consider the simpler case where the consumer receives no utility from leisure. In this case, $\beta_0 = 0$, there will be a perfectly inelastic labor supply and the utility function reduces to:

$$(3.7) \qquad U = \prod_{i=1}^{m} (C_i - \lambda_i)^{\beta_i} .$$

This is the standard Stone-Geary utility function which yields demand functions (23) and (24). Given that the demand functions represent an optimization of the consumer's maximization problem, substituting the demand functions into the utility function gives the the maximum utility obtainable given the prices and income, i.e., the indirect utility function:

$$(3.8) \qquad IU = \prod_{i=1}^{m} [(\beta_i/P_i)\ (Y - \mu)]^{\beta_i} \qquad\qquad i = 1, \ldots, m$$

Continued from previous page

This yields demand and supply equations identical in form to our equations (3), (23) and (24). The problem with this formulation, in the context of general equilibrium, is that we have:

$$\sum_{i=1}^{m} \beta_i < 1.$$

This implies that the commodity demand functions do not satisfy the adding-up condition, i.e., consumers are not spending all of their income. This in turn means that Walras Law will fail to hold. Hence our reformulation.

Define the aggregate commodity C as:

$$(3.6) \qquad C - \lambda_C = \prod_{i=1}^{m} (C_i - \lambda_i)^{\beta_i}$$

where $C - \lambda_C > 0$ and C is an aggregate of all commodities.

Equations (3.5) and (3.6) imply that the utility function is weakly separable between leisure and commodities. Thus, the consumer-worker's decision problem can be viewed as a two-stage maximization procedure. In the first stage, we substitute the lhs of (3.6) into (3.5) and maximize utility subject to "full income." This stage, which is discussed below, determines the allocation of time to work and leisure, and the money income to spend on commodities. Having determined the money income to spend on commodities, the consumer then maximizes her branch utility function (3.6) subject to money income. Due to weakly separable utility, the influence of the wage rate is limited to its effect on money income.9/ It has been shown (Samuelson, 1947-48) that equations (23) and (24) result from maximization of 3.6 subject to money income.10/

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This implies that the commodity demand functions do not satisfy the adding-up condition, i.e., consumers are not spending all of their income. This in turn means that Walras Law will fail to hold. Hence our reformulation.

where IU is indirect utility.

Denote $\beta = \prod_{i=1}^{m} \beta_i^{\beta_i}$. Since $\sum_{j=1}^{m} \beta_j = 1$, we have:

(3.9) $$IU = \beta(Y - \mu) / \prod_{i=1}^{m} P_i^{\beta_i}$$

Inverting gives the minimum level of income necessary to produce level IU, given the prices, i.e., the expenditure function:

(3.10) $$E(P, IU) = (IU/\beta) [\prod_{i=1}^{m} P_i^{\beta_i}] + \mu$$

where P is the vector of final goods prices. Varian (1984) refers to the expenditure function in this form as the indirect compensation function. The expenditure function may also be expressed in terms of the direct utility function as:

(3.11) $$E[P, U(C)] = \{[\prod_{i=1}^{m} P_i^{\beta_i}] [\prod_{i=1}^{m} (C_i - \lambda_i)^{\beta_i}]/\beta\} + \mu.$$

When written in this manner the expenditure function is sometimes called the direct compensation function or the "money metric" utility function.

Use superscripts o and 1 to denote the initial equilibrium and the one the prevails after the policy change, respectively. We desire a measure of how much better or worse off the representative consumer is in the initial equilibrium, facing prices and income (P^o, Y^o), compared with the equilibrium after the policy shift, facing (P^1, Y^1). The answer will depend on whether we take P^o or P^1 as the base, but we may utilize the expenditure function to develop a measure.

Define:

(3.12a) $EV = E[P^o, IU(P^1, Y^1)] - E[P^o, IU(P^o, Y^o)]$ and

(3.12b) $CV = E[P^1, IU(P^1, Y^1)] - E[P^1, IU(P^o, Y^o)]$.

where EV and CV are the Hicksian exact measures of the change in consumer's surplus known as the equivalent and compensating variation, respectively. The first term in EV is the minimum income necessary to reach utility level $IU(P^1, Y^1)$ given prices P^o. The second term in EV is the minimum income level necessary to reach utility level $IU(P^o, Y^o)$ given prices P^o; this term is equal to Y^o. If EV is positive, then the consumer is made better off as a result of the policy shift, because it takes an income greater than his initial income to allow him to reach his new utility level, when initial prices are the constraint. It is well known that EV and CV have the same sign.

In our case EV reduces to:

(3.13) $$EV = [IU(P^1, Y^1)/\beta] \left(\prod_{i=1}^{m} P_i^{o\,\beta_i}\right) + \mu^o - Y^o$$

$$= (Y^1 - \mu^1) \left[\prod_{i=1}^{m} (P_i^o/P_i^1)^{\beta_i}\right] - (Y^o - \mu^o),$$

where $\mu^t = \sum_{j=1}^{m} \lambda_j P_i^t$ t= 0, 1. All of the arguments of the "unobservable" EV in this form are observable; so we take EV as our measure of the welfare change resulting from a policy shift.11/

From the definition of the compensating variation we have:

$$(3.14) \quad CV = (Y^1 - \mu^1) - (Y^o - \mu^o) \left[\prod_{i=1}^{m} P_i^1/P_i^o)^{\beta_i} \right]$$

The welfare measures we shall report are for the EV. Our numerical experience, however, confirms the arguments of Willig (1976), namely that there is very little difference between the two measures.

Labor-Leisure Tradeoff Case

(a) Labor Supply and Leisure Demand

Now consider the general case where there is a labor-leisure tradeoff. In this case equation (3.5) defines the consumer's utility. Substitute equation (3.6) into equation (3.5), yielding equation (3.15).

$$(3.15) \quad U(C_o, C) = (C_o - \lambda_o)^{\beta_o} [C - \lambda_C]^{\beta_C}$$

11/ Since the expenditure function depends on utility and utility is unique only up to a monotonic transformation, the reader may be concerned that our measure is not invariant with respect to a monotonic transformation of the utility function. The expenditure function, however, is defined in relation to an underlying utility function, and it remains invariant with respect to a monotonic transformation of the utility function. That is, let U(C) be the utility function and E[P, U] the expenditure function. Let $U^* = f(U)$ be a monotonic increasing transformation of U. Then the expenditure becomes $E[P, f^{-1}(U^*)]$, which has the same value as the original expenditure function; see Deaton and Muellbauer, 1980, p.43.

It has been shown, by Deaton and Mullbauer (1980, p. 95), that if the consumer-worker maximizes the extended utility function (3.15) subject to her nonlabor income and time constraints, her labor supply function is:

$$(3.16) \quad LS = \overline{MAXHOURS} - (\beta_O/WG)\ [X - P_C\lambda_C - WG*\lambda_O].$$

and her consumption of leisure is:

$$(3.17) \quad C_O = \lambda_O + (\beta_O/WG)\ [X - P_C\lambda_C - WG*\lambda_O].$$

Here X is full income, and P_C is the price of the consumption good C.

X is defined as nonlabor income plus the inputed value of time, i.e., $X = Y_{NL} + WG*T$, where Y_{NL} is nonlabor income and T is total time available. (See Deaton and Mullbauer, 1980 or Abbot and Ashenfelter, 1976.) Since time is spent either working or on leisure, we have:

$$(3.18) \quad X = Y + WG * C_O.$$

Substitute for X from (3.18) into (3.17) and rearrange to get:

$$(3.19) \quad C_O - \lambda_O = (\beta_O/WG)\ [(Y - P_C\lambda_C)/(1-\beta_O)].$$

Subtract $[WG*\lambda_O + P_C\lambda_C)$ from both sides of (3.18). Then utilize (3.19) to substitute for $(C_O - \lambda_O)$ and rearrange to obtain:

$$(3.20) \quad X - P_C\lambda_C - WG*\lambda_O = (Y - P_C\lambda_C)\ /\ (1-\beta_O).$$

In equation (3.16) substitute the rhs of 3.20 for the lhs of 3.20; we obtain equation (3), the labor supply function. Thus, equation (3) is derived under a full optimization procedure. Equation (3.20) shows that when the consumer-worker optimally allocates full income between leisure and commodities, there is a relationship between full income and money income; then the labor supply function derived from an extended Stone-Geary utility function, may be written without reference to the time available to the consumer-worker.12/

(b) The Price of the Composite Commodity.

It is necessary to discuss P_C, the price of the composite commodity, which appears in the labor supply and leisure demand functions. Since P_C is the price of a single aggregate commodity and the consumer spends off all of her money income on commodities, P_C must satisfy:

$$(3.21) \quad P_C C = Y.$$

In addition, in order for the cross-substitution effects between leisure and commodities to be unchanged by the aggregation, we must restrain $P_C\lambda_C$, the value of committed expenditures. In particular, we must have:

$$(3.22) \quad P_C\lambda_C = \sum_{i=1}^{m} P_i\lambda_i = \mu.$$

12/ We shall show that the parameter $\overline{\text{maxhours}}$ is also independent of time.

We shall utilize the expenditure function to derive the price index. Substitute from (3.6) into the lhs of (3.7) and utilize the derivation of (3.9). We obtain:

(3.23) $C - \lambda_C = \beta(Y-\mu)/\bar{P}$

where $\bar{P} = \prod_{i=1}^{m} P_i^{\beta_i}$. Rearranging yields the expenditure function:

(3.24) $Y = C\,\bar{P}/\beta - \lambda_C\,\bar{P}/\beta + \mu.$

From (3.21), the lhs of (3.24) is equal to $P_C C$. Define:

(3.25) $\lambda_C = \mu\beta/\bar{P}.$

Then (3.24) becomes:

(3.26) $P_C C = (\bar{P}/\beta)\ C$

and the desired price index is:

(3.27) $P_C = \bar{P}/\beta.$

With λ_C and P_C defined by (3.25) and (3.27), respectively, they satisfy (3.21) and (3.22).

(c) Welfare Analysis with Labor-Leisure Tradeoffs

In order to obtain the indirect utility function, we must substitute the optimum values of C_i, i = 0, 1, ..., m into (3.5). The form of the optimum value of $(C_o - \lambda_o)$, which we choose to utilize, is given by equation (3.19). Substitute (3.19) into (3.5), and the optimum values of C_i, i=1,...,m as was done in deriving equation (3.9). We obtain the indirect utility function:

$$(3.28) \quad IU = [(\beta_o/WG)*[(Y - P_C\lambda_C)/(1-\beta_o)]]^{\beta_o} * [\beta(Y-\mu) \;/\; \prod_{i=1}^{m} P_i^{\beta_i}]^{\beta_C}$$

Substitute $1-\beta_o$ for β_C, and rearrange to get:

$$(3.29) \quad IU = \left[\beta_o^{\beta_o} \beta^{(1-\beta_o)} [(Y-P_C\lambda_C)/(1-\beta_o)]^{\beta_o} * (Y-\mu)^{(1-\beta_o)} \right] \;/\; [WG^{\beta_o} * \prod_{i=1}^{m} P_i^{\beta_i(1-\beta_o)}]$$

Note that in the special case of no labor-leisure tradeoff, $\beta_o = 0$, and (3.29) reduces to (3.9).

Analogous to the case of no labor-leisure tradeoff, we would like to invert the indirect utility function (3.29), to obtain the expenditure function. The Hicksian equivalent and compensating variations can be determined from the expenditure function. Unlike equation (3.9), the indirect utility function (3.29) is not explicitly invertible, for the expenditure function. That is, we cannot rearrange (3.29) to isolate Y on the lhs as a function of IU, the prices, the wage rate and the parameters on the rhs. One approach to the problem would be to take a special case of

(3.29) where we assume that μ equals zero. This is the approach chosen by Ballard et al. (1985). Requiring μ to equal zero for any set of prices, however, implies that the $\lambda_i = 0$ for all i. This in turn requires that all final demand elasticities are restricted to unity and all cross-elasticities of final demand to zero.13/

In order to allow for different elasticities of demand, according to econometric estimates from the literature, and non-zero cross substitution effects, we choose another approach. Recognize that (3.29) implicitly defines the expenditure function as a function of indirect utility , prices, the wage rate and the parameters, i.e.,

$$(3.30) \quad E = E\{IU, P, WG, \Omega\}$$

where Ω is a vector of the parameters that appear in (3.29). As above, consider a policy change that results in a new equilibrium; use superscripts ^{o} and ^{1} to denote the initial and new equilibria, respectively and define variables analogous to the no labor-leisure tradeoff case. Then IU^o and IU^1 become:

$$(3.31) \quad IU^o = \left[\beta_o^{\beta_o} \beta^{(1-\beta_o)} [(Y^o - P_C^o \lambda_C)/(1-\beta_o)]^{\beta_o} * (Y^o - \mu^o)^{(1-\beta_o)} \right] / [WG^{o\beta_o} * \prod_{i=1}^{m} P_i^{o\beta_i(1-\beta_o)}]$$

13/ See the elasticities chapter for an explanation of the relationship between the λ_i and the own and cross-elasticities.

$$(3.32)\quad IU^1 = \left[\beta_o^{\beta_o} \beta^{(1-\beta_o)} [(Y^1 - P_C^1 \lambda_C)/(1-\beta_o)]^{\beta_o} * (Y^1 - \mu^1)^{(1-\beta_o)} \right]$$

$$/ [WG^{\beta_o} * \prod_{i=1}^{m} P_i^{1\,\beta_i (1-\beta_o)}],$$

where P_C^o and P_C^1 are the prices of the composite commodity in the initial and new equilibria, respectively. Analogous to (3.12), the Hicksian equivalent and compensating variations are:

$$(3.33)\quad EV = E[IU^1, P^o, WG^o, \Omega] - Y^o.$$

$$(3.34)\quad CV = Y^1 - E[IU^o, P^1, WG^1, \Omega].$$

The first term on the rhs of (3.33) is defined implicitly as the solution for Y from:

$$(3.35)\quad IU^1 = \left[\beta_o^{\beta_o} \beta^{(1-\beta_o)} [(Y - P_C^o \lambda_C) / (1-\beta_o)]^{\beta_o} * (Y - \mu^o)^{(1-\beta_o)} \right]$$

$$/ [WG^{o\,\beta_o} * \prod_{i=1}^{m} P_i^{o\,\beta_i (1-\beta_o)}]$$

and the second term on the rhs of (3.34) is defined implicitly as the solution for Y from:

$$(3.36) \quad IU^{o} = \left[\beta_o^{\beta_o} \beta^{(1-\beta_o)} [(Y - P_C^1 \lambda_C)/(1-\beta_o)]^{\beta_o} * (Y - \mu^1)^{(1-\beta_o)} \right] / [WG^{1^{\beta_o}} * \prod_{i=1}^{m} P_i^{1^{\beta_i (1-\beta_o)}}]$$

In (3.35) and (3.36), the lhs is a real number given by (3.32) and (3.31). Thus, Y is the only variable that appears in these equations. We can obtain the <u>numerical</u> solution for Y from equations (3.35) and (3.36), using the General Algebraic Modelling System (GAMS) programming language. Thus, we are able to solve for the value of the expenditure function numerically, and thereby obtain our estimate of equivalent and compensating variation.

APPENDIX 3A

THE REAL EXCHANGE RATE

We briefly discuss the subject of the "real exchange rate." Formally speaking, there is no money in the model, and all prices are relative prices. This fact extends to the concept of the exchange rate. With money in the model, we could define the nominal exchange rate as the number of US dollars necessary to pay for one unit of foreign exchange (say the yen, mark or market basket of foreign currencies such as the SDR). The real exchange rate could then be defined as the nominal exchange rate deflated by a general index of nontraded goods prices. This concept is straightforward to understand, and Harberger (1988) has shown that this concept of the real exchange rate is very versatile and useful. (For some purposes it is necessary to deflate doubly by using an index of foreign traded goods; see Dornbusch and Helmers, 1988.)

Given that there is no money in the model, however, we must define the real exchange rate as a relative price. In models such as these, it is conventionally defined as the price of tradeable to nontradeable goods. That is, if we define an index of the value of all tradeable goods (on world markets) and an index of the value of all nontradeable goods, the ratio is the real exchange rate. We now show that in our model, this less intuitive concept of the real exchange rate, is not far removed from the real exchange rate concept of the first paragraph.

Based on the definitions in our model, the real exchange rate is:

$$RER = \sum_{i=1}^{n-1} [\alpha^i PWE_i{*}ER + \beta^i PWI_i{*}ER + \gamma^i PWM_i{*}ER] / \sum_{i=1}^{n} \tau^i PD_i,$$

where $\sum_{i=1}^{n-1} [\alpha^i + \beta^i + \gamma^i] = \sum_{i=1}^{n} \tau^i = 1$, and all the index weights in the sums are nonnegative. From our equations, this can be rewritten as:

$$RER = \{ER / \sum_{i=1}^{n} \tau^i PD_i\} * \sum_{i=1}^{n-1} [\alpha^i PWE_i + \beta^i PWI_i + \gamma^i PWM_i].$$

Since, for the purposes of a comparative statics exercise,

$\sum_{i=1}^{n-1} [\alpha^i PWE_i + \beta^i PWI_i + \gamma^i PWM_i]$ is fixed unless the home country can influence the world price of the product, the percentage change in the real exchange rate reduces to the difference between the percentage change in <u>our</u> variable ER and the percentage change in the index of domestic prices:

$$\hat{RER} = \hat{ER} - [\hat{\sum_{i=1}^{n} \tau^i PD_i}].$$

where ˆ indicates percentage change in a variable. In general, we choose as the numeraire in our model $\sum_{i=1}^{n} \tau^i PD_i$ (see equation (33)), and fix this value at unity. Thus, given our choice of numeraire, the percentage change in the variable ER in our model is the percentage change in the real exchange rate. Given this relationship, so as to not unnessarily complicate the discussion, we sometimes refer to the variable ER as an exchange rate variable that converts foreign currency units into domestic, despite the fact that there is no money in the model.

APPENDIX 3B

HICKSIAN DEMAND FUNCTIONS

Although we do not employ them in the present study, it is convenient to discuss here, the Hicksian compensated demand functions. In the event that rationed imports are subject to price controls, it would be necessary to have the Hicksian demand functions to follow the Neary-Roberts procedure. The "unobservable" Hicksian compensated demand function can be expressed in terms of the Marshallian demand curve, and is hence indirectly observable. In particular, we have (Varian, 1984, p. 126): $H_i\ (P,\ U) = C_i\ [P,\ E(P,\ U)]$, where H_i and C_i are the Hicksian and Marshallian demand curves for final good i, respectively, and the other variables have been defined. Given the particular Marshallian demand functions above, the Hicksian demand functions may be indirectly observed as:

$$H_i[P,\ U] = \lambda_i + (\beta_i / P_i)\ \beta^{-1} U \prod_{i=1}^{m} P_i^{\beta_i}$$

Analogous to the discussion of expenditure functions above, the Hicksian demand functions are also invariant with respect to a monotonic transformation of the utility function. That is, if $f(U) = U^*$ is a monotonic increasing transformation of the utility function U, then the Hicksian demand functions are replaced by $H_i\ [P,\ f^{-1}(U^*)]$.

CHAPTER 4

BENCHMARKING AND COMPUTATION OF EQUILIBRIA

4.1 Introduction

As mentioned above, we require that the model replicate a base year set of values as an equilibrium. In our case, we choose 1984 as that year. The process of choosing values of certain parameters in the equations of the model, so that the model produces the historical data set as an equilibrium, is known as "benchmarking" the model.

Benchmarking can be illustrated most - simply using a partial equilibrium single market model, with linear supply and demand curves. We observe the price and quantity in a particular historical period and obtain the elasticities of supply and demand. (The elasticities are either econometrically estimated or obtained from best available esimates from the literature.) It then becomes necessary to select values of the intercepts of the supply and demand curves such that the observed data point is an equilibrium. Calibrating the intercepts, given the data point and the elasticities, would be benchmarking in this simple example.

Generally, benchmarking is a straightforward procedure that does not involve assumptions, beyond those just discussed. For the reader unfamiliar with benchmarking, we illustrate how calibration is performed, though we shall not describe all of the benchmarking. In the case of the demand functions for capital and labor, the supply of labor function and the demand functions for commodities, some detail is required, and is presented below.

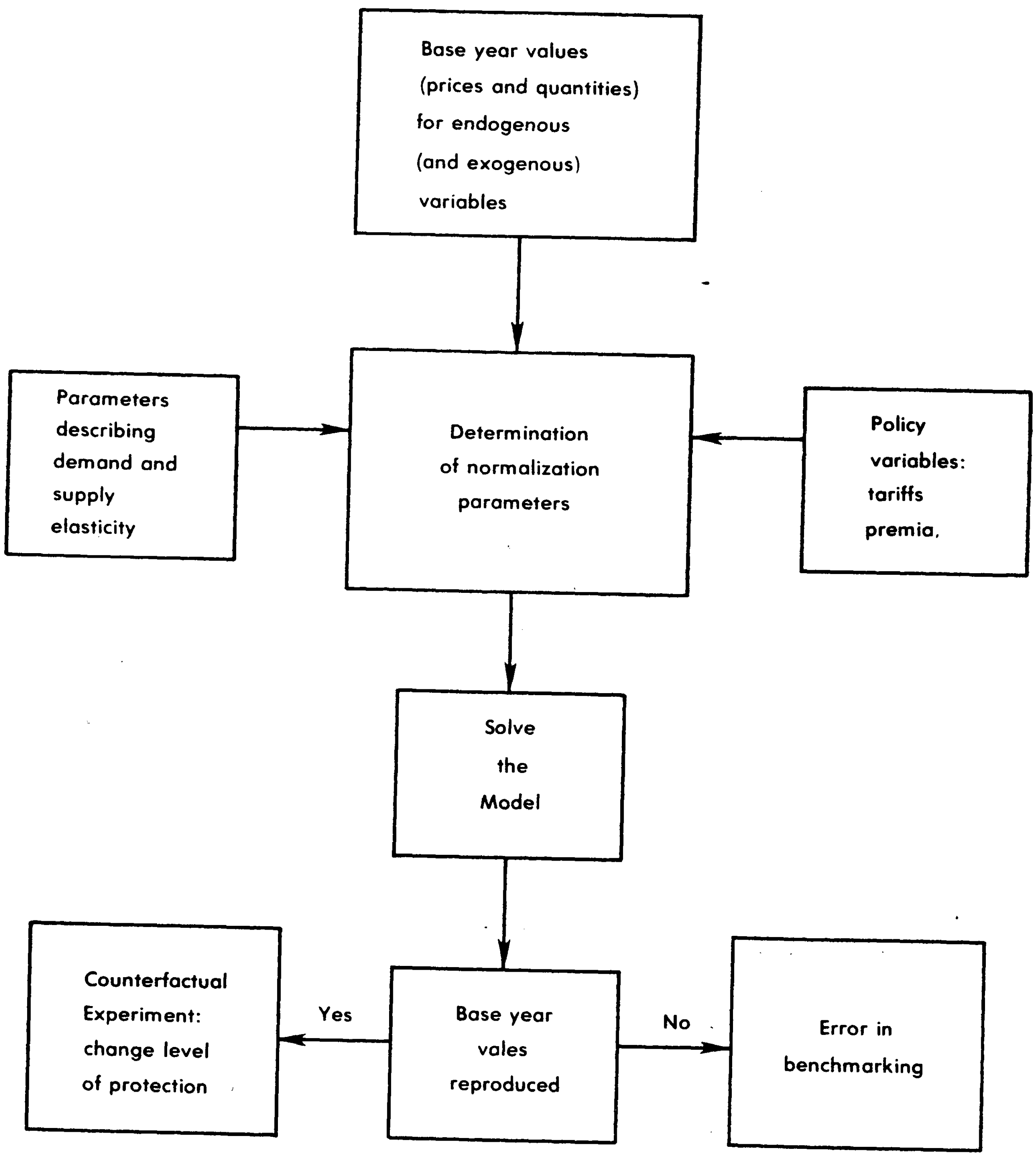
Figure 4.1 illustrates the steps involved in calibrating the USGETM. Start from a consistent set of base year value flows, (i.e., from a "SAM" where each institution's accounts are balanced such that total outlays equals totals receipts, see the data appendix). Then with policy variables and parameters describing demand and supply response, a set of initializing parameters is determined so as to reproduce observed quantities given prices (set equal to unity by choice of units) and elasticities. Formally, the procedure is analogous to the one described above for the single market model. If the procedure is correctly carried out, once the normalization constants are determined, solving the model with the complete set of parameters (including the normalizing constants) will reproduce the initial prices and quantities.

One general observation is in order. First, a strong assumption is made, namely that the base year data represents an equilibrium subject to all the distortions incorporated in the model. In our case, we restrict distortions to trade distortions, assuming in particular that factor markets are in equilibrium (subject to the exception of wages in steel and vehicles discussed below) in the sense that factors are paid their value marginal products. We also assume that "normal" capacity utilization rates prevail in the base year. These are strong assumptions made in CGE simulation models and worth recalling. However, they are also implicit in the underlying partial equilibrium derived estimates as well.

The chapter concludes with a discussion of the method used to compute equilibria.

FIGURE 4.1

MODEL CALIBRATION



4.2 Benchmarking the Data Set

Production Transformation Functions

We begin the discussion of benchmarking in this model with equations (11) and (12a). First, we obtain from the literature the best estimates of the elasticities of transformation between production for the domestic or export markets, σt_i, for each of the 10 sectors. There is a one-to-one correspondence between this elasticity and ρt_i, i.e., $\sigma t_i = 1/(1-\rho t_i)$. The parameters that need to be calibrated are the γ_i and the normalizing constants $\overline{AT}_i$. We chose units such that all prices are unity in the initial equilibrium. For each sector i, equation (12a) may be solved for γ_i in terms of the other values:

$$(4.1) \qquad \gamma_i = 1/[1 + (E_i/D_i)^{(\rho t_1 - 1)}] \qquad i \in T.$$

The values on the rhs of (4.1) are either known data in the initial equilibrium (E_i and D_i), values determined from given elasticities (ρt_i) or values taken to be unity by choice of units (PD_i and PE_i). The solution for γ_i guarantees that equation (12a) holds in the initial equilibrium. Similarly, equation (11) may be solved for $\overline{AT}_i$ in terms of the other values:

$$(4.2) \qquad \overline{AT}_i = X_i/[\gamma_i E_i^{\rho t_i} + (1-\gamma_i)D_i^{\rho t_i}]^{1/\rho t_i} \qquad \rho t_i > 1, \quad i = 1, \ldots, n.$$

Given the solution for γ_i from (4.1), we may calculate $\overline{AT}_i$ from equation (4.2). The solution for $\overline{AT}_i$ from (4.2) guarantees that (11) holds in the initial equilibrium. This calibration must be done for all traded goods sectors. For the nontraded goods sector we take $\gamma_i = 0$.

Substitution Between Imported and Domestic Intermediates

Benchmarking of equations (8) and (9a) is analogous. First we obtain from the literature the best estimates of the elasticities of substitution between domestic and imported intermediate goods, σc_i, for each of the 10 sectors. There is a one-to-one correspondence between this elasticity and ρc_i; in particular $\sigma c_i = 1/(1 - \rho c_i)$. As discussed in the appendix, equation (A.13) holds in the initial equilibrium. The parameters that need to be calibrated are the δ_j and the $\overline{AC}_{ji}$. For each sector i, equation (9a) may be solved for δ_j in terms of the other values:

$$(4.3) \qquad \delta_j = 1/[1 + (VM_{ji}/VD_{ji})^{(\rho c_j - 1)}] \qquad i = 1, \ldots, n \qquad j \in T$$

the values on the rhs of (4.3) are either known data in the initial equilibrium (VD_{ji} and VM_{ji}), values determined from given elasticities (ρc_i) or values taken to be unity by choice of units (PD_j and PMI^V_{ji}). Since the rhs is indexed over both i and j, the parameter δ_j appears to lack sufficient dimensionality. It follows, however, from equations (A.12) and (A.13) that, in the initial equilibrium, $VM_{ji} / VD_{ji} = (1 - d_j)/d_j$, where d_j is the average domestic use ratio for sector j. The solution of (4.3) guarantees that equation (9) holds in the initial equilibrium.

Similarly, equation (8) may be solved for $\overline{AC}_{ji}$ in terms of the other values.

$$(4.4) \qquad \overline{AC}_{ji} = V_{ji} \;/[\delta_{ji} VM^{\rho c_i} + (1-\delta_{ji})\; VD_{ji}^{\rho c_i}]^{1/\rho c_i} \qquad \rho c_i < 1;\; i=1,\ldots,n \quad j \in T$$

Given the solution for δ_j, we may calculate $\overline{AC}_{ji}$ from (4.4). This guarantees that equation (8) holds in the initial equilibrium. This calibration must be done for $i = 1,\ldots,n$, and $j \in T$. We take $\delta_j = 0$ for the nontraded good sector.

Capital and Labor Substitution in Production

As discussed in the elasticities chapter, the value-added functions are normally CES, but are Cobb-Douglas in some cases. The calibration varies according to the value-added function. With Cobb-Douglas functions for a given sector, we calibrate based on equations (4a) and (5a). With CES, we utilize (4b) and (5b). It is not necessary for all sectors to have value-added functions of the same form, and in our simulations they generally do not.

(a) Efficiency Units and Distortions in Factor Markets

Before proceeding with the discussion of the calibration of the parameters, it is necessary to discuss how we measure capital, labor and factor market distortions. Consider the Cobb-Douglas value-added function (1a) and the first order condition for capital demand, associated with it, (5a). In these equations, we measure capital in units of comparable productivity, i.e., in "efficiency units." In any sector, "the capital stock" is composed of many different kinds of capital, e.g., machinery, vehicles and buildings. By writing the value added function as equations (1a) or (1b), we assume that these different types of capital can be aggregated, for each sector, into a measure of the capital stock. The official statistics of the US Department of Commerce report the dollar value of the capital stock by sector. That is, the capital stock of each sector is aggregated, based on a measure of the value of each of the components.

Due to the extreme difficulty in measuring capital accurately, the official statistics of the US Department of Commerce do not fully adjust for differences in productivity of capital across sectors. That is, a dollar of capital in one sector does not necessarily produce the same value of output in all sectors. Moreover, due to various measurement problems the value of capital may not be correctly measured. To illustrate how this measurement error affects the rate of return calculation, let RD_i be a scalar that converts a dollar of capital in sector i (as measured by the official statistics) into capital in efficiency units in sector i, i.e.:

$$(4.5) \qquad K_i = RD_i * \bar{K}_i,$$

where $\bar{K}_i$ is the capital reported in official statistics and K_i is an accurate measure of the quantity of the capital stock in use in sector i. That is, the K_i, which is relevant to the firm's production function (efficiency units of capital) is related to measured capital, $\bar{K}_i$, through (4.5).

Utilizing (4.5), equation (5a) can be rewritten as:

$$(4.6) \qquad R*RD_i = \frac{(1-\alpha_i)\ X_i PN_i}{\bar{K}_i}$$

Equation (4.6) thus displays how the value of the rate of return to measured capital (the rate of return on $\bar{K}_i$) and the value of the composite capital stock in sector i is related to the efficiency unit parameter. On the rhs of (4.6), the numerator is the return to capital. Since the denominator is the measured capital stock, the ratio is the return to measured capital. R is the average return to capital (explained in section 9 of the appendix) across the economy; the more productive is a dollar of capital in sector i (higher RD_i), the higher will be the rate of return to measured capital $\bar{K}_i$, $R*RD_i$.

These observed rate of return differences result, however, from a failure to accurately measure capital. Divide both sides of (4.6) by RD_i yielding:

$$(4.6') \qquad R = \frac{(1-\alpha_i)\ X_i\ PN_i}{RD_i * \bar{K}_i}$$

The denominator of (4.6') is the true capital stock in sector i, and the rhs is the return to appropriately measured capital. That rate of return is equal across all sectors.

Economic theory implies that when capital is mobile across sectors, the rate of return to capital will be equilibrated (as in 4.6'). The above shows that observed differences in rates of return to measured capital across sectors, is consistent with equal rates of return to properly measured capital.

We have an analogous heterogeneity for labor. Depending on the skill level of labor in different sectors, however, the same amount of labor would result in varying amounts of output and hence in different wages. For example, a surgeon is more productive than an unskilled worker, but both are measured as one unit of labor (i.e. one man year).

There is, however, an alternative interpretation of equation (4.6). Suppose we believe that the official statistics of the US Department of Commerce accurately measure the capital stock of different sectors in terms of their relative efficiency. In this case, given $K_i=\bar{K}_i$, the lhs of (4.6) is the rate of return on K_i and we would get different rates of return across sectors. One could then interpret these different rates of returns as due to factor market distortions after accounting for differences in the composition of capital and adjusting for risk. Now let RD_i equal the relative distortion in the capital market of sector i, so that $R*RD_i$ equals the rate of return on capital in sector i. Then equation (4.6) holds, where RD_i would now be interpreted as a measure of the distortion in the capital market in sector i.

As a practical matter, we will observe different rates of return on the measured capital stock across sectors. The question is: do we believe these reflect measurement error that has failed to account for the different efficiency of capital, or do we believe there are limitations on the flow of capital that would result in capital market distortions? Our approach is primarily based on the former view. That is, we believe that capital is not adequately measured for us to build in distortions throughout the model, with consequent second best effects. We do not know of limitations on the movement of capital that would prevent capital moving into a sector when rates of return there are relatively high. When rates of return are low, capital in a sector can decrease through depreciation without reinvestment. It is not necessary for the same physical capital to be mobile across sectors for the rates of return to equalize over time.

We do, however, have a short run version of the model, where capital is fixed across sectors, and the rate of return can vary across sectors. Moreover, where we believe there are distortions in the capital or labor markets, we incorporate that information, and depart from the equal returns to factors assumption. In our model, we limit this interpretation to wage distortions in the automobile and steel markets, where there is strong evidence that labor receives above normal wages after adjusting for skill variations.

(b) Benchmarking the Value-Added Functions

Now consider the problem of benchmarking the value-added functions. In the Cobb-Douglas case, equation (4a) may be rewritten as:

$$(4.7) \qquad \alpha_i = L_i W \phi_i / X_i P N_i \qquad i = 1, \ldots, n$$

We regard the variables on the rhs of (4.7) as data, and calibrate α_i, labor's share of output. ϕ_i, which is the measure of distortion in the labor market is taken to be unity, unless otherwise indicated. In the next chapter, we discuss the measurement of wage distortions in the automobile and steel sectors. Given total employment, and the overall wage share, α, in GNP, we determine W as $W = \alpha$ GNP/L. [1]

Given α_i, we can use (5a) to calibrate the capital stock in each sector (measured in efficiency units). Finally, given α_i and K_i, use of equation (1a) allows calibration of the $\overline{AD}_i$.

If the production function of sector i is of the CES type, then we determine the three parameters α_i, K_i and $\overline{AD}_i$ simultaneously. We treat these parameters as three unknowns and solve equations (1b), (4b) and (5b) simultaneously for these three paramaters.

<u>Consumption Functions</u>

The values of the β_i^d and β_i^m of the demand functions (23) and (24) are related to the price elasticities of demand. How they are chosen, given price and income elasticities of demand, is discussed in the elasticities chapter. For the purposes of the calibration, they are treated as known data, exogenously determined. Define μ as:

1/ This is approximately $18,000 per worker per year. In the context of the above discussion, α_i should be regarded as an efficiency units adjusted share. That is, we reserve ψ_i for a distortion measure. Let

(4.5') $L_i = \bar{L}_i * WD_i$

where $\bar{L}_i$ is hours worked, L_i is skill adjusted or efficiency units of labor, and WD_i is the scalar that converts unadjusted hours worked into efficiency units. Substitute (4.5') into (4.7). The more productive is labor in sector i (higher WD_i), the larger will be the calibrated share α_i. The actual share of employed labor in sector i, $\bar{L}_i$, is α_i/WD_i.

(4.8) $$\mu = \sum_{j=1}^{n} (\lambda_j^d \; PD_j + \lambda_j^m \; PM_j^v) \qquad \text{with } \lambda_j^m = 0 \qquad i \in NT;$$

μ is the value of the minimum subsistence requirements. Define Frisch as the elasticity of the marginal utility of income with respect to income; see Frisch (1959) and Brown and Deaton (1972). In the LES case, it can be shown that Frisch reduces to

(4.9) $$\text{Frisch} = -Y/(Y-\mu).$$

Rearranging, the demand functions and substituting from (4.9), we have

(4.10) $$\lambda_i^d = C_i^d + (\beta_i^d \; / \; PD_i) \; [Y/\text{Frisch}] \qquad i = 1, \ldots, n$$

and

(4.11) $$\lambda_i^m = C_i^m + (\beta_i^m / \; PM_i^v) \; [Y/\text{Frisch}] \qquad i \in T.$$

The value of the Frisch parameter has been estimated by Lluch et al. (1978, pp. 74-75) for 14 countries including the US. The estimated values for the US are between -1.4 and -1.8. The value tends to decrease in absolute value in countries with higher per capita income. The value of Frisch is treated as an exogenously determined parameter in the calibration; but see the elasticity chapter for its precise determination.

Thus, the values on the rhs of (4.10) and (4.11) are known data, and we can determine the minimum subsistence values λ_i.

The Supply of Labor Equation

From the labor supply equation (3) we can obtain:

$$\text{(4.13)} \quad \overline{\text{MAXHOURS}} = \text{LS} + [\beta_0/\text{WG}]*[(\text{Y}-\text{P}_C\lambda_C)/(1 - \beta_0)].$$

β_0 is determined by the labor supply elasticity. All other values on the rhs of (4.13) are data. Thus, although the total time available to the worker-consumer (and the minimum subsistence level of leisure) is part of the maximization process, the labor supply equation (and all other equations) is calibrated without having to reference or make an assumption regarding its value (or that of the minimum subsistence value of leisure). The welfare analysis has also avoided reference to these parameters. The selection of their values is somewhat arbitrary and the welfare results can be surprisingly dependent on their values (see Ballard et al., 1985, 135). Thus, like Abbot and Ashenfelter (1976, p. 397) we regard avoiding reference to these parameters as an advantage.

4.3 Computation of Equilibria

Equations and Unknowns

The number of functionally independent equations and unknowns varies depending on the version of the model. In table 3.2 we have presented a list of the variables. We have counted the variables in the case of quotas on imports, but no rationing of the quota by sector. This yields an equal premia rate, on quota restrained imports, by sector, i.e., equation (20d) is present in the model. Thus, instead of the n(n-1) variables PMI_{ij}^{v}, the 2(n-1) variables PMI_{i}^{v} and PHI_i are present. Moreover, we have considered the case of perfectly elastic import supply and export demand in all sectors, so that PWE_i and PWM_i are exogenous; and with capital stocks mobile, $RENT_i$ reduces to the common rental rate R for all sectors.

In the 10 sector model (n=10) the number of endogenous variables described in table 3.2 is 585. In addition, there are a number of other equations which are part of the "closure conditions." For example, all quantities of imports or exports of nontraded goods are restricted to zero.

Choice of Algorithm

The computer language utilized to write the model is the General Algebraic Modelling System, known as GAMS. GAMS was developed at the World Bank by Alex Meeraus and Tony Brooke. It is a language that (among other things) allows optimization of an objective function (possibly nonlinear) subject to constraints (either linear or nonlinear).

GAMS has a number of algorithms available to solve nonlinear programming (NLP) problems. The algorithm we utilized was MINOS 5, developed by B. Murtagh of the University of New South Wales and P. Gill, W. Murray, M. Saunders, and M. Wright of Stanford University.

In our case, we have equality between the number of unknowns and the number of functionally independent equations. Thus, in NLP terminology, there is only one feasible solution, so GAMS/MINOS reports that one solution as its optimal solution.

Subject to dimensionality constraints, GAMS/MINOS has allowed us to write the model based on what we believe to be the economically correct approach. We have been able to utilize the GAMS/MINOS algorithm to solve the model. This is a significant advantage over the situation five years ago; see, Dervis, de Melo and Robinson, appendix B.

CHAPTER 5

ELASTICITY SPECIFICATIONS

Introduction

This chapter specifies the elasticities used in the model and the sources for these elasticities. Since the values of these elasticities affect results, a range of elasticities is specified. How the range of elasticities is reached is discussed in some detail along with the various data sources. Section 5.1 presents elasticity of substitution estimates for imported and domestic intermediates. Elasticities of substitution between capital and labor are in section 5.2. Elasticities of transformation between domestic and export sales are in section 5.3. Elasticities of final demand are presented in section 5.4, and elasticities of labor supply are in section 5.5.

5.1 Elasticity of Substitution Between Imported and Domestic Intermediates

Consider first σc_i, the elasticity of substitution between imports and domestic goods in intermediate production. As has previously been discussed, $\sigma c_i = 1/(1-\rho c_i)$. Thus, equation (9a) can be rewritten as:

$$(5.1) \qquad VD_{ji}/VM_{ji} = [(1-\delta_{ji})/\delta_{ji}]^{(\sigma c_j)} [PD_j/PMV^v_{ji}]^{(-\sigma c_j)} \qquad i = 1, \ldots, n \quad j \in T$$

Note that 5.1 assumes that there is one elasticity of substitution, regardless of the destination sector. For example, the elasticity of substitution between domestic and imported steel is the same, whether steel is used in automobiles, agriculture or any other sector.

Multiply both sides of 5.1 by VM_{ji}, and for any variable Z denote dZ/Z by $\hat{Z}$. Then we have:

$$\hat{VD}_{ji} = -\sigma c_i \, (\hat{PD}_{ji} - \hat{PMV}^{v}_{ji}) + \hat{VM}_{ji} \qquad i = 1, \ldots, n; \; j \in T \tag{5.2}$$

If we hold all other variables constant, then $\sigma c_i = -(\hat{VD}_{ji}/\hat{PD}_{ji})$. Similarly, if we hold all other variables constant, $\sigma c_i = (\hat{VD}_{ji}/\hat{PMV}^{v}_{ji})$. That is, when all other variables are held constant, the elasticity of substitution is the own elasticity of demand for domestic goods, or analogously the cross elasticity of demand for domestic goods with respect to a change in the price of imported goods. σc_i is not, however, an ordinary uncompensated own elasticity of demand. In the derivation of equation 5.1, we have minimized the cost of producing any output level; that is, the output is held constant. Thus, it is like a compensated elasticity of demand, since the firm stays on the same isoquant in response to the price change.1/

Estimates of σc_i are available from two main sources: Shiells, Stern and Deardorff (SSD) (1986) and Stern, Francis and Schumacher (SFS) (1976). The book by SFS summarizes estimates from the literature and reports best guesses; these estimates have been widely used in applied economic models. The paper by SSD estimates the elasticities econometrically, provides an upper bound on the weighted average standard error of the estimate, and compares the results of the two approaches.

1/ I want to thank Clint Shiells for a helpful discussion regarding these issues.

For the central elasticity (or best estimate) case, the estimates of SSD (their table 4) have been used, where there is a close concordance between the sectors in our model and the aggregation defined there. This includes steel, vehicles, textiles and food. For the textiles and apparel sector, we used the SSD estimate of σc_i for textiles, rather than apparel, because σc_i is an elasticity relating to intermediate production. The elasticity we seek in final demand is one relating to apparel. In a number of cases there is no close concordance between the sectors of SSD and that of our model, so we selected elasticities from representative sectors in the SSD tables. In two cases, traded sevices and mining, we utilized the elasticity estimates for the Australian ORANI model, as reported in Dixon et al. (1982).

The high and low estimates are obtained from the standard error of the estimate, as reported in SSD. The high and low estimates are equal to the best estimate plus or minus one times the standard error of the estimate. Where the standard error exceeded the best estimate, we subtracted a smaller value. For the aggregated products, SSD report a weighted average standard error, which is an upper bound estimate of the true standard error. For three products, consumer goods, traded services and mining, the estimates were approximately doubled to get the high estimate or halved to get the low estimate.

5.2 Elasticity of Substitution of Capital for Labor

Caddy (1976) has surveyed estimates of the elasticity of substitution between capital and labor. These elasticities are reproduced in Whalley (1985). The elasticities generally fall in the range of .5 to 1, with time series estimates generally producing estimates around .5, and

TABLE 5.1

ELASTICITIES OF SUBSTITUTION:
IMPORTS FOR DOMESTIC GOODS IN INTERMEDIATE PRODUCTION

	Elasticities (σc_i)		
Sector	Low Estimate	Central Estimate	High Estimate
Agriculture	.85	1.42	1.99
Food	.15	.31	3.51
Mining	.25	.50	1.10
Iron and Steel	1.10	3.05	5.00
Motor Vehicles	.50	2.01	8.39
Textiles and Apparel	.60	2.58	4.56
Other Manufactured Goods	.13	3.55	6.97
Other Consumer Goods	1.58	3.15	6.30
Traded Services	.90	2.00	4.00

SOURCE: Interpolated from data in Shiells, Deardorff and Stern (1986); and Dixon, Parmenter, Sutton and Vincent (1982).

TABLE 5.2

ELASTICITIES OF SUBSTITUTION: CAPITAL FOR LABOR IN PRODUCTION

	Elasticities (σp_i)		
Sector	Low Estimate	Central Estimate	High Estimate
Agriculture	.48	.61	.74
Food	.62	.79	.96
Mining	.60	.80	1.00
Iron and Steel	.84	1.00	1.16
Motor Vehicles	.50	.81	1.12
Textiles and Apparel	.83	1.00	1.17
Other Manufactured Goods	.60	.80	1.00
Other Consumer Goods	.60	.80	1.00
Traded Services	.60	.80	1.00

SOURCE: Interpolated from data in Caddy (1976) as reported in Whalley (1985); Hekman (1978); and Dixon et al. (1982).

cross-section estimates generally producing estimates around 1. For agriculture, motor vehicles, food and textiles and apparel, we take as our best estimate, the overall assessment from Caddy.2/ The high and low estimates, for these industries, are obtained by adding or subtracting one times the variance of the estimates, respectively. In the case of steel, Hekman (1978) has estimated the elasticity of substitution for the US to be unity, and this value has been used. For the remaining four industries, nontraded services, mining, other manufactured goods and other consumer goods, data are not directly available from Caddy. Since Caddy finds it difficult to rationalize assigning different elasticities to different industries, in these cases we assigned a central elasticity of .8. High and low estimates were obtained by adding or subtracting .2, a value representative of the variances listed by Whalley(1985). The results are reported in table 5.2. The values for the best estimate case are similar to those chosen by Whalley (1985), and by Ballard et al. (1985).

5.3 Elasticities of Transformation

Recall that the elasticity of transformation between domestic and foreign sales is: $\sigma t_i = 1/(\rho t_i - 1)$ where $\rho t_i > 1$ is from equation (12a). Multiplying both sides of (12a) by E_i and substituting σt_i yields:

$$(5.3) \qquad D_i = [(1-\gamma_i)/\gamma_i]^{(-\sigma t_i)} \, [PD_i/PE_i]^{(\sigma t_i)} * E_i \qquad i \in T$$

2/ The textiles and apparel elasticity is a weighted average of the elasticities for textiles and apparel separately.

Analogous to the argument for the elasticity of substitution, we have that, with all other variables held constant, the own elasticity of supply to the domestic market or the export market equals the elasticity of substitution:

$$(5.4) \qquad \hat{D}_i/\hat{PD}_i = \sigma t_i = \hat{E}_i/\hat{PE}_i$$

In the derivation of equation 5.3, however, the firm allocates any fixed level of composite output between domestic and foreign sales to maximize profits. Since the output level is fixed, it is not an ordinary elasticity of supply; rather it is an elasticity of transformation, reflecting the ease with which the firm can shift its factors of production to substitute domestic for foreign output, given a change in the relative price of domestic to foreign output. The elasticity is related to the production function, not to sales.

Econometricians generally have had much more success estimating elasticities of demand than elasticities of supply. As such there are many more studies of the former available. Estimates of the elasticity of transformation, however, are even more scarce. For most of the sectors of the model, we take 2.9 as our central elasticity estimate, with 4.2 and 1.3 as the high and low estimates. These should be regarded as our interpolations. Some basis for these estimates is from Riccardo Faini (1988). He finds that, for Turkey, the long run elasticity of transformation for an aggregate of manufactured goods is 2.9, with a standard error of 1.3. For most goods, this is the value we take in the best estimate case. Because these elasticities enter only indirectly into our model, we have found that our welfare estimates are rather insensitive to significant changes in their values.3/

In principle, the more homogeneous the product, the greater we would expect the elasticity of transformation to be. If, the export and domestic products are identical, and the manufacturer need not alter the production process to produce for the domestic or export market, the substitution between domestic and export products will be great when the relative price changes. We assume that traded services are much less homogeneous than average and agricultural products are more homogeneous than average, and adjust the elasticity of transformation accordingly. The results are in table 5.3.

5.4 Elasticities of Demand for Imported Final Goods

Rewrite the final demand functions, (23) and (24), for domestic and intermediate goods, respectively:

$$(5.5) \qquad C_i^d = \lambda_i^d + (\beta_i^d / PD_i)\ [Y - \sum_{j=1}^{n} (\lambda_j^d\ PD_j + \lambda_j^m\ PM_j^v)] \qquad i = 1, \ldots, n$$

and

$$(5.6) \qquad C_i^m = \lambda_i^m + (\beta_i^m / PM_i)\ [Y - \sum_{j=1}^{n} (\lambda_j^d\ PD_j + \lambda_j^m\ PM_j^v)] \qquad i \in T$$

3/ For example, doubling (halving) the elasticity estimates from the central elasticity case, increases (decreases) our estimates of the welfare gains of aggregate removal of quotas in all 3 sectors (see table 1.1) from $20.9 billion to $21.0($20.8) billion, respectively, or ± .5%.

TABLE 5.3

ELASTICITIES OF TRANSFORMATION IN PRODUCTION

Sector	Elasticities (σt_i)		
	Low Estimate	Central Estimate	High Estimate
Agriculture	2.6	3.90	5.2
Food	1.6	2.90	4.2
Mining	1.6	2.90	4.2
Iron and steel	1.6	2.90	4.2
Motor vehicles	1.6	2.90	4.2
Textiles and apparel	1.6	2.90	4.2
Other manufactured goods	1.6	2.90	4.2
Other consumer goods	1.6	2.90	4.2
Traded services	.30	.70	1.1

SOURCE: Author's interpolations (see text).

subject to: $\beta_i^d > 0$; $C_i^d > \lambda_i^d$, $i = 1, \ldots, n$; $\beta_i^m > 0$; $C_i^m > \lambda_i^m$ $\quad i \in T$

$$\sum_{j=1}^{n} (\beta_j^d + \beta_j^m) = 1; \text{ and } C_i^m = \beta_i^m = 0 \qquad i \in NT$$

Denote by e_{ij}^{dd}, the elasticity of demand for the ith domestic good with respect to the price of the jth domestic good; there are 100 of these own and cross elasticities. Define e_{ij}^{dm} as the elasticity of demand for the ith domestic good with respect to the price of the jth imported good; since there is one nontraded good, there will be 90 of these. Define e_{ij}^{md}, and e_{ij}^{mm} analogously; these compose matrices of 90 and 81 elasticities, respectively. This yields a total of 361 elasticities of final demand for our ten good model.

Our task is considerably simplified, however, by the structure of our demand system. In equations (5.5) and (5.6) there are 19 β_i and 19 λ_i parameters. All other values in these equations are data in the initial equilibrium. Moreover, as discussed in chapter 4, once the β_i are given, the λ_i are determined by the assumption of initial equilibrium. Thus, we need only specify 19 elasticities, to obtain the β_i, and one parameter, known as the Frisch parameter.

In terms of the parameters of the demand functions, the own elasticities of demand can be written as:

$$(5.7) \qquad e_{ii}^{dd} = -1 + (1-\beta_i^d) * \lambda_i^d / C_i^d \qquad i = 1, \ldots, n$$

Given the restrictions on the parameters, this means that good i will be price inelastic if λ_i^d is positive, and it will be price elastic if λ_i^d is negative. An identical relationship holds for the imported goods.

All of the cross-price elasticities follow the same pattern. We consider the matrix of e_{ij}^{dm} as an example. The cross-elasticities of demand are equal to:

$$(5.8) \qquad e_{ij}^{dm} = -(\lambda_j^m \beta_i^d PM_j^v) / (C_i^d PD_i) \qquad \begin{matrix} i = 1, \ldots, n \\ j \in T \end{matrix}$$

Thus, the cross-elasticity is positive (that is, the jth good is a gross-substitute for the ith) if, and only if, λ_j^m is negative. In view of the discussion of 5.7, this means that we can only have gross substitutes where we have price elastic goods. That is, if any good is price elastic with respect to its own demand, then it will be a gross substitute for all other goods in the system. Conversely, if it is price inelastic with respect to its own demand, then it will be a gross-complement for all other goods in the system.

We previously discussed that the λ_i^d and λ_i^m are determined, once the β_i^d and β_i^m and the Frisch parameter are determined. Thus, given Frisch and β_i^d, the own elasticity is determined. With respect to the calibration of the β_i^d parameters, there are two alternate ways to proceed. First, we can choose the β_i^d so that the implied own price elasticities are consistent with literature estimates of price elasticites. Second, we can choose the β_i^d so that the β_i^d are consistent with literature estimates of income elasticities. The latter procedure is possible because $\beta_i^d = \epsilon d_i * PD_i * C_i^d / Y$, where ϵd_i is the elasticity of demand for ith domestic good with respect to a change in income. An analogous relationship holds for the β_i^m and ϵm_i for imported goods. Thus, if we believe that the literature estimates of the elasticity of income is better than the estimates of the own price elasticity, we could allow the β_i to be determined by estimates of the income elasticity. This would, in turn, imply estimates of the own price elasticities that will, in general, be different from the first procedure. Since we believe that estimates of own price elasticities are generally more reliable than estimates of income elasticities, we choose the first procedure.

For the estimates of the own elasticities of demand, we generally relied upon the survey of the estimates for the US by Stern et al. (SFS). The best guess estimate by SFS, is the approximate median of the estimates they surveyed. We choose their best guess as our best estimate. The concordance between their industries and ours is as follows. Food, iron and steel, other consumer goods, and textiles and apparel in the table 5.4 are taken from SFS, table 2.3. We utilize the SFS estimate of apparel (-3.92) for our estimate of the own elasticity of import demand for textiles and apparel, because we desire a final demand elasticity here, and textiles are primarily intermediate products. We use the SFS estimate of the footwear (a representative product) elasticity, as our estimate for the other consumer goods category. For agriculture, all manufacturing, and mining we used the SFS estimates for SITC 0 + 1, 5-9, and 3, respectively. For motor vehicles, we utilized the study by Levinsohn (1987, table 4). Finally, for traded services, we note that the estimates by Houthakker and Taylor (1970) of demand elasticities for services are generally low. We take them to be slightly higher for imported services, but still low relative to the other product categories.

For those elasticity estimates taken from the survey by SFS, the high and low estimate is generally the high and low estimate in their range of estimates. In two cases, all manufacturing and agriculture, we obtained the high estimate by doubling the best guess rather than accept what we

TABLE 5.4

OWN ELASTICITY OF DEMAND FOR FINAL IMPORT GOODS

	Elasticities		
Sector	Best Estimate	High Estimate	Low Estimate
Agriculture	-0.80	-1.60	-0.21
Food	-1.13	-2.30	-0.44
Mining	-0.96	-1.30	-0.63
Iron and steel	-1.42	-2.00	-0.85
Motor vehicles	-1.05	-1.17	-0.92
Textiles and apparel	-3.92	-4.06	-3.77
Other manufactured goods	-1.84	-3.68	-0.48
Other consumer goods	-2.39	-4.31	-0.79
Traded services	-0.60	-1.20	-0.30

SOURCE: Interpolated from data in Stern, Francis and Schumacher (1976), Levinsohn (1987); and Houthakker and Taylor (1970).

TABLE 5.5

OWN ELASTICITY OF DEMAND FOR FINAL DOMESTIC GOODS

	Elasticities		
Sector	Best Estimate	High Estimate	Low Estimate
Agriculture	-0.75	-1.50	-0.38
Food	-0.90	-1.80	-0.45
Mining	-0.50	-1.00	-0.25
Iron and steel	-1.00	-2.00	-0.50
Motor vehicles	-1.19	-1.33	-1.04
Textiles and apparel	-0.40	-0.80	-0.20
Other manufactured goods	-1.50	-3.00	-0.75
Other consumer goods	-1.90	-3.80	-0.95
Traded services	-0.50	-1.00	-0.25
Nontraded services	-0.50	-1.00	-0.25

SOURCE: See footnote for this section.

TABLE 5.6

ELASTICITY OF FINAL DEMAND FOR IMPORTS AND DOMESTIC GOODS WITH RESPECT TO INCOME

Medium (or best estimate) Elasticity Case *

	Elasticities	
Sector	Imports	Domestic
Agriculture	1.21	1.11
Food	1.67	1.37
Mining	1.43	.67
Iron and steel	2.16	1.54
Motor vehicles	1.51	1.75
Textiles and apparel	5.90	0.54
Other manufactured goods	2.80	2.00
Other consumer goods	3.61	2.00
Traded services	0.89	0.00
Nontraded services	0.00	0.51

* The income elasticities also have a high and low value, but are not reported.

SOURCE: Determined by the model, given other estimates of the elasticities.

judged to be an unreasonably high estimate of the SFS range. For traded services, the best estimate was doubled and halved to get the high and low estimates. For automobiles, the high and low estimates were obtained by adding and subtracting the standard error of the estimate from Levinsohn.

5.5 Elasticities of Demand for Domestic Final Goods

The own elasticities of demand for domestic final goods were assembled from a variety of sources.4/ The results are presented in table 5.5.

Unlike the elasticities of substitution and transformation, the elasticities of final demand, for either imported or domestic goods, do not enter explicitly in the model. That is, the elasticity of final demand parameters are not listed explicitly in table 3.2. Rather these values are implied by equation (5.7) and the analogous equation for final import demand. The final demand elasticities, in the initial equilibrium, are determined by the β_i and Frisch parameters. These latter parameters are

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4/ The best estimates of the domestic elasticities were assembled from a variety of sources as follows. For motor vehicles, Levinsohn was again relied upon. For textiles and apparel, the assessment of the literature estimates (-0.40) by Hufbauer et al. (1986) was selected. For iron and steel, Crandall (1981) estimated elasticities of demand for five domestic steel products. These estimates ranged from -.5 to -2. We take -.5 and -2 as our low and high estimates, respectively, with -1 as our best estimate. For mining, we employ the estimate of Bohi and Russell (1978) for crude oil. For agricultural products, we utilize the Department of Agriculture (1984) estimate for dairy_products. For the remaining products, we take approximately 80 percent of the value of the corresponding import demand elasticity. This reflects assumed greater brand loyalty to domestic products.

The high and low estimate for motor vehicles was obtained by adding and subtracting, from the best estimate, the standard error of the estimate. For the other products, the high and low estimates were obtained by doubling and halving the best estimates.

adjusted iteratively until the implied elasticities are within .05 of the values in tables 5.4 and 5.5.

5.6 Elasticity of Labor Supply

Analogous to the demand functions for commodities, we can either choose a value of β_0 to be consistent with an estimated value of the elasticity of labor supply with respect to income or with respect to the real wage. Given our choice of β_0, both elasticities will be determined. This can be seen from the following relationships.

From equation (3), the elasticity of labor supply with respect to the real wage is:

$$(5.8) \qquad e_{LW} = [(1-\beta_0)MAXHOURS/LS] - 1,$$

and the elasticity of labor supply with respect to income is:

$$(5.9) \qquad e_{LY} = -\beta_0\ Y/[(1-\beta_0)\ W*LS]$$

Since MAXHOURS is determined from the initial data once β_0 is, given a choice of the parameter β_0, both elasticities will be determined, in the initial equilibrium, given the data on the initial values of the labor supply, wage rate and income level.

It turns out that in our experiments, the real wage changes by very small amounts, generally less than one-tenth of one percent. Changes in income, however, as a result of the trade policy experiments, are sometimes much more significant, as much as one-half of one-percent. Thus, we choose β_0 to be consistent with the estimates of the elasticity of labor supply with respect to income. We discuss the estimates of the elasticity with respect to the real wage, as well, because if the wage elasticity were significantly greater than the income elasticity, it would become empirically important.

Estimates of the elasticity of US labor supply with respect to income have been surveyed by Killingworth (1983, table 3.5). The Abbot and Ashenfelter (1976, 1979) estimate for a model such as ours are about -0.12. Almost all other estimates for the US fall in between -0.12 and -0.24. Thus, we take -0.12 as the central elasticity estimate and -0.24 as the high elasticity estimate of the elasticity of labor supply with respect to income.

Most studies of the elasticity of labor supply, with respect to the real wage rate, separate males from females. Estimates of the uncompensated elasticity of labor supply of men, based on nonexperimental data, have been surveyed by Pencavel (1986). The 14 elasticity estimates he reports, range from -0.29 to +0.14. The median of the estimates is -0.11. Pencavel (1986, p. 82) takes -0.10 as the best point estimate of the elasticity of labor supply for US men with respect to the real wage.

The evidence for women is somewhat more controversial. Until recently, it was generally accepted that the labor supply of women is much more sensitive to the real wage than that of men. (See Killingsworth, 1983, p. 432). In the Handbook of Labor Economics, Mark Killingsworth and James Heckman (1986, chapter 2, especially pp. 189, 190) survey the evidence regarding the elasticity of supply of female workers with respect to the real wage. The estimates for females cover a much larger range than for males. The 15 studies they survey provide estimates that range from approximately 0 to 15. Recent work by Mroz (1987), however, argues for dramatically lower estimates. Using the same data set, Mroz is able to replicate most of the range of elasticities found in previous studies. His statistical tests, however, reject the economic and statistical assumptions needed to obtain the larger estimates. He concludes that his tests indicate the elasticity of labor supply for women should be close to that of prime age males.5/ Therefore, rather than take the median of the estimates surveyed by Killingsworth and Heckman, a much lower value, that is not very far from zero, appears appropriate.

Since the overall elasticity of labor supply with respect to the real wage is a weighted average of the male and female elasticities of labor supply (women comprised 43.7 percent of the work force in 1984; US Department of Labor, Employment and Earnings, January 1985), the overall elasticity cannot be greater than zero by a significant amount. If we choose β_0 to be consistent with the estimates of the elasticity of labor supply with respect to income (as discussed above), then the implied elasticity of labor supply with respect to the real wage is +0.020 in the medium case and +0.039 in the high elasticity case.

5/ Killingsworth and Hekman (1986, pp. 193-196) accept that Mroz has made a significant contribution regarding the formal testing of a variety of previously untested propositions.

CHAPTER 6

AN ASSESSMENT OF IMPORT RESTRAINTS AND WAGE DISTORTIONS IN TEXTILES AND APPAREL, AUTOMOBILES AND STEEL

6.1 Introduction

In the base year of our model, 1984, both the automobile and the textile and apparel sectors were subject to quantitative restraints. The US had negotiated a voluntary export restraint (VER) with Japan on automobile imports. This VER was unambiguously in effect for 4 years, beginning on April 1, 1981.1/ Quantitative restraints (QRs) on textiles and apparel go back 30 years. The number of countries, whose exports to the US have been subject to QRs, has widened over the years, so that by 1984 the US had QRs on 31 countries (USITC, 1985, p.101). Regarding steel, in late 1984, the US began to negotiate VERs with all significant suppliers of steel to the US market, except Canada. These agreements, however, were not binding in 1984, and we take 1984 as a year of no QRs on steel.2/ Our task in this chapter is to determine how much more US consumers had to pay (per unit), in 1984, as a result of the QRs on textiles and apparel and on automobiles. We also

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1/ The situation after March 31, 1985 regarding Japanese restraint of exports is less clear. In March of 1985, the US Administration announced that it would not seek an extension of the VER. The Japanese then, apparently unilaterally, announced a willingness to extend their limitation on automobile exports to the US, at a level less restrictive than negotiated under the VER. Two explanations for this action are possible. One is that the Japanese learned from their experience with the VER that they could increase their profits in the US by limiting supply and increasing price. That is, they believed they had market power in automobiles, and choose to exploit it in classic monopoly restriction fashion. Second, the Japanese may have been concerned that Congress would impose stiff sanctions against them, if automobile exports to the US were not limited somewhat. We have no information on which explanation is the dominant one.

2/ The US did have some restraints on steel imports in 1984. See footnote 21 for details.

want to determine the level of quantitative restraint, compared with 1984 levels, achieved by the steel VERs.

A number of authors, including Kreinin (1984), Tarr (1985) and Crandall (1987), have argued that steelworkers and autoworkers receive a wage rate that makes it difficult for these industries to compete internationally. The argument is that the respective unions in these industries negotiate a wage that is above the opportunity cost of workers of comparable skill levels, for comparable types of work. Firms are then free to employ as many of these workers as they choose, subject to this artificially high wage rate. The difference between the opportunity cost and the wage received in these industries is a distortion that we shall attempt to measure in this chapter. Welfare results will be dependent upon the estimated value of the distortion. If there is no distortion, that is, workers are receiving their opportunity costs, then the wage rate cannot be lowered. Workers will shift to other sectors of the economy, if the wage rate is lowered. If we estimate that the wage rates are above the competitive level, removal of the distortion will be the first best solution for the economy. We shall estimate the effects of this policy shift. The benefits from removing the quota from the industry, however, will be less the greater the distortion. This is because the value of the worker's marginal product is higher in the industries subject to the artificially high wage. Removing a quota from this industry means that resources, including labor, shift to industries where the value of their marginal product is lower. In the jargon of economics, this is a "second best" result. Given our quantitative model, however, we can determine the overall welfare effects.

6.2 Textiles and Apparel

Introduction

US postwar restraints on imports of textiles and apparel go back to 1957. In that year, a five-year VER on Japanese cotton textiles and apparel exports to the US was negotiated. This was followed by the "Long Term Agreement" regarding cotton textiles, which was in place from October 1962 to December 1973.3/ The agreement was signed by 19 countries, and during this time the US imposed restrictions against 37 suppliers. The Long-Term Agreement was superceded by the first Multi-Fiber Arrangement (MFA I). MFA I, which was in effect from January 1974 to December 1977, expanded the fibers that were subject to restraint. In particular, wool and man-made fibers, as well as cotton fibers, were covered by MFA I. MFA I was followed by MFA II (from January 1978 to December 1981), which in turn was followed by MFA III (January 1982 to July 1986).4/ The MFA has now been extended once more, covering from August 1, 1986 to July 31, 1991. The newest MFA expands quota coverage to previously uncontrolled silk blends and vegetable fibers, principally linen and ramie; it also excludes from coverage some textile items previously covered.5/

3/ The "Short Term Agreement" was in place from October 1, 1962 to September 30, 1963.

4/ There were 41 country participants in the MFA as of 1984 (USITC, 1985, p.xi.).

5/ The reader should consult Keesing and Wolf (1980), for a more detailed history of the MFA.

As of June 1984, the US had imposed QRs on the exports of textiles and apparel from 31 nations. Agreements with 24 of these nations were negotiated under the provisions of the MFA. (See USITC, 1985, p.101 for details.) All important suppliers outside of Europe and Canada are covered.6/ A characteristic of the textile and apparel restraints is that the developed countries tend to restrain the exports of developing countries, but not of each other. Most of the agreements cover a number of different types of textile and apparel products separately. Moreover, for a number of countries and product categories the restraint levels are not immediately binding. Thus, until recently, researchers have found it very difficult to estimate the level of restraint offered by the QRs on textiles and apparel.

Before addressing the measurement problem, we should deal with the issue of whether retailers capture the quota rents from imports. It is sometimes alleged that US retailers will increase their markups in response to lower import prices, and therefore US consumers will not benefit from quota removal. First, note that retailing is a competitive industry, and therefore economic theory would indicate that competition would force retailers to pass along price decreases on imports. Second, Cline (1979) surveyed 1,479 price observations in 4 major US cities; he found that imports of comparable quality, sold at a lower price. Thus, both theory and evidence suggest that retailers pass along lower prices when available.7/ Moreover, it is irrelevant for the purposes of our estimates of net social

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6/ By May 1987, the US had negotiated bilateral agreements with 39 countries to control imports of textiles and apparel (USITC, 1987).

7/ Since we do not know the wholesale price, we cannot, however, conclude from the Cline data that retailers take comparable profit margins on imports and domestic apparel products.

welfare whether retailers capture lower prices. If retailers capture some of the lower prices from quota removal, in the form of higher profits (or returns on capital), then the owners of capital in that industry will have their incomes and welfare increase to that extent. Since, in calculating net social welfare we are not making interpersonal comparisons, the welfare estimates are not affected.

Measuring the Effects of the Quotas

Despite the above mentioned difficulties, Morkre (1984) measured the effects of the restraints on 9 important categories of textile and apparel products from Hong Kong. He did this by obtaining data on the sale of quota rights in Hong Kong in 1980. In Hong Kong, individuals who hold the rights to export textile and apparel products to the US (or Europe) under the MFA can sell these rights. Given competition in this market, the price paid for the right to export the product should equal the premia earned on sales in the US.8/ For example, suppose a producer can make a men's cotton shirt for $4 and sell it in the US for $6. Let the $4 include all costs, including normal profit and delivery charges to and tariff charges in the US. If that producer does not own the right to export the shirt to the US, he will be willing to pay up to $2 to obtain the right to export the shirt. Competition among similar producers in Hong Kong should force the price of the quota rights up near $2.9/ Without the quotas,

8/ See Morkre (1979) for a description of this market.

9/ If there is insufficient competition to force the price of the quota rights up to their full value, then our measure of the premia rate will be an underestimate of the true cost of the quotas. That is, the costs of the quotas will be higher than we estimate, due to this bias.

competition among suppliers would force the price of Hong Kong shirts in the US to be $4. Thus, in this example, $2, or the value of the quota rights, is the premium paid by US consumers on Hong Kong shirts attributable to the quota. It is a premium over and above any tariffs that are in place on shirts from Hong Kong.

Our ability to measure the effects of the QRs on textiles and apparel, was significantly extended by Carl Hamilton (1988). First, Hamilton collected data on the sale, in Hong Kong, of the right to export textile and apparel products to the US.10/ His data covered a larger group of items than did Morkre's, and Hamilton's data are monthly from January 1982 to May 1984. Thus, we now have a good set of data on the value of quota rights in Hong Kong during this time period. Hamilton's quota sale data indicate that the average premia paid by US consumers of imports of Hong Kong apparel products in 1984 was 47 percent.11/ That is, let p^{US} equal the price paid on imported apparel products in the US; let t^{HK} be the

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10/ Hamilton obtained the data from the US Chamber of Commerce in Hong Kong.

11/ The average quota premium for Hong Kong in 1984, 47 percent, is a weighted average over all of Hamilton's apparel products exported by Hong Kong to the US in 1984. We take this to be reflective of all exports. Quota premia vary considerably across different apparel products, reflecting the relative severity of the relevant quotas on individual products. For some products there may even be no quota premium (i.e., zero quota premium). This occurs when the quota is not binding. Since we are examining the effects of quotas on all apparel imports, it is appropriate to use the average quota premium discussed in the text. Note that this procedure is analogous to using the weighted average tariff rate for a class of products when assessing the effects of tariffs on imports.

Note also that while we are estimating the effects of quotas in 1984, we recognize that the average quota premium for Hong Kong changes from year to year. In 1982, for example, the average quota premium reported by Hamilton was only 10 percent. Unfortunately, information

Continued on next page

US tariff rate on apparel products from Hong Kong; let p^{HK} be the price at which Hong Kong producers are willing to supply apparel products to the US; finally, let prc^{HK} be the premia rate paid by US consumers of apparel products shipped from Hong Kong. The following relationship must hold:

(6.1) $$p^{US} = p^{HK}(1+t^{HK})\ (1+prc^{HK}).$$

Hamilton's data reveals, that in 1984, prc^{HK} equals .47. where .47 is the premia rate paid by US consumers, or, in the more commonly used jargon of economics, the import tariff equivalent of the quota.12/

That is, US consumers paid 47 percent more than they would have had to, were it not for the quotas on Hong Kong exports. We take 47 percent to be representative of the premia paid (due to the quota) by US consumers of apparel products from Hong Kong in 1984. We do not take it to be representative of the premia on textile products. Hamilton's data did not include any textile products.

The main contribution of Hamilton, however, allows us to infer the quota premia in third countries from the Hong Kong data. It is based on a

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Continued from previous page
on quota premia are not available after 1984. However, as discussed in the text (page 6-3), the recently extended MFA (which covers the period August 1, 1986 to July 31, 1991) expands quota coverage to previously uncontrolled products and therefore is more restrictive. Thus, the average quota premium under the new MFA may be higher than that reported in 1984.

12/ We prefer the use of the term premia rate to import tariff equivalent, because the quota rents from textile and apparel and automobiles are captured by foreigners. The import tariff equivalent of the quota is not equivalent in its economic effects, if quota rents are captured by foreigners. See Bhagwati (1965) and Takacs (1978).

simple but clever observation. That is, if another country is subject to QRs on its apparel exports to the US, and it is a lower cost producer than Hong Kong, then the premia rate for that country is greater than the premia rate for Hong Kong. Let p^x be the price at which a third country is willing to supply apparel products to the US. Let t^x be the US tariff that applies to apparel imports from this country. Let prc^x be the premia rate on imports from this country. Then we have:

(6.2) $$p^{US} = p^x(1+t^x)\ (1+prc^x).$$

Substitute .47 for prc^{HK} in (6.1), and divide (6.1) by (6.2); rearrange to get:

(6.3) $$p^x(1+t^x)\ /\ p^{HK}(1+t^{HK}) = (1+prc^{HK})\ /\ (1+prc^x).$$

If country x is a lower cost supplier than Hong Kong, p^x is less than p^{HK}. The lhs of 6.3 will be less than unity unless the US applies a higher tariff rate to imports from country x than it does from Hong Kong. If the lhs is less than unity, then the premia rate paid on Hong Kong apparel products, prc^{HK}, is less than the premia paid on apparel products from country x, prc^x.

The US does not apply preferential tariff rates for developing countries in the case of textile and apparel products. Thus, since Hong Kong is subject to most-favored-nation tariff treatment, for any country subject to most-favored-nation tariff treatment, equation (6.3) reduces to equation (6.4).

(6.4) $p^x/p^{HK} = (1+prc^{HK}) / (1+prc^x)$.

Equation (6.4) applies to all countries we discuss below.

Since the supply price is determined by relative costs, we need to get an estimate of the relative costs of producing apparel products among the major producers around the world. As Hamilton argues, the costs that vary most significantly across nations are the labor costs. Moreover, relative to textile products, apparel products are not very capital intensive.13/ Thus, for apparel products, the principal cost that varies across countries is the labor cost. If we index hourly compensation of production workers in the US apparel industry at 100, then Hong Kong is at 21 and the following countries rank lower than Hong Kong: Brazil, 20; Taiwan, 18; South Korea, 13; India, 6; Thailand, 6; and China, 2.14/

Hong Kong, Taiwan and South Korea are together known as the "Big Three" suppliers. In recent years, however, China has emerged as a major

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13/ See Morkre and Tarr (1980) and Cline (1987, p. 26) for a description of the relative capital intensity of the two sectors of the industry.

14/ These labor cost estimates are obtained from the US Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, as reproduced in Hamilton. The data are an average of the compensation costs for 1981-83. In the case of Thailand and China, the compensation costs are for the textile industry. For a particular developing country in the sample, if data are reported for both textiles and apparel, the index is close.

supplier. By 1986, in terms of square yards of exports to the US, it had passed South Korea and Hong Kong. Without restraints on its exports, it could well be expected to become the dominant supplier of the future. The share of US imports captured by the Big Three plus China was 53 percent (in terms of value) in 1984, and 50 percent in 1986.15/ As a result of the extensive system of quotas, we have a greatly distorted pattern of trade. There are some firms and countries, that are not as efficient as the suppliers in the Big Three and China, who, nontheless, export to the US. They are able to export, only because the quotas result in high prices in the US. They are simply not efficient enough to compete in a free US market. To return to the above example, suppliers from Hong Kong can deliver a men's cotton shirt to the US for, say, $4. Due to the quotas, it sells for $6. A supplier from, say Japan (which according to the Bureau of Labor Statistics data, has labor costs almost three times that of Hong Kong) might be able to supply the shirt for, say $5. Under the quotas, the Japanese supplier earns a profit of $1 on every shirt it is entitled to export. In a free market the price might fall to $4. The Japanese supplier would then be unable to compete, and would have to exit the market. The Japanese supplier in this example is marginally efficient. He is protected in the US market, just as are the domestic US firms. (In fact, due to greater product differentiation between domestic and foreign products, than exists between imports from different countries, the Japanese supplier is even more protected than the domestic US firm.) Thus, it is in the interest of all marginally efficient foreign suppliers, who fear that in a free market they will not be able to compete with countries

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15/ Calculated from data in USITC (1987a, p.A-12).

as efficient as the Big Three and China, to support the MFA, and the price umbrella it affords in the US and other developed countries.

Which country would be the marginally efficient supplier in a free market? Returning to the cost data, mentioned above, it seems there are quite a few countries in the world that can produce at least as efficiently as Hong Kong. Thus, we assume that if a foreign country cannot sell at prices at least as low as those Hong Kong can provide, then it will not be able to compete in a quotaless US market for apparel. (This does not apply to US firms who will continue to operate due to product differentiation.) If Hong Kong can just compete in a US market without quotas, then it is the marginal supplier. That implies that the quota premia prices observed in Hong Kong in 1984, would determine the quota premia rate paid by US consumers in a quotaless US market in 1984. If, however, Hong Kong cannot compete in a US market without quotas, then, as explained above, the quota premia rate is higher than the quota premia rates determined from Hong Kong data. We conservatively assume that Hong Kong is the marginal supplier of apparel imports in a free US market. Thus, we take 47 percent as the quota premia rate on apparel products.

We have illustrated the above argument, by assuming all countries have perfectly elastic supply curves. This is not necessary for the conclusion: If supply curves for each country are upward sloping, due to the inclusion of progressively less efficient firms, then removal of US quotas would be expected to force some, but not all of a country's firms, out of the US market. The important point for the conclusion is that there are enough producers in the world who are sufficiently efficient that they earn a quota premia rate of at least 47 percent in 1984.

To obtain the overall textile and apparel quota premia rate, we need the quota premia rate on textile products. A recent detailed report by the USITC (1987b, pp. 3.4-3.15) has found that a significant portion of the textile product categories are subject to binding quotas. In particular, 81, 31 and 67 percent of cotton, wool and manmade fiber imported fabrics, respectively, are subject to binding quotas.16/

Cline (1987, p.117) assumes that the quota premia rate on textiles was 5 percent during the Long Term Agreement, 10 percent from 1974 to 1981, and 15 percent thereafter, reflecting successive tightening of the agreements. In the absence of hard data, such as Morkre's or Hamilton's, and with the knowledge that the US textile industry is more competitive internationally than apparel (Morkre and Tarr, 1980), we take 5 percent as our estimate of the quota premia rate on textiles. In view of the vehemence with which the industry seeks the continuance of the quotas and the evidence cited from USITC (1987b), this estimate is likely to be conservative.

In 1984, the value of textile imports was 15.4 percent of the total value of textile and apparel imports into the US.17/ Thus, we

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16/ The USITC study notes that the MFA imposes quotas on groups of product categories that, in general, is less than the sum of the quota amounts of the individual categories within the group. Therefore, quotas for a subcategory may be binding, even if the quota for that subcategory is less than 100 percent filled.

17/ This was calculated from data in USITC, 1987a, pp. B-1, C-1, D-1. In these tables, I classified categories 300-329, 400-429 and 600-629 as textile products, and the remainder as apparel. A number of the items classified under apparel, are not items of wearing apparel, such as quilts and pillows. But these are final products, and contain more labor value added than yarns and fabrics which characterize textiles. Thus, they more appropriately go in the apparel category.

calculate the overall quota premia rate on textiles and apparel products in 1984 as 40.5 percent. This is a weighted average of the quota premia rates of the two segments of the industry:

(6.5) $40.5 = (.154)*5 + (.846)*47.$

Thus, for textiles and apparel, .405 is the value we utilize for prc_i and pri_i in equations (17) and (18).

6.3 Quotas on Automobiles from Japan

Introduction

In the Spring of 1981, the Japanese government announced, after negotiations with US government officials, that it would voluntarily restrain its exports of automobiles to the US. The Japanese agreed to limit their exports of automobiles into the US to 1.68 million vehicles per year, between April 1, 1981 and March 31, 1984.18/ This action was taken against a background of falling US production and employment in automobiles, and a number of legislative attempts to curb Japanese imports.19/ Between April 1, 1984 and March 31, 1985, Japanese automobile exports to the US were limited to 1.85 million vehicles.

18/ See Tarr and Morkre (1984) for details of the VER limitations as it related to vans and Puerto Rico.

19/ See Feenstra (1984) for a description of the legislative efforts to curb imports.

The Effect on the Price of Japanese Automobiles

We wish to estimate the effects, on the US, of the VER with Japan on automobiles. It is well documented (Crandall, 1983 and 1985; Feenstra, 1984, 1985a and 1985b; and Tarr and Morkre, 1984) that during the period in which the VER with Japan was in effect, the price of Japanese automobiles in the US rose considerably. Not all of the price increase in Japanese vehicles, however, was due to the VER. Some of the price increase was due to the fact that the Japanese began shipping in higher quality vehicles during the VER period.20/ Using the technique of hedonic regressions, Feenstra has estimated the amount of quality upgrading that occurred during the VER period. Thus, by using the work of Feenstra, we can adjust for the effects of quality upgrading on the price of Japanese vehicles, and obtain an estimate of the amount of the price increase that was due solely to the VER.

The technique of hedonic regressions involves estimating how much consumers are willing to pay for various characteristics of vehicles. Take air conditioning as an example. Suppose we can estimate that consumers are willing to pay $500 for air conditioning on Japanese cars. Suppose also that in the pre-VER period, a specific model was sold without air conditioning, but during the VER period air conditioning was a standard feature. If the price of the vehicle went up by $700, all other things equal, we should not attribute all of the price increase to the VER. Part of the price increase is due to the inclusion of air conditioning. The technique of hedonic regressions would predict a price increase in the vehicle of

20/ See Falvey (1979) for an explanation of why a VER would induce quality upgrading.

$500, and only attribute the excess price increase to the VER. Since some consumers would choose not to purchase air conditioning if provided with the option (that is, it is worth less than $500 to them), the technique of hedonic regressions overestimates the value to consumers of the quality increase. Our estimates will be conservative estimates of the costs to to the economy of the VERs, to the extent that consumers value the higher quality at less than the estimated value from the hedonic regressions.

Feenstra (1985a) also adjusted for the appreciating value of the US dollar over the 1981-84 period. Japanese trucks were not subject to the VER, but rather to a higher tariff. Thus, Feenstra assumed that absent the VER, Japanese car and truck prices would have moved together, provided both car and truck prices are adjusted for quality and tariff changes. In particular, Feenstra (1985a) has estimated that, during 1984, the VER caused Japanese automobile prices in the US to rise by $1096 per vehicle. Although Japanese prices went up by over $2300 between 1980 and 1984, a large portion of this increase was accounted for by quality improvements in Japanese vehicles. Since the average unit value of a Japanese import in 1984 was $7,518 (Feenstra, 1985a, table 2), $1096 per vehicle represents a 14.6 percent premium due to the VER.

The Effect on the Price of European Automobiles

Recently, Dinopoulos and Kreinen (1988) have provided evidence that the price of European automobiles in the US increased, by a considerable amount, during the period of the Japanese VER. This may have occurred because in the short run the European export supply curve to the US is inelastic; or because the Europeans were acting to extract higher prices in monopoly-like fashion; or because the Europeans feared US restraints on their exports, if they increased quantities. They observe that a failure to account for the increase in the price of the European vehicles, induced by the Japanese VER, will lead to a significant underestimate in the welfare cost estimates of the VER.

Like Feenstra, Dinopoulos and Kreinin recognize that it is important to adjust the price increase for the effects of quality upgrading. Dinopoulos and Kreinin employ two methods to estimate the amount of the price increase in European cars that is due to the Japanese VER. They use the technique of hedonic regressions. Hedonoic regressions yield the result that the average price of a European imported automobile increased by $6,212. They also use a supply function estimation technique, which adjusts for the higher costs of supplying higher quality. The supply function technique yields the result that the VER induced a price increase in European cars of $6,912. Dinopoulos and Kreinin average the two techniques to obtain their estimate of $6,562 per automobile.21/

Since the average unit value of a European import was $18,933 in 1984, $6,562 represents a premia rate of 34.7 percent. The relatively higher premia rate on European imports is explained in Dinopoulos and Kreinin by relatively less quality upgrading.

The Overall Premia Rate

The value of US imports of Japanese automobiles was 59 percent of the total value of Japanese and European imports in 1984. The weighted average of the premia rates is thus:

21/ The supply function technique will, appropriately adjust for the appreciating value of the US dollar over this period, and would be expected, therefore, to yield higher estimates.

(6.6) prc = .59*(14.6) + .41*(34.7) = 22.8.

That is, the overall Japanese-European weighted average premia rate is 22.8 percent. We take that premia rate to be representative of all imports of automobiles. 22/

6.4 Voluntary Export Restraints on Steel

In early 1984, the United Steelworkers Union and Bethlehem Steel Corporation petitioned the US International Trade Commission for protection from imports under section 201 of the Trade Act of 1974. In that petition, they requested that quotas be imposed on carbon and alloy steel such that imports would be at most 15 percent of domestic apparent consumption. The President, in response to an affirmative ITC decision for part of the industry, rejected quotas through the 201 process. Instead, he directed his Trade Representative to negotiate VERs with foreign governments. The goal of the President's program was to limit the imports of carbon and alloy

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22/ The premia rate for Japanese autos was calculated as: 1 + 1096/7518, where $7518 was the amount received by the Japanese of which $1096 was the additional amount paid due to the VER. This yielded a premia rate of 14.6 percent. Alternatively, one could calculate the premia as: 7518/(7518-1096) = 1.171 or 17.1 percent premia. Similarly, for European autos, we calculated the premia rate as $6562/18933 = 34.7 percent. Alternatively, we could have calculated a higher premia if we had used the formula for the premia as: 18933/(18933-6562) = 1.510 or 51 percent. These alternate higher premia calculations, yield a weighted average premia rate of 31.8 percent, instead of 22.8 percent. The higher premia calculations for autos correspond to the formulas for the premia in the model of chapter three. Consequently, in the medium elasticity case, we estimate the welfare costs with the higher premia rates and report those results as well. Our focus in the text will be on the lower premia estimates, and for that reason those estimates can be regarded as conservative estimates of the costs of the auto restraints (and, by implication, of the combined auto, textile and steel restraints).

steel products to 18.5 percent of domestic apparent consumption, from the 26.4 percent level of 1984.23/ By mid-1985, the US had negotiated VERs with virtually all significant suppliers of steel to the US, except Canada.

Thus, the stated goal of the VER program for steel was to reduce the quantity of imports to 70 percent of the level of 1984. We shall assume, however, that the retraints were not severe enough to reduce imports to 70 percent of the level of import penetration in 1984. Rather, we assume that imports would be reduced to 85 percent of domestic apparent consumption by the system of VERs. This is based on the fact that imports averaged 22.3 percent of US apparent consumption during 1986 and 1987.24/

23/ Semi-finished steel was excluded from these calculations. A separate quota was prescribed for semi-finished steel. See Tarr and Morkre (1984, chapter 6) for details of the restraints.

Some quotas were in effect prior to the negotiation of the VERs. Most notable among these was the US-EC Arrangement. This agreement settled the antidumping and countervailing dispute of 1982. In return for the US steel companies withdrawing their antidumping and countervailing complaints, the EC agreed to hold its exports of certain steel products to the US to specified percentages of US consumption. See Tarr (1988a) for details of the negotiation of this agreement. In addition, in July 1983, the President granted four years of global quotas on imports of stainless steel bar and rod and alloy tool steel. The estimates in this study are for the additional costs and effects of the new VERs, given that these other restraints were in effect in 1984.

24/ See Steel Industry: Quarterly Industry Review, Merrill Lynch, January 1988, p.33.

6.5 Wage Distortions in Automobiles and Steel

The majority of automobile and steel workers have their wage rates negotiated by the United Autoworkers and the United Steelworkers, respectively.25/ Once the wage and compensation package is determined by this negotiation, firms in the industry are free to hire as many of the workers as they choose, but must do so at the negotiated wage rate.

A number of authors (Kreinin, 1984; Tarr, 1985; and Crandall, 1987) have argued that auto and steelworkers receive a level of compensation that makes it difficult for these industries to be internationally competitive. What we wish to assess is a related, but not identical question: Are the wage rates in steel and autos above the opportunity costs of workers of comparable skill for work of comparable attractiveness? We shall call the latter wage, the competitive wage. In principle, it is possible that wage rates in steel and autos are not above the competitive wage, but the US has no comparative advantage in steel or autos. In that case, wage rates will be too high to maintain international competitiveness (as suggested by the above authors), but wage rates cannot go lower without workers leaving for other sectors of the economy where they will receive a competitive wage. If, however, wage rates are above the competitive wage, that is a distortion that should be measured and incorporated into our model.

25/ One exception to this are the steelworkers at "minimills." The proportion of output produced by the minimills has grown from about 3 percent in 1960 to now over 20 percent; these workers are generally not represented by the United Steelworkers. See Barnett and Crandall (1987) for a discussion of the minimill sector of the steel industry.

In table 6.1, we present data on the hourly compensation of steel and automobile workers, during 1984, in the significant producing countries around the world. The two columns on the right reveal that, in almost all countries, both steel and auto workers receive a premium wage above that earned by the average manufacturing worker in their respective country.

Regarding steel, US steelworkers earned 63 percent above the average of all US manufacturing workers in 1984. With the exception of Japan and Korea, that premium was significantly lower in other countries. In all the European countries, the premium earned by steelworkers over their respective manufacturing worker ranges from a low of 13 percent in Germany to a high of 27 percent in Austria.

Regarding motor vehicle and equipment manufacturing, US workers earned a 53 percent premium over the average US manufacturing worker in 1984. This premium exceeded that obtained by motor vehicle and equipment workers in any of the other countries listed. For motor vehicle and equipment workers, in 9 of the 16 non-US countries, the premium earned is 13 percent or less.

It is possible that the disparity of skills between US steel and auto workers and the average US manufacturing worker is greater than the comparable disparity in foreign countries. In that case, the relative wage differential could be explained by greater skills, and is not a distortion. Thus, a lower bound estimate of the wage distortion in steel and autos is that there is zero distortion. This means ϕ_i equals 1 in the factor demand equations. On the other hand, if the difference in skills between US steel or auto workers and the average US manufacturing worker is no greater than that which exists in other countries, then the greater wage premium is a distortion. We take the average of the premia earned by steelworkers in other countries and divide that into the premium US steelworkers earn.

That value is 1.23. This provides an upper bound estimate of the relative wage distortion in steel. The same procedure, applied to automobiles, yields a value of 1.31. 26/ As table 6.1 reveals, the premium steelworkers earn in the US is greater than the premium earned by workers in motor vehicles and equipment. But the premium earned by motor vehicle and equipment workers in other countries is smaller than that earned by foreign steelworkers. Thus, by international standards, US autoworkers earned a greater premium in 1984.

Thus, our low and high estimates of ϕ_i, for i equal to iron and steel, is 0 and 1.23. For motor vehicles, the low and high estimates are 1 and 1.31, respectively.

26/ Goto (1986) has endogenously estimated the wage distortion of auto workers at 22.1 percent.

TABLE 6.1

INTERNATIONAL COMPARISONS OF HOURLY COMPENSATION COSTS FOR PRODUCTION WORKERS IN IRON AND STEEL AND MOTOR VEHICLES AND EQUIPMENT
1984

Country	Hourly Compensation (in US dollars)		Compensation Relative to Average Production Worker Compensation in the Same Country	
	Motor Vehicles and Equipment	Iron & Steel	Motor Vehicles and Equipment	Iron & Steel
UNITED STATES	18.92	20.26	1.53	1.63
CANADA	13.18	15.38	1.19	1.39
BRAZIL	1.68	1.68	1.45	1.45
MEXICO	2.55	2.58	1.25	1.26
AUSTRALIA	9.56	NA*	1.02	NA
JAPAN	7.92	11.14	1.25	1.75
KOREA	1.94	2.23	1.38	1.58
TAIWAN	2.05	NA	1.39	NA
AUSTRIA		8.96	NA	1.27
BELGIUM	9.64	10.72	1.12	1.24
DENMARK	7.53	NA	0.93	NA
FRANCE	8.42	9.15	1.13	1.22
GERMANY	11.92	10.63	1.26	1.13
IRELAND	6.05	NA	1.10	NA
ITALY	7.72	8.87	1.05	1.20
NETHERLANDS	8.14	10.74	0.93	1.23
SPAIN	5.35	NA	1.17	NA
SWEDEN	9.64	NA	1.05	NA
UK	6.67	7.19	1.13	1.22
AVERAGE (excluding the US)	7.06	8.27	1.16	1.33
US MINUS AVERAGE	11.86	11.99	1.31	1.23

* Not available.

SOURCE: Based on data from US Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, November 1986, mimeo.

CHAPTER 7

WELFARE AND EMPLOYMENT EFFECTS OF VERS ON TEXTILES AND APPAREL, AUTOMOBILES AND STEEL: CORE MODEL

7.1 Introduction

This chapter presents the results of simulating the effects of the QRs on textiles and apparel, automoblies, and steel. First, we consider the effects of removing all of the VERs together; subsequently, we separately examine the effects of removing the QRs on textiles and apparel, steel and automobiles. When we consider the effects of the QRs on the individual industries, we change the QR policy in that industry alone. When we consider the aggregate effects, we change all of the QRs.

The model is general enough to examine quantitatively the importance of relaxing a number of assumptions in the core competitive model. These complications include terms of trade effects (which would occur if the US has monopoly or monopsony power in trade in some sector); fixed capital stocks by sector (which would reflect short-run adjustments); wage distortions; and labor-leisure choice. Except for terms-of-trade effects, we reserve discussion of the impact of these variations to the basic model until the next chapter.

This chapter makes the standard assumption that labor supply is perfectly inelastic, i.e., fixed. Thus, the employment effects we examine in this chapter are the effects of protection on the distribution of employment across sectors. Our main concern, however, is with estimating the welfare costs of QRs. The next chapter will look into the likely employment effects in more detail.

Policy changes are simulated under a high, medium (or best estimate) and low elasticty scenario. That is, there are five tables of elasticities presented in chapter 5. For the high elasticity scenario, we take the high elasticity case for all sectors from all five tables.

The benefits or costs to the economy subjected to the shock of QR removal or imposition, respectively, will depend on the flexibility (i.e., elasticities) of the economy to adapt to the shock. Regardless of whether QRs are removed or imposed, the economy will be expected to be better off if it has greater flexibility (elasticities). This is because when QRs are removed, with higher elasticities at the QR induced equilibrium, the economy can better substitute into the now lower-priced imports, yielding higher benefits from QR removal. When QRs are imposed, with higher elasticities at the pre-QR equilibrium, the economy can better substitute away from the higher-priced imports, thus yielding lower costs to the economy. Thus, given a change in import protection, we expect our estimates to reveal that the economy is better off with greater flexibility (elasticities).

Before presenting the results, it is useful to provide a brief intuitive discussion of our welfare measure. Consider removing quotas on textiles and apparel. This means that the premium above world prices, paid by US residents on imported textile and apparel products in our base year, is reduced to zero. The first order effect is that US residents pay less for all textile and apparel products that they previously consumed. Foreign suppliers to the US no longer receive prices for textile and apparel products above the price at which they are available on world markets. US residents are able to purchase the initial equilibrium bundle of goods for less money. Thus, after the removal of quotas, consumers have income left over to make additional consumption purchases. This income aspect of removing the quotas is generally equivalent to a policy of capturing the rents, and we shall subsequently estimate this effect separately.

The second order effect comes from the distortionary components associated with QRs. The distortionary effects include what are known as consumption and production distortion costs. Start with the consumption distortion costs. Lower prices for textile and apparel products, induce consumers to switch into textile and apparel consumption from other products. These other purchases were formerly valued more highly in the initial equilibrium, when a distorted set of prices prevailed. At the undistorted prices, consumers (in USGETM, the one representative consumer) purchase more imported textile and apparel products, which they now value more highly than some of their previous purchases of other goods.

Second are the production distortion costs. As relative prices change due to the quota removal, firms will shift production across sectors. Factors of production will now shift to sectors where they are valued more highly at undistorted prices. Similarly, firms substitute imported textiles for domestic textiles as inputs into production. Thus, the presence of the quotas imposes costs on the economy from both the production and consumption sides. We refer to these effects as the distortion costs of the quotas.

At the new equilibrium, with the new level of income, the economy produces a new bundle of commodities. How the representative consumer values the consumption of the new bundle of commodities relative to the initial bundle is assessed through the Hicksian equivalent variation measure, as discussed in chapter 3.1/ This measure assesses the combined impact of all of the above mentioned rent capture and distortion effects. In addition, if there are other distortions in the economy, so that there are "second best" effects, the Hicksian equivalent or compensating variation will also assess these. Thus, it is an overall assessment of any changes that have occurred between the equilibria, given any distortions that are present or have been removed.

In the cases where we allow terms-of-trade effects, we assess the sectors in which the US has either monopoly power in exports or monopsony power in its imports. We assume that the US has monopoly power in the sale of its agricultural exports, and monopsony power in the purchase of its automobile imports. The evidence, discussed in chapter 6, suggests the US possesses some monopsony power in the automobile market. We assess the effects of a value of 5 for the elasticity of import supply of automobiles; and an elasticity of 4 for the elasticity of foreign demand for US agricultural exports. That is, in these experiments, the US cannot obtain all of the imports it desires of automobiles, without affecting the world price. The US is assumed to be large in relation to the world supply of the product. In the terms-of-trade case, the US influences the price of its imported automobiles. By restricting imports, the price at which foreigners supply the product will fall. That reduction in price is a benefit to the

1/ We do not report results from the Hicksian compensating variation measure because it is extremely close (usually to the last million) with the equivalent variation measure.

US. Even though it may be small, there will be an optimal tariff or import restraint.

Regarding US exports, we assume that the US has monopoly power in agriculture. That is, the US is large in relation to the world demand for its exports. Within the range of agricultural exports that it may supply, it faces a downward sloping demand curve. By restricting the supply of its agricultural exports, the US can increase the price it obtains on world markets. Although it may be quite small, there is an optimal export tax or export restraint, that will increase US welfare.

The experiments with terms-of-trade effects, assess the terms-of-trade costs of liberalizing trade and weigh them against the other benefits. However, as mentioned earlier, we will not look for the optimal restriction for the U.S. This would be easy to do with our model, but this would not be a policy oriented exercise, since foreign retaliation would be likely and we would be unable to take this retaliatory effect into account.

7.2 Combined Effects of VERs on Steel, Textiles and Apparel and Automobiles

Benefits from Removing All Quantitative Restraints

As discussed in the previous chapter (footnote 21), total imports of steel were not restrained in 1984. Restraints were in place on textiles and apparel and automobiles. In order to consider the combined effects of VERs on all three industries, it was first necessary to restrain steel imports by the amount of the effects of the steel VERs in subsequent years. This produced a new base equilibrium where imports into all three industries were quantitatively restrained.

Having produced an equilibrium where all three industries are subject to QRs, we then remove QRs on all three industries. The welfare effects of that experiment are reported in table 7.1A.2/ The results are reported under a low,3/ medium and high elasticity scenario, and a medium elasticity scenario with terms-of-trade effects.

The welfare results are presented in table 7.1A. The benefits to the US range from $19.8 billion to $22.7 billion, depending on the elasticities. That is, if the US were to remove QRs on all three industries simultaneously, at the level of restraint that recently prevailed, the gain to the US would be about $20-$23 billion annually.

In the case of terms-of-trade effects, the benefits of moving to free trade are slightly lower as expected. In these experiments, the real exchange rate depreciates, but by less than one percent. Initially, we import more in the sectors that have their trade liberalized. This induces depreciation of the dollar so that there are less imports and more exports; otherwise the balance of trade will not be in equilibrium. The effect, however, is small because of the offsetting effect of the quota rent transfer from foreigners. We discuss this offsetting effect in the next experiment.

The effect on the real wage is small. In all cases, the change in the real wage is less than three-tenths of one percent. Changes in relative wages will depend on the relative sectoral capital intensities. Suppose

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2/ All of the tables for this chapter are found at the end of the chapter.

3/ In the low elasticity experiments of this study, in which QRs are removed on all three industries or on steel alone, we utilized the medium elasticities of substitution of capital for labor (see table 5.2).

that expanding sectors are relatively labor intensive. Expanding sectors will attract labor and capital from contracting sectors; contracting sectors will not be able to supply labor and capital in proportions that are used in expanding sectors. In particular, there will be too little labor in relation to capital. This will put pressure on the wage-rental ratio to increase, thereby inducing less use of labor and more use of the now relatively abundant capital input. We have ten sectors in USGETM, with varying capital-labor ratios. Depending on the average labor intensity of the expanding versus contracting sectors, the wage-rental ratio will rise or fall.

In the case of removing QRs on all three sectors, the real wage is estimated to increase very slightly--by four-hundreths of one percent. In neither these experiments, nor any other that we perform, does the real wage decrease by as much as two-tenths of one percent.4/ Thus, we conclude that there is no evidence for the McDonalds effect.5/ That is, there is no evidence from this model indicating that trade restraints retain high wage jobs in the US, or that removal of the restraints will cause US worker wages to decline significantly. There are two reasons for this result. First, trade liberalization increases income. This increases the demand for commodities and hence labor, which puts pressure on the wage rate to

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4/ In a few of the experiments, the real wage does increase by more than one-tenth of one percent as a result of liberalizing trade. The largest increase in three-tenths of one percent.

5/ There are, of course, many other forces that affect wage rates. See, for example, Bluestone and Harrison (1988). Note, however, that in the high elasticity case employment in the domestic auto industry declines by 8 thousand jobs. In the high elasticity case, the strong substitution effect in consumption between domestic and imported autos dominates the income and cost saving effects discussed in the text.

rise. Second, relative factor intensities are not very different across sectors at our level of aggregation.

Regarding employment effects, which are reported in table 7.1B, all of the previously unprotected sectors gain employment. In the medium elasticity case, textiles and apparel lose 158 thousand jobs. Manufacturing is the largest gainer of jobs, at 79 thousand. Automobiles gains almost two thousand jobs in the simulation. This occurs for two reasons. First, the auto industry pays less for its steel and textile inputs. Second, the economy is wealthier after the removal of the QRs. With the added income, there is a greater demand for automobiles. These effects are slightly stronger than the loss of demand the domestic automobile sector suffers from greater consumer purchases of imported automobiles. In the case of textiles and apparel, and steel, the substitution of imports dominates, especially for textiles and apparel. Overall, there is no change in the aggregate level of employment.

In table 7.1C, we report the change in the value of imports and exports by sector. The change in the value of imports and exports by sector depends, in part on substitution effects induced by the exchange rate depreciation when quotas are removed. At the new relative prices, in domestic currency units, firms substitute domestic for imported intermediates and firms supply more for sale abroad. Moreover, consumers substitute domestic goods for imports in final demand. The change in the value of imports and exports by sector also depends, in significant part, on sectoral income elasticities. We will illustrate this in our next simulation, where we capture the quota rents; which is a pure income effect experiment. Thus, the change in imports and exports reported in table 7.2C can be interpreted as the income effect on sectors from the removal of the three quotas. In table 7.1C, we have the combined income and substitution effects of the removal of the quotas on the three industries. The income elasticities, which were listed in table 5.6, reveal that imported textile products and consumer goods have relatively high income elasticities of demand, whereas those of imported agriculture and traded services are relatively low. Removing QRs results in increased income. Imported textiles and apparel goods receive a relatively large share of the expenditures from the increased income.

Exports of all sectors either increase or show no significant change. This is due to the real depreciation of the US dollar.

The three sectors in which QRs are removed, all experience an increase in the value of imports. Most other sectors experience a decrease in the value of their imports, again due to the exchange rate depreciation. The mining sector, however, experiences an increase in the value of its imports. This is explained by the large expansion in the manufacturing sector. Since manufacturing output increases, it must use more inputs from all sectors. Mining, which is almost a pure intermediate good, is an important input into manufacturing. Although there is a slight shift in manufacturing use of mining inputs toward domestic usage, manufacturing purchases more imported mining inputs in total.

Benefits From Capturing the Quota Rents

As discussed in chapter 2, the US method of granting quota rights allows foreign countries to capture the quota rents. There are alternative methods of capturing the quota rights that would allow the US to capture the quota rents. The most efficient method is auctioning, by the US government, of the quota rights.6/ We now consider the effect of the US capturing the quota rents in textiles and apparel, automobiles and steel, which would occur through a policy such as auctioning of the quota rights. The results are reported in table 7.2A.

The results reveal that a policy of capturing quota rents in these three industries is estimated to result in a gain in US welfare of about $14 billion, depending on elasticities. In the medium elasticity case, the full effect of removing the quotas is estimated above at $20.9 billion; the difference between $20.9 billion and $14.2 billion are the distortion costs of the quotas. Thus, in aggregate, about two-thirds of the costs of the quotas is due to rent capture by foreigners. This result implies that the US could have roughly the same level of protection for the three industries subject to quotas at about one-third the cost, if it used tariffs. Thus, the effects of quota rent capture are quite significant.

The exchange rate falls slightly below unity as a result of quota rent capture. This is an appreciation of the exchange rate. It reflects the fact that as a result of capturing quota rents, the US demand for imported goods, in value terms, shifts down. At the original real exchange rate, the now reduced value of demand for imported goods is less than the value of US goods supplied to foreigners, i.e., there is a surplus in the balance of trade. The surplus in the balance of trade induces an appreciation of the real exchange rate until equilibrium is restored in the balance of trade.

6/ See Morkre and Tarr (1980) for a discussion of alternative methods of capturing the quota rents. See Elliott, Schott and Takacs (1987) for an assessment of the benefits of auctioning the quotas.

There is a significant difference between partial and general equilibrium results with respect to this policy. When using partial equilibrium analysis, economists generally think of the capture of quota rents as a pure transfer that will not affect the allocation of resources. There is, however, a significant income effect of the transfer. That income effect induces a number of changes. We have just mentioned the exchange rate effect. In addition, consumers have different income elasticities of demand for final goods. Thus, there will be a shift in the share of consumer income spent on the various goods that will depend on these income elasticities. The result is that in general equilibrium real resources shift around. We cannot view the capture of rents as a pure transfer that does not affect the allocation of resources.

The impact of the capture of the quota rents on employment is presented in table 7.2B. The shifts in employment (which are shifts relative to the QR constrained equilibrium) among industries are explained primarily by the different income elasticities of demand (presented in table 5.6). The QR protected sectors remain protected at the tariff equivalent level of the QRs. Consequently, capturing the quota rents in a protected sector does not necessarily imply the protected sector will lose jobs. The result depends on the relative income elasticities of the various sectors. For example, our estimates below show that the automobile sector gains employment when quota rents on automobiles are captured.

The effects of capturing rents from all three sectors on the exports and imports of the economy are presented in table 7.2C. These are effects that are ignored by partial equilibrium analysis.

Benefits of Tariff Removal

We next consider the additional benefits obtained by removing all tariffs after all QRs have been removed. The welfare and employment effects reported are relative to the equilibrium obtained after QRs on textiles and apparel, automobiles and steel have been removed.

The benefits range from $.6 to $1.3 billion. These benefits are significantly less than the benefits of QR removal. This again emphasizes the high costs of QRs, especially when the rents are not captured.

The effects on employment are presented in table 7.3B. Textiles and apparel, which is the sector with the highest tariff rate, is the sector that loses the most jobs.

The real wage rises by +0.28 percent when all tariffs are removed. See appendix 7A for the explanation.

7.3 Effects of Quotas on Textile and Apparel

Benefits of Removing Quotas on Textiles and Apparel

The results for the case of removal of quotas on textiles and apparel alone are presented in table 7.4A. The gains to the economy from removal of the quotas range from $11.5 billion to $14.9 billion. In the high elasticity case, the economy is better able to take advantage of the removal of the quotas, so it gains more. In the low elasticity case, the economy cannot shift as well from the initial quota- constrained equilibrium.

Rounded to the nearest one-tenth of one percent, we observe no change in the overall value of the real wage received in production. Thus, there is no McDonalds effect when textile and apparel quotas are removed.

The real exchange rate shows a slight depreciation. This is due to the fact that we are liberalizing trade in textiles. The US is importing more textile and apparel products. Given that the trade balance is fixed (the exchange rate and other variables adjust so that it remains constant), the US must export more and import less of other goods. To accomplish this, the value of the US dollar must depreciate. The change in the value of the US dollar, however, is less than one percent in all three cases.

In table 7.4B we report the effects on employment, by sectors, of the removal of the quotas on textile and apparel products. In the medium (or best estimate) case, employment in textiles and apparel declines by 158 thousand jobs as a result of removing the quotas. Employment in all other sectors increases. The combined increase in employment in manufacturing, traded and nontraded services is 119 thousand new jobs. For reasons previously discussed, the shifts in employment between textiles and apparel and the other sectors of the economy are significantly greater in the high elasticity case than in the low elasticity case.

In the medium elasticity case, textile and apparel imports increase by $12.6 billion. Other manufactured products, however, experience an increase in exports of $3.8 billion, and a decrease in imports of $1.9 billion. In fact, all sectors in the economy experience an increase in the value of their exports, under all elasticity scenarios.

Benefits of Capturing Quota Rents in Textiles and Apparel

As reported in table 7.5A, the benefits of capturing quota rents on textiles and apparel are about $7.1 billion. This estimate changes very little with the elasticity specification. Thus, over one-half of the costs to the US of the quotas on textiles and apparel are due to quota rent capture by foreigners. The US could achieve roughly the same level of protection of textiles and apparel (in terms of employment and output effects) at less than one-half the cost, by employing tariff protection, or by auctioning the quota rights.

The proportion of the total costs that are distortion costs is greater in textiles and apparel than in autos or steel (see table 1.1). This is due to two effects. First, the estimates of the elasticity of demand for imported textiles and apparel products are high relative to autos and steel. This means the higher prices caused by the quotas, induce a relatively large switch by consumers out of imported textile and apparel products. This in turn implies the distortion costs will be relatively high, since consumers are departing by greater amounts from their desired optimum choice with no quotas.

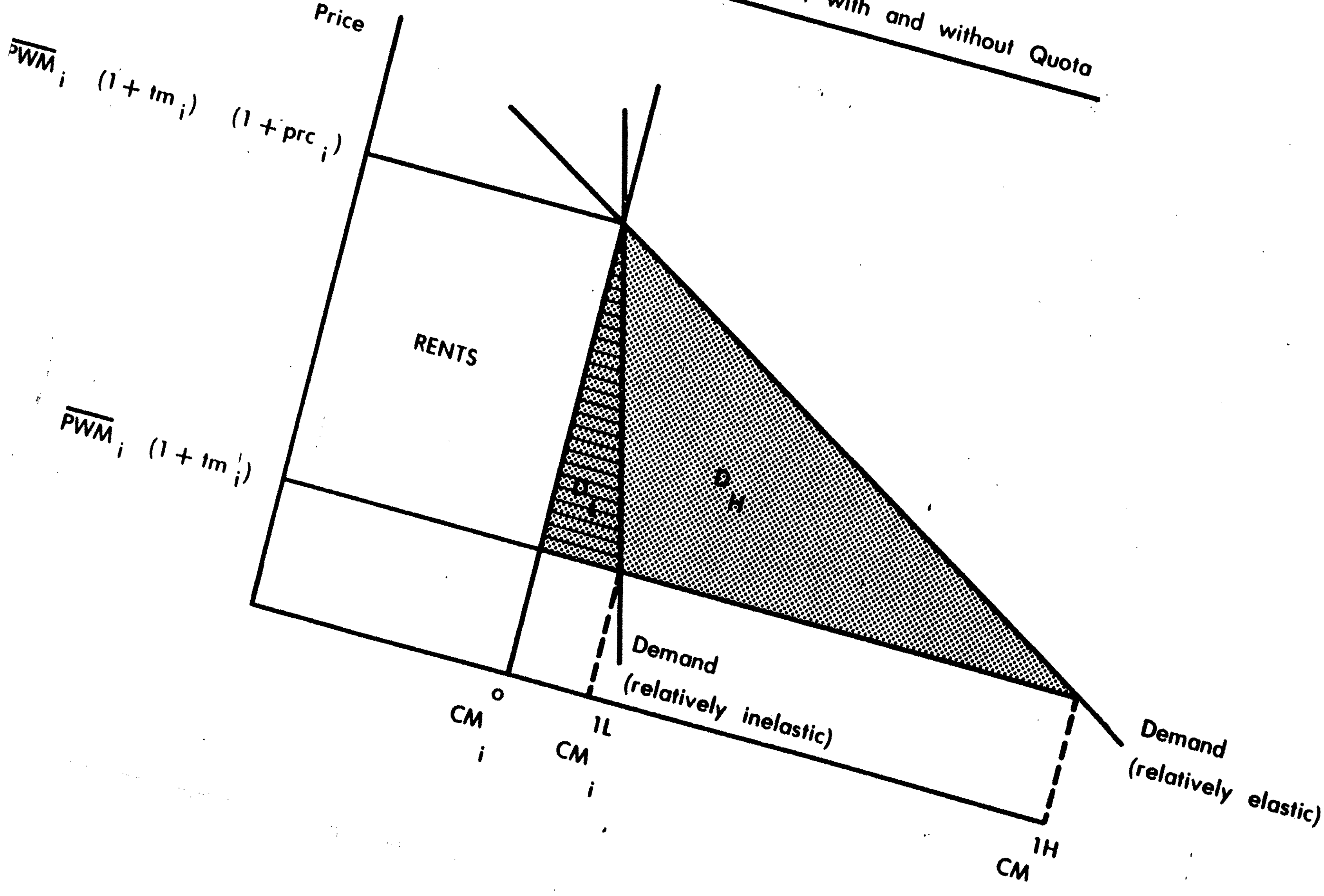
We illustrate this for the partial equilibrium case in figure 7.1. A quota exists for a final good in the initial equilibrium, so, in the notation of chapter 3, the price is $\overline{PWM}_i(1+tm_i)\,(1+prc_i)$ and the quantity demanded is CM_i^0, initially. Quota removal reduces the price to $\overline{PWM}_i\,(1+tm_i)$; quantity demanded increases to CM_i^{1L} or CM_i^{1H} depending on the elasticity of demand. The captured rent rectangle is independent of the elasticity of demand, and equals $\overline{PWM}_i * (1+tm_i) * prc_i*CM_i^0$. The distortion costs are measured by the deadweight loss triangle D_L or D_H, depending on the demand elasticity. This value is $1/2\ \overline{PWM}_i\ (1+tm_i)\ prc_i\ [CM_i^1 - CM_i^0]$, where CM_i^1 increases with the absolute value of the demand elasticity.

A second explanation of the higher distortion costs, is the fact that textiles and apparel have a much higher tariff rate (about 17.3

FIGURE 7.1

HOW DISTORTION COSTS OF QUOTA INCREASE WITH THE ELASTICITY OF IMPORT DEMAND

Import Demand for Final Good, with and without Quota



percent) than the auto (about 3 percent) or steel (about 5 percent) sectors; and the estimated quota premium rate paid on imported goods (the percentage increase in price paid by US consumers on the imported articles due to the quota) is also higher in textiles and apparel (about 40.5 percent). Thus, textiles and apparel are a highly distorted sector. Due to the combination of tariffs and quotas, US consumers of textiles and apparel are paying, on average, about 58 percent more than they would have to, were it not for the US government imposed restraints on these imports. As the economy moves away from free trade, the distortion costs increase more than proportionately with the rate of the distortion (the tariff plus premia rate).

Due to income effects and differing income elasticities of demand across sectors, an auction quota or tariff will not yield exactly the same level of protection as the quota in effect in 1984. In the medium elasticity case, due to the low elasticity of demand for domestic textiles and apparel, an auction quota would reduce employment in the textile and apparel sector by 3.3 thousand jobs. As table 7.5B details, on balance, other sectors of the economy gain this number of jobs.

7.4 Automobiles: Effects of the VER on Japanese Imports

Effects of Removing the VER on Japanese Automobiles

The estimated gains to the economy of removing the VER on automobiles are reported in table 7.6A. The low, medium and high elasticity cases assume that the US does not possess monopsony power in buying automobiles from the rest of the world. In the case labelled "terms-of-trade," the US is assumed to possess monopsony power in the purchase of automobiles from the rest of the world, but does not have monopoly or monopsony power elsewhere.

The gains from removing the automobile VER range from $6.8 billion to $7.2 billion, without terms-of-trade effects. The gains are greater the greater the elasticities. With terms-of-trade effects incorporated, the US gains less from removing the automobile VER, namely $5.9 billion. This reflects the fact that the US is able to induce foreign suppliers to supply automobiles at a lower price when it possesses monopsony power.

The employment effects in automobiles are much less significant than they are in textiles and apparel. In the medium elasticity case, removal of the Japanese VER, results in the automobile sector losing only 1.1 thousand jobs; these jobs are gained by other sectors of the economy as detailed in table 7.6B. As the economy becomes wealthier, consumers buy more automobiles. Most of the increased purchases of automobiles goes to imported automobiles at the lower relative price for automobiles. But, given the low cross-substitution effects in demand between domestic and foreign automobiles, consumers buy slightly more domestic automobiles after the removal of the VER.7/ A small or negative impact on employment would not be surprising in view of the work of Cliff Winston and Associates

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7/ As explained in table 5.4, the estimated own elasticity of demand for imported motor vehicles (taken from Levinsohn, 1987) is: -1.17 in the high elasticity case, -1.05 in the medium elasticity case, and -0.92 in the low elasticity case. Recall from our discussion of equation (5.8), that imported automobiles will be gross substitutes (complements) with all goods in the system, if the own elasticity of demand is greater (less) than one in absolute value. If the own elasticity is negative one, there is no cross-substitution effect. In the medium and low elasticity cases, the elasticity is close to negative one, so the cross-substitution effect is small. In the low elasticity case, the impact on purchases of domestic automobiles from a reduction in the price of imported automobiles is positive. This explains the result of the increase in employment in the low elasticity case.

(1987). These authors estimated that the US lost 32 thousand jobs in 1984 as a result of the automobile VER on Japan.8/

In the medium elasticiy case, imports of automobiles increase by $288 million as a result of the removal of the VER. Exports, however, of all sectors increase, so that the overall trade balance is unchanged.

Benefits of Capturing the Quota Rents on Automobile Imports

As a result of imposing VERs on automobiles, the price of imported automobiles rose, giving foreign producers a premium above their supply price. Estimates of the benefits of a US policy that captured these premia are presented in table 7.7A. The elasticities do not significantly affect the estimates of the gains to the US, in this policy experiment. The gains are approximately $6.2 billion in all cases.

Some interpretation of the nature of this experiment is necessary. The evidence presented in chapter 6 reveals that the VER with Japan induced a price increase on European automobiles sold in the US. In the previous experiment, removal of the VER with Japan would remove those pressures or barriers that allowed the Europeans to increase the price of their cars in the US. Thus, we assumed above that the premium above the world supply price would fall to zero after the VER with Japan was removed.

8/ Winston's results are explained by the assumption of domestic monopoly power. After the imposition of the quota, domestic firms are better able to collude, and in Winston's model they do. The effect on output and employment of the monopoly restriction effect dominates the import substitution effect. We have assumed perfect competition, so there is no employment reduction effect except in the low elasticity case.

In order to capture the full quota rents of the VER, however, it is not sufficient to capture the quota rents on the Japanese imports. Quota rents on Japanese automobile imports can be captured by auction quotas, a tariff or other domestic quota allocation schemes. Capturing the quota rents on the European imports (rents which exist only while the VER on Japanese imports is in place), requires a policy mechanism, despite the fact that European imports were not restrained by the US. If the Europeans restrained their automobile exports to exploit monopoly power gained as a result of the US restraint on Japanese imports, then one would have to impose a positive tariff on European imports to capture these rents, as long as the VER with Japan is in effect. If the Europeans are not explicitly restraining exports, but have a very inelastic supply curve to the US, then a tariff on their exports to the US will capture the rents they are earning. The tariff rate required is the premia rate (estimated in chapter 6) earned on European auto exports. In this experiment, we assume implicitly that the US adopts a policy that captures the rents earned by all automobile exporters to the US. However, we do not measure the welfare costs of imposing a tariff on European exports alone.

If the US establishes an auction quota for Japanese auto imports, but does not employ a policy to capture the rents on European automobile imports, the US will capture the rents on Japanese imports only. In the medium elasticity case, we have simulated the effects of capturing the rents on Japanese imports only, while the VER on Japanese automobile imports is in place, and presented those results in parentheses in table 7.7A.

Comparison of tables 7.6A and 7.7A, reveal that, in the cases without term-of-trade effects, the gains from capturing the quota rents are about 90 percent of the total gains from removing the quotas. This means that the US could obtain roughly the same level of protection for the automobile industry, at only 10 percent of the costs, if it employed a policy that captured the quota rents. In the case where there are terms-of-trade effects, the US actually gains more from a policy of capturing the quota rents than it does from removing the quotas. This is because the US possesses monopsony power in the terms-of-trade case, which goes unexploited when the VER is removed. Since the US gains over $5.8 billion from removal of the VER, the VER is obviously not the right mechanism to exloit that monopsony power.9/

Although the details are not presented, most sectors in the US export less as a result of the capture of the quota rents. Capturing the quota rents is a transfer from foreigners to the US that induces an appreciation of the US dollar. That appreciation results in the US exporting less and importing more, so that equilibrium in the balance of payments is restored.

Estimates with Alternate Higher Premia Rate on Automobiles

As mentioned in chapter 6, footnote 22, there is an alternate method of calculating the premia rate due to the auto VERs which yields a premia rate of 31.8 percent, rather than the 22.8 percent for which we have just presented estimates. We have also utilized USGETM to estimate the benefits to the economy of a number of the policies, assuming a 31.8 percent premia rate for autos in the central elasticity case. The poli-

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9/ There is a positive tariff, that increases welfare, when monopsony power exists.

cies, with the benefits estimates in parentheses, are: (1) remove auto VERs ($9.313 billion); (2) capture the quota rents in autos ($8.632 billion); (3) remove QRs on autos, textiles and apparel and steel simultaneously ($23.325 billion); and (4) capture the quota rents in these three industries ($16.622). These policies all yield benefit estimates that are approximately $2.4 billion greater than the estimates under the assumption of the lower premia rate for autos. Thus, our approach, which is utilized throughout this Report except for the current subsection and which emphasizes the 22.8 percent premia calculation for autos, should be considered conservative in this regard. Policies which are not directly dependent on the auto premia, such as removing the remaining tariffs after all QRs have been removed or imposing QRs on steel, do not have their welfare benefit estimates affected.

Regarding employment effects, autos lose only about 400 additional jobs from auto VER removal with the higher premia assumption. In general, employment for the other sectors is only slightly affected by the higher premia assumption, with changes compared to the lower premia case of less than 100 jobs in all non-auto sectors.

7.5 VERS on Steel

Imposing VERs on Steel

We estimate that as a result of imposing the widespread system of VERs, the US loses between $2.6 billion and $0.6 billion annually in 1984 dollars. The results are displayed in table 7.8A. There is a considerable variance here between the high and the low estimates; much more of a variance than exists in the previously discussed cases. This is because steel is a pure intermediate good; as a result, the elasticity of substitution between imported and domestic steel in the production functions of firms is crucial. As we reported in table 5.1, these values are: 5.0, 3.05 and 1.10, in the high, medium and low cases, respectively. That is, the standard error of the estimate (which we use to define the high and low estimates from the medium), taken from Shiells, Stern and Deardorff (1986) is relatively high for this particular parameter. Thus, we needed to perform sensitivity analysis over a wider range of relevant parameter values than in the earlier cases, and this produced a wider range of estimates.

The steel industry is estimated to gain between 20.4 and 22.1 thousand jobs as a result of the steel VERs. The other sector that is estimated to gain jobs under all elasticity scenarios is mining. Since mining is an important input into steel, this is not surprising. Most of the other sectors lose employment under most of the elasticity scenarios, with the manufacturing sector being the largest loser. The manufacturing sector is estimated to lose 15 thousand jobs in the medium elasticity case.

As a result of the VERs, the US imports $1.15 billion less in steel. But all nonsteel sectors export less. There is no net effect on the US balance of trade.

Benefits of Capturing the Quota Rents on Steel

If the US were to capture the quota rents from the VERs on steel, it would gain between $2.3 billion and $0.5 billion, depending on the elasticities assumed. The estimates are presented in table 7.9A. These gains are approximately 85 percent of the total losses due to the VERs on steel. The US could obtain roughly the same level of protection of steel, at 15 percent of the cost, if it protected the domestic steel industry through a mechanism that captures the quota rents. We can see from table 7.9B, that there are negligible employment effects on steel, from a policy of capturing the quota rents. Thus, in this case, labor obtains virtually equivalent protection from a policy that captures the quota rents.

APPENDIX 7A

IMPACT ON THE REAL WAGE

Although the change in the real wage is rather small in all cases, some readers may have noticed that the increase in the real wage is larger in the case of tariff removal than in the cases of quota removal or quota rent capture. This occurs for two reasons.

First, to the extent that the economy captures quota rents, it makes consumers wealthier, but not through their roles as suppliers of factors of production. We envision (and model) the process of quota rent capture as one in which the government captures the quota rents and transfers these rents directly to consumers. Thus, even though consumers are enriched by quota rent capture, the real wage (wage divided by the price level) does not increase, only transfer income. On the other hand, tariff removal increases the income of consumers, and does so through their role as providers of factors of production to firms. As a result of the tariff removal, intermediate inputs are generally lower in price, providing profit opportunities for firms to expand, which bids up the price of primary factors of production, including the real wage of labor.

Second, note that quota rent capture induces an appreciation of the real exchange rate, whereas tariff removal induces a depreciation of the real exchange rate (explained by opposite effects these policies have on the value of demand for foreign goods and services). An appreciation of the real exchange rate means that the relative price of nontradable goods and services rises relative to tradables. This will induce a shift of resources out of tradables into nontradables. The impact on the relative wage (wage divided by the rental rate on capital) depends on the relative labor intensity of tradables to nontradables. If tradables are relatively labor intensive, then it will release capital and labor in proportions too labor intensive for nontradables to absorb at the existing relative wage. The relative price of labor will have to fall to induce the nontradable goods sector to become more labor intensive. This is exactly analogous to the Stolper-Samuelson theorem, which states that if protection is removed in an industry, the factor used intensively in that industry will suffer a decline in relative returns. 10/ In fact, our nontraded goods and services sector is slightly more capital intensive than the average sector in the economy (it includes among others, capital intensive industries such as electricity and gas utilities). Thus, we interpret the observed result in the case where quota rents are captured in all three sectors simultaneously, where there is a slight decline in the real wage, in terms of the above scenario. In other words, capture of the quota rents does not have a direct impact on the real wage rate because it does not affect factor markets. But the capture of quota rents does lead to an appreciation of the real exchange rate and as a consequence the relative wage declines, causing the real wage to fall.

Since removing tariffs has the opposite effect on the real exchange rate as quota rent capture, ceterus paribus, it has the opposite effect on relative wages, i.e., it will tend to increse them . At the same

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10/ See Sebastian Edwards (1988), "Terms-of-Trade, Tariffs, and Labor Market Adjustment in Developing Countries," The World Bank Economic Review, 2, 165-185, for a more extensive discussion of the effect of the removal of protection on real wages.

time, the increased income obtained through tariff removal will result in higher real wage (and higher real rental rate on capital).

Quota removal will represent an intermediate case, since it involves both quota rent capture and the removal of a distortion analogous to tariff removal. The former has a depressing effect on the real wage (given the particular capital intensities of the USGETM) and the latter increases it. Like tariff removal, quota removal induces an increase in income that is captured (partly in the case of quotas) in the factor markets. Thus, the real wage can increase, even if the relative wage decreases.

TABLE 7.1A

WELFARE EFFECTS OF REMOVING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES AND STEEL

(in billions of 1984 US dollars)

	Gains or Costs to Economy*	Real Exchange Rate**	Percentage Change in the Real Wage
Low Elasticity	20.969	1.008	+0.11
Medium Elasticity	20.900	1.007	+0.04
High Elasticity	22.666	1.008	+0.04
Medium Elasticity (with Terms-of Trade)	19.767	1.007	+0.04

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.1B

EMPLOYMENT EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL, AUTOMOBILES AND STEEL

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity	Medium Elasticity (with Terms-of-Trade Effects)
Agriculture	8.41	14.26	21.57	5.99
Food	-0.12	1.64	3.71	1.18
Mining	0.48	3.99	7.70	4.25
Textiles	-21.05	-157.56	-285.36	-157.07
Automobiles	2.83	1.95	-8.31	1.99
Steel	-20.68	-16.22	-12.61	-15.93
Nontraded Services	-4.39	21.60	35.64	22.11
Traded Services	1.84	34.28	65.90	36.53
Consumer Goods	7.31	17.45	39.60	18.11
Manufactured Goods	25.36	78.62	132.15	82.83

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.1 C

CHANGE IN EXPORTS AND IMPORTS FROM REMOVING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL

(changes are in billions of 1984 dollars)*

Sector	Low Elasticity		Medium Elasticity		High Elasticity		Medium Elasticity (with Terms-of-Trade Effects)	
	Export	Import	Export	Import	Export	Import	Export	Import
Agriculture	0.72	0.06	1.12	-0.02	1.56	-0.10	0.56	-0.02
Food	0.07	0.04	0.13	0.02	0.18	-0.10	0.13	0.02
Mining	0.05	0.31	0.08	0.39	0.12	0.38	0.09	0.41
Textiles	0.37	7.69	0.36	12.61	0.49	18.46	0.37	12.60
Automobiles	0.16	-0.76	0.24	0.28	0.29	3.50	0.25	0.27
Steel	-0.02	-0.32	-0.00	1.11	0.02	1.31	0.00	1.10
Traded Services	0.74	0.18	1.08	-0.04	1.44	-0.50	1.14	-0.04
Consumer Goods	0.23	-0.00	0.42	-0.34	0.68	-0.86	0.44	-0.36
Manufactured Goods	2.70	1.00	4.45	-2.23	6.46	-6.08	4.70	-2.36

* A positive (negative) value means that the value of exports or imports is estimated to increase (decrease).

Source: Estimates from USGETM.

TABLE 7.2A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(in billions of 1984 US dollars)

	Gains or Costs to Economy *	Real Exchange Rate **	Percentage Change in the Real Wage
Low Elasticity	15.953	0.975	-0.14
Medium Elasticity	14.205	0.990	-0.04
High Elasticity	13.814	0.994	-0.03
Medium Elasticity (with Terms-of Trade)	14.295	0.990	-0.04

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.2B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity	Medium Elasticity (with Terms-of-Trade Effects)
Agriculture	-31.90	-14.47	-11.41	-4.40
Food	3.78	4.09	3.47	4.65
Mining	-2.41	-2.83	-3.23	-3.15
Textiles	-5.12	-6.75	-6.87	-7.34
Automobiles	5.79	2.37	0.63	2.31
Steel	-1.23	-1.93	-2.21	-2.18
Nontraded Services	37.75	41.27	56.31	40.69
Traded Services	10.58	15.17	10.45	12.38
Consumer Goods	5.41	7.58	5.01	6.79
Manufactured Goods	-22.65	-44.50	-52.15	-49.76

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.2 C

CHANGE IN EXPORTS AND IMPORTS FROM MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(changes are in billions of 1984 dollars)*

Sector	Low Elasticity		Medium Elasticity		High Elasticity		Medium Elasticity (with Terms-of-Trade Effects)	
	Export	Import	Export	Import	Export	Import	Export	Import
Agriculture	-2.87	-0.16	-1.38	0.05	-1.03	0.09	-0.69	0.06
Food	-0.30	-0.13	-0.15	0.01	-0.12	0.11	-0.15	0.01
Mining	-0.20	-1.02	-0.11	-0.34	-0.09	-0.14	-0.12	-0.37
Textiles	-0.43	1.21	-0.24	0.61	-0.19	0.42	-0.25	0.63
Automobiles	-0.25	0.21	-0.14	0.16	-0.12	0.15	-0.15	0.16
Steel	-0.09	-0.02	-0.05	-0.01	-0.04	-0.01	-0.06	-0.01
Traded Services	-2.90	-0.47	-1.30	0.20	-0.94	0.49	-1.38	0.20
Consumer Goods	-0.64	0.15	-0.32	0.63	-0.25	0.75	-0.34	0.66
Manufactured Goods	-8.69	-3.22	-4.85	3.31	-3.95	4.61	-5.15	3.48

* A positive (negative) value means that the value of exports or imports is estimated to increase (decrease).

Source: Estimates from USGETM.

TABLE 7.3A

WELFARE EFFECTS OF REMOVING ALL TARIFFS AFTER QUOTAS ARE REMOVED

(in billions of 1984 US dollars)

	Gains or Costs to Economy *	Real Exchange Rate **	Percentage Change in the Real Wage
Low Elasticity	.593	1.008	+0.33
Medium Elasticity	.937	1.028	+0.28
High Elasticity	1.336	1.029	+0.30
Medium Elasticity (with Terms-of Trade)	.570	1.030	+0.26

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.3B

EMPLOYMENT EFFECTS OF REMOVING ALL TARIFFS AFTER QUOTAS ARE REMOVED

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity	Medium Elasticity (with Terms-of-Trade Effects)
Agriculture	24.95	48.10	71.06	19.13
Food	-1.85	-0.21	-0.33	-1.79
Mining	1.89	3.77	7.14	4.68
Textiles	-5.35	-57.19	-88.51	-55.52
Automobiles	-1.33	1.71	4.35	1.90
Steel	-2.87	-8.31	-13.47	-7.30
Nontraded Services	-23.70	-38.48	-92.48	-36.66
Traded Services	-7.46	10.94	30.23	18.61
Consumer Goods	-10.58	-4.90	0.93	-2.50
Manufactured Goods	26.31	44.57	81.06	59.46

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.3 C

CHANGE IN EXPORTS AND IMPORTS FROM REMOVING ALL TARIFFS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL AFTER QUOTAS ARE REMOVED

(changes are in billions of 1984 dollars)*

Sector	Low Elasticity		Medium Elasticity		High Elasticity		Medium Elasticity (with Terms-of-Trade Effects)	
	Export	Import	Export	Import	Export	Import	Export	Import
Agriculture	2.29	0.04	3.68	-0.02	5.01	-0.11	1.70	-0.04
Food	0.23	-0.15	0.40	-0.06	0.57	0.28	0.41	-0.06
Mining	0.15	0.68	0.25	0.64	0.35	0.34	0.27	0.71
Textiles	0.47	2.23	0.76	4.13	1.28	6.07	0.80	4.09
Automobiles	0.25	-0.23	0.49	-0.12	0.72	-0.03	0.51	-0.12
Steel	0.06	-0.04	0.09	0.60	0.12	1.25	0.10	0.59
Traded Services	2.08	0.37	3.06	-0.26	3.90	-1.54	3.28	-0.28
Consumer Goods	0.49	-0.28	0.92	1.71	1.37	4.54	1.00	1.65
Manufactured Goods	6.89	-1.82	11.79	2.30	16.81	6.09	12.70	1.87

* A positive (negative) value means that the value of exports or imports is estimated to increase (decrease).

Source: Estimates from USGETM.

TABLE 7.4A

REMOVING QUOTAS ON TEXTILES AND APPAREL: EFFECTS ON U.S. WELFARE, THE REAL WAGE AND THE REAL EXCHANGE RATE UNDER DIFFERENT ELASTICITY ESTIMATES

(welfare estimates are in billions of 1984 US dollars)

	Gains to the U.S.*	Percentage Change** in the Real Wage	Real Exchange Rate ***
Low Elasticity Case	11.535	0.0	1.009
Medium Elasticity Case	13.060	+0.04	1.007
High Elasticity Case	14.870	0.0	1.006

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** The percentage change is rounded to the nearest one-tenth of one percent.

*** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.4B

EMPLOYMENT EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity
Agriculture	11.10	12.33	15.09
Food	-0.93	1.28	3.24
Mining	1.19	4.27	7.32
Textiles	-21.29	-158.26	-286.90
Automobiles	-0.00	2.68	5.11
Steel	1.59	4.48	7.12
Nontraded Services	- 7.50	22.42	40.13
Traded Services	0.02	33.15	64.02
Consumer Goods	2.48	14.15	34.93
Manufactured Goods	13.34	63.50	109.96

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.5A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(in billions of 1984 US dollars)

	Gains or Costs to Economy *	Real Exchange Rate **	Percentage Change in the Real Wage
Low Elasticity	7.163	.989	0.0
Medium Elasticity	7.072	.996	0.0
High Elasticity	7.037	.997	0.0

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.5B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity
Agriculture	-14.26	-7.16	-5.79
Food	1.70	2.03	1.76
Mining	-1.09	-1.42	-1.65
Textiles	-2.22	-3.30	-3.45
Automobiles	2.64	1.19	0.33
Steel	-1.75	-2.17	-2.28
Nontraded Services	16.74	20.36	28.47
Traded Services	4.95	7.65	5.39
Consumers Goods	2.70	3.92	2.69
Manufactured Goods	-9.41	-21.12	-25.48

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.6A

WELFARE EFFECTS OF REMOVING ALL VERS ON AUTOMOBILES

(in billions of 1984 US dollars)

	Gains or Costs to Economy*	Real Exchange Rate**	Percentage Change in the Real Wage
Low Elasticity	6.794	.999	0.0
Medium Elasticity	6.901	1.000	+0.01
High Elasticity	7.249	1.001	0.0
Medium Elasticity (with Terms-of Trade)	5.854	1.000	0.0

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.6B

EMPLOYMENT EFFECTS OF REMOVING VERS ON AUTOMOBILES

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity	Medium Elasticity (with Terms-of-Trade Effects)
Agriculture	-2.21	0.18	4.69	0.18
Food	0.11	0.07	0.32	0.07
Mining	-0.12	0.01	0.56	0.01
Textiles	-0.23	-0.13	-0.11	-0.13
Automobiles	1.28	-1.14	-13.61	-1.14
Steel	-0.20	0.00	0.64	0.00
Nontraded Services	1.76	0.50	-1.78	0.51
Traded Services	0.22	0.18	2.12	0.19
Consumer Goods	-0.01	0.21	1.74	0.22
Manufactured Goods	-0.60	0.12	5.43	0.10

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.7A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON AUTOMOBILES BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(in billions of 1984 US dollars)

	Gains or Costs to Economy*	Real Exchange Rate**	Percentage Change in the Real Wage
Low Elasticity	6.236	.990	0.0
Medium Elasticity	6.221	.996	0.0
Capture Japanese Rents Only	(3.664)	(.998)	(0.0)
High Elasticity	6.214	.998	0.0
Medium Elasticity (with Terms-of Trade)	6.191	.996	0.0

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.7B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON AUTOMOBILES BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity	Medium Elasticity (with Terms-of-Trade Effects)
Agriculture	-12.45	-6.31	-5.12	-6.31
Food	1.48	1.79	1.56	1.79
Mining	-0.95	-1.25	-1.46	-1.25
Textiles	-1.93	-2.90	-3.05	-2.90
Automobiles	2.30	1.05	0.29	1.05
Steel	-1.52	-1.91	-2.01	-1.91
Nontraded Services	14.59	17.92	25.15	17.92
Traded Services	4.33	6.74	4.76	6.74
Consumer Goods	2.35	3.45	2.37	3.45
Manufactured Goods	-8.20	-18.58	-22.50	-18.58

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.8A

WELFARE EFFECTS OF IMPOSING VERS ON STEEL

(in billions of 1984 US dollars)

	Gains or Costs to Economy *	Real Exchange Rate **	Percentage Change in the Real Wage
Low Elasticity	-2.552	1.001	-0.11
Medium Elasticity	-0.906	.999	-0.04
High Elasticity	-0.568	1.000	-0.02

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.8B

EMPLOYMENT EFFECTS OF IMPOSING VERS ON STEEL

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity
Agriculture	0.40	-1.75	-1.63
Food	-0.71	-0.29	-0.16
Mining	0.58	0.30	0.16
Textiles	-0.49	-0.80	-0.85
Automobiles	-1.53	-0.41	-0.25
Steel	22.08	20.70	20.35
Nontraded Services	-1.29	1.30	2.42
Traded Services	-1.56	-0.95	-0.06
Consumer Goods	-4.86	-3.09	-2.93
Manufactured Goods	-12.62	-15.01	-17.06

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 7.9A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(in billions of 1984 US dollars)

	Gains or Costs to Economy *	Real Exchange Rate **	Percentage Change in the Real Wage
Low Elasticity	2.289	.997	-0.11
Medium Elasticity	0.777	.999	-0.04
High Elasticity	0.467	.999	-0.02

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

SOURCE: Estimates from USGETM.

TABLE 7.9B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS

(change in employment by industry in thousands of jobs)*

Sector	Low Elasticity	Medium Elasticity	High Elasticity
Agriculture	-4.72	-0.81	-0.40
Food	0.54	0.22	0.12
Mining	-0.35	-0.16	-0.11
Textiles	-0.73	-0.37	-0.23
Automobiles	0.83	0.13	0.02
Steel	-0.18	-0.11	-0.07
Nontraded Services	5.46	2.27	1.91
Traded Services	1.63	0.85	0.36
Consumer Goods	0.80	0.41	0.17
Manufactured Goods	-3.29	-2.43	-1.76

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

CHAPTER 8

RESULTS: EFFECTS OF VARIABLE LABOR SUPPLY, WAGE DISTORTIONS AND IMMOBILE CAPITAL STOCKS

In this chapter, we examine how the results change when we extend the core model regarding assumptions in the factor markets. We begin in section 8.1, with the most straightforward of the extentions. What is the consequence of fixed capital stocks by sector? We progress, in section 8.2, to the interesting policy case of the effects of wage distortions in the auto and steel sectors. Finally, in section 8.3, we consider the effects of allowing a labor-leisure choice, with resulting endogenous labor supply.

8.1 Effects of Fixed Capital Stocks (Short-Run Model)

In the basic model, it was assumed that the time period was long enough that capital could flow between sectors; capital mobility assured that the rental rate on capital was equalized across sectors. We now alter that assumption. Consider a time period short enough that capital is fixed in all sectors, as in the Marshallian short run. How will our welfare estimates change as a result of capital being fixed?

With capital fixed in each sector, instead of a common rental rate R for all sectors, and an endogenously determined capital stock for all sectors K_i, we have a fixed capital stock for each sector $\overline{K}_i$, and an endogenously determined rental rate for each sector, $RENT_i$. So in the short-run model, instead of having capital stock mobility across sectors in response to a policy experiment, the rental rate varies across sectors.

The effects on the welfare results of fixing the capital stock in each sector are analogous to the effects of moving to a lower elasticity regime. Fixed capital stocks mean the economy has less flexibility to adjust to exogenous shocks, such as those resulting from changes in trade policy. Therefore, as in the different elasticity scenarios, the costs to the economy would be expected to be larger in the case of the imposition of a quota, such as occurred in the steel industry. Conversely, if quotas are removed, as occurred in the textiles and apparel and automobile experiments, the economy is less able to adjust and benefit from the quota removal.

In table 8.1A we report the welfare results, in the medium elasticity case, of removing QRs in textiles and apparel, automobiles and steel.1/ With a common medium elasticity base, the results for the short-run model are compared to the estimates for the long-run model, where capital is mobile across sectors. The results for the long run are listed in parentheses.

The largest difference between the long-run and short-run models appears in the case of the steel industry. As explained in the previous chapter, imposition of the steel VERs results in a significant shift in demand toward domestic steel because there is a high elasticity of substitution between imported and domestic steel. Given that capital cannot flow into the steel industry to help accomodate that shift in demand, the costs to the economy are higher.

The smallest difference in the gains to the economy are in the automobile industry (which shows no difference). Again, as we explained in the previous chapter, the removal of the automobile VER results in very little shift in demand for domestic automobiles, or for other sectors; this

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1/ All the tables for this chapter are found at the end.

is because a change in the price of imported automobiles has a small cross-elasticity of demand with respect to other final goods in the economy.

Textiles and apparel falls in the middle. The gains to the economy are slightly smaller with fixed capital stocks, because the economy is not capable of moving capital out of textiles, when the textile and apparel quotas are removed.

When quotas are removed on textiles and apparel in the short-run model, the real wage declines by 3/100 of one percent, as opposed to an increase of 4/100 of one percent in the long-run model. This is because textiles and apparel is one of the most labor intensive sectors in USGETM. In the short-run model, with capital fixed, in order to accommodate the output decrease induced by the decline in protection, the sector must release even more labor than in the long-run model. The extra labor on the market implies that the real wage will have to decrease relative to the long-run model.

8.2 Effects of Eliminating Wage Distortions

Until now, we have assumed that workers in all industries are earning a competitive wage. It has been assumed that differences in observed wage rates are explained by different skill mixes in the different industries. As was discussed in chapter 6, however, there is evidence that the wage rates in the steel and automobile industries are not competitive, but, in part, reflect a premium due to monopoly power of the unions and, in part, reflect a productivity difference.

The argument is that the union negotiates a wage rate that is above the competitive level, that is, above the wage rate that prevails in the rest of the economy.2/ Firms in the automobile and steel industries are then free to hire as many employees as they like; these firms will do so only up to the point where the value of the marginal product of the workers equals the wage rate in steel and automobiles. Given the wage differential, additional workers would like to enter the automobile and steel industries, but are unable to do so because of lack of demand from firms in the industry. That is, there is excess supply of workers for the steel and automobile industries. These workers are not unemployed; they find jobs elsewhere in the economy, but at a lower wage. Since the wage rate (now adjusted for skill mix and attractiveness of the work) in steel and automobiles is higher than in the rest of the economy, the value of the marginal product (VMP) of workers in steel and automoblies is higher in these two industries.

Effects of Eliminating the Wage Distortion

Because the VMP of workers in these two industries is higher than elsewhere in the economy, if a worker shifted into the steel or automobile industry, from the rest of the economy, there would be an improvement in US welfare. This is because a worker would be moving from an industry where his VMP is relatively low, to an industry where it is relatively high. Thus, a policy that induced a lowering of the steel or automobile wage rates (assuming they represent distorted wages), would be welfare

2/ USGETM does not allow that wage premium, estimated for the benchmark year, to endogenously adjust to model shocks, such as quota removal; see Goto (1986). As our experiments on removing the wage premium reveal, if the wage premium is reduced when quotas are removed, then the economy will gain even more from quota removal than we have estimated.

improving. This is the first policy that we simulate below. We ask what would be the gains to the economy if the wage rate in steel, automobiles, and steel and automobiles together were lowered to the competitive level starting from an equilibrium with QRs in autos and textiles and apparel and no QRs in steel. As discussed in chapter 6, in these experiments, the wage rate in steel is assumed to be 23 percent above the competitive level; and the wage rate in automobiles is assumed to be 31 percent above the competitive level.

We can observe from table 8.2A, that the economy gains: $0.9 billion, if wage distortions are removed from both automobiles and steel; $0.2 billion if wage distortions are removed from automobiles only; and $0.7 billion if wage distortions are removed in the steel industry only. These are the expected results. It is interesting to observe that the overall economy-wide real wage increases after the higher distorted wage in automobiles and steel is removed. This is because there is an increased demand for labor as firms move to substitute labor for capital in automobiles and steel.

In table 8.2B, we report the employment effects by industry when these wage distortions are removed. In the case where distortions are removed in both sectors, employment in steel and automobiles increases by 63 thousand and 88 thousand, respectively. Employment in all other sectors (especially the two service sectors) decreases, except for manufacturing which shows a slight increase. Manufacturing uses steel and automobiles as intermediate products. As a result of the lower wage in automobiles and steel, the price of steel and automobiles declines. The decline in the price of steel and automobiles, allows manufacturing to produce its products more cheaply. Consequently, there is an increased demand for manufacturing goods, which explains the increased use of labor. For other sectors, steel and automobiles are not as important as intermediate inputs, so they lose employment to the steel and automobile sectors. When wage distortions are removed on steel and automobiles separately, the pattern is similar, with one additional sector gaining employment in each case.

Benefits of Removing Quotas in the Presence of Wage Distortions

When quotas are removed in automobiles and steel, resources are induced to exit these industries in favor of employment elsewhere in the economy. In particular, there will be fewer employees in these industries after the removal of the quotas. As mentioned above, however, the value of the marginal product in steel and automobiles is higher than in the rest of the economy. There are too few employees in steel and automobiles than is optimal for the economy (that is what the previous experiment verified). For every employee who exits the steel or automobile industry as a result of quota removal, the economy bears a cost measured roughly as the difference between the value of the marginal product in steel and automobiles compared to the value of the marginal product elsewhere in the economy. Thus, due to the presence of a wage distortion, there is a tradeoff between the benefits of removal of the distortion costs (and capture of the rents) of the quota, and the costs of moving employees out of the sectors where the value of their marginal product is highest.3/ That is, this is a "second best" situation; the policy of removing the quota is not necessarily optimal, given the presence of another distortion in the

3/ See Magee (1973) for a general theoretical discussion of factor market distortions, and de Melo (1979) for an application of these principles in the case of factor market distortions in Colombia.

economy. We can, however, estimate the effects of removing the quota and observe which effect dominates.

In table 8.3A, we present the results of estimating the effects of quota removal in the presence of wage distortions, in the medium elasticity case. When we remove quotas on automobiles (steel) alone, we assume there are wage distortions on automobiles (steel) alone. When we remove quotas on all three industries, we assume wage distortions exist in both automobiles and steel. To facilitate comparison, the results for the case where there are no wage distortions, are presented in the table 8.3A in parentheses.

We observe that the gains from removing the quotas (imposing in the case of steel), either separately or together, are less (in absolute value) in all cases when wage distortions are present. The mitigating effect of the wage distortions, however, is relatively small. It remains the case that the economy strongly benefits from the policy of removal of quotas.

We also observe that the real wage now increases in all cases. In the case of removal of all quotas, the real wage increases by three-tenths of one percent. Removal of the quotas shifts demand toward the industries that were previously unprotected. Given the higher wage rates in steel and automobiles, there is a greater shift of labor into these industries than in the case with no wage distortion. Then relative wages will be dependent on relative capital intensities as previously discussed.

8.3 Effects of Introducing Labor-Leisure Choice

Up to this point we have assumed that the labor supply available to the economy is fixed. In this section we conduct experiments where the labor supply is endogenously determined. As discussed in chapter 3, we allow for a labor-leisure choice. Our formulation then leads to labor supply varying with the real wage, income and the prices of commodities. The values of these elasticities have been discussed in the elasticities chapter.

Incorporating a labor-leisure choice results in diminished costs of protection. When the economy is protected, such as in the imposition of the steel restraints, the consumer-worker is capable of switching out of the consumption of commodities, into the consumption of leisure. His level of real income is not solely dependent on commodity consumption. The ability to switch into leisure consumption partially insulates the worker-consumer from the distortions due to protection. The key to understanding this (as one can observe from the extended utility function in chapter 3) is that with a labor-leisure choice, the consumer values a unit of aggregate commodity consumption less highly than with no labor-leisure choice. The more the worker-consumer values leisure, relative to commodity consumption, the less will be the costs of protection, because protection only impairs commodity consumption. Higher absolute values of the elasticities of labor supply correspond, in our formulation, to a greater relative valuation of leisure to commodities. Thus, the greater the elasticities of labor supply, the lower the losses from protection.

Similarly, when protection is removed, the worker-consumer chooses to consume some additional leisure rather than all additional commodities. Given his preferences, he does not value commodity consumption as highly as he does in the no labor-leisure tradeoff situation. The more he values leisure, relative to commodity consumption, the less he will gain from the removal of protection, because protection removal only improves his ability to consume commodities. Thus, the higher the labor supply elasticities, the less the worker-consumer will gain from the removal of the quotas.

In tables 8.4A through 8.12B, we present the results of the welfare experiments with a labor-leisure choice. In all of the experiments in this section, we utilize the central (or medium) elasticity estimates, with the exception of the labor supply elasticities. The low elasticity case, is the case of fixed labor supply with otherwise medium elasticities; it reduces to the medium elasticity case discussed in the previous chapter. The medium and high elasticity cases are for the medium and high labor supply elasticities with otherwise medium elasticities.

There is a pattern to the effect of the labor-leisure choice that is consistent throughout all the experiments, so we discuss all of the experiments together. As argued above, the qualitative effect of the labor-leisure choice is to diminish the gains (losses) from removing (imposing) protection. The quantitative effect, in virtually all the experiments, is that compared with fixed labor supply, the absolute value of the change in welfare from a change in protection is about 6 (12) percent less in the medium (high) labor elasticity case.

The labor-leisure choice has no effect on the real exchange rate. It has a small effect on the real wage. The situations where the real wage increases, relative to the fixed labor supply case, is where there is less labor supplied. Think of labor supply and labor demand as a function of the real wage. When protection is removed, the level of income in the economy increases, ceteris paribus. This increases the demand for labor, which would tend to increase the real wage. This effect was present in the fixed labor supply experiments. But, with a labor-leisure choice, labor supply decreases with increases in income, causing a further increase in the real wage. The effect, however, is not large.

TABLE 8.1A

WELFARE EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL, AUTOMOBILES AND STEEL WITH IMMOBILE CAPITAL

(central elasticity case)
(in billions of 1984 US dollars)

Removal of quotas on:	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Textiles and Apparel	13.023 (13.060)	1.008 (1.007)	-0.03 (+0.04)
Automobiles	6.901 (6.901)	1.000 (1.000)	+0.01 (+0.01)
Steel ***	-1.227 (-0.906)	1.000 (.999)	-0.07 (-0.04)

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

*** For steel, estimates are for the imposition of quotas. The steel VERs did not take effect until 1985 and our benchmark year is 1984.

Note: Values in parentheses provided for comparison are from the long-run model with capital mobility between sectors.

SOURCE: Estimates from USGETM.

TABLE 8.1B

EMPLOYMENT EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL, AUTOS AND STEEL WITH IMMOBILE CAPITAL

(change in employment by industry in thousands of jobs)*
(central elasticity case)

	Remove Quotas on:		
Sector	Textiles and Apparel	Autos	Steel**
Agriculture	17.78	0.13	-0.66
Food	0.62	0.07	-0.53
Mining	10.12	0.07	0.71
Textiles	-163.90	-0.07	-0.49
Automobiles	3.50	-1.91	-1.19
Steel	6.24	0.02	49.00
Nontraded Services	0.89	0.71	-2.88
Traded Services	34.34	0.31	-2.05
Consumer Goods	16.64	0.14	-5.41
Manufactured Goods	73.78	0.53	-36.51

* A positive (negative) number means that employment is estimated to increase (decrease).

** The steel experiment involves imposing, not removing, quotas. The steel VERs did not take effect until 1985 and our benchmark year is 1984.

SOURCE: Estimates from USGETM.

Table 8.2A

WELFARE EFFECTS OF REMOVING WAGE DISTORTIONS IN AUTOMOBILES AND STEEL: SEPARATELY AND TOGETHER

(central elasticity case)
(in billions of 1984 US dollars)

Removal of Distortions in:	Gains to the Economy*	Percentage Change in the Real Wage
Automobiles and Steel	0.892	+0.15
Automobiles	0.237	+0.16
Steel	0.664	+0.12

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

SOURCE: Estimates from USGETM.

TABLE 8.2B

EMPLOYMENT EFFECTS OF REMOVING WAGE DISTORTIONS IN AUTOMOBILES AND STEEL, SEPARATELY AND TOGETHER

(change in employment by industry in thousands of jobs)*
(central elasticity case)

	Remove Distortions in:		
Sector	Autos & Steel	Autos Only	Steel Only
Agriculture	-12.55	-5.70	-6.86
Food	-5.35	-3.25	-2.10
Mining	-1.03	-0.72	-0.31
Textiles	-1.36	1.12	-2.46
Automobiles	87.90	87.57	0.29
Steel	62.75	0.05	62.31
Nontraded Services	-66.75	-39.46	-27.22
Traded Services	-65.59	-33.37	-32.16
Consumer Goods	-6.91	-7.09	0.22
Manufactured Goods	8.90	0.84	8.32

* A positive (negative) number means that employment is estimated to increase (decrease).

SOURCE: Estimates from USGETM.

TABLE 8.3A

WELFARE EFFECTS OF REMOVING QUOTAS IN THE PRESENCE OF WAGE DISTORTIONS

(central elasticity case)
(in billions of 1984 US dollars)

Removal of quotas on:	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Automobiles, Steel & Textiles-Apparel	20.843 (20.900)	1.007 (1.007)	+0.31 (+0.04)
Automobiles	6.895 (6.901)	1.000 (1.000)	+0.16 (+0.01)
Steel ***	-0.82 (-0.906)	0.999 (.999)	+0.08 (-0.04)

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

*** For steel, welfare estimates are for the imposition of quotas. The steel VERs did not take effect until 1985 and our benchmark year is 1984.

Note: Values in parentheses provided for comparison are from the long-run model with capital mobility between sectors.

SOURCE: Estimates from USGETM.

TABLE 8.3B

EMPLOYMENT EFFECTS OF REMOVING QUANTITATIVE RESTRAINTS, GIVEN WAGE DISTORTIONS PRESENT

(change in employment by industry in thousands of jobs)*
(central elasticity case)

	Remove QRs in:		
Sector	Textiles, Autos & Steel	Autos Only	Steel** Only
Agriculture	14.22	0.18	-1.70
Food	1.64	0.07	-0.29
Mining	3.99	0.01	0.29
Textiles	-157.56	-0.13	-0.79
Automobiles	1.89	-1.14	-0.41
Steel	-16.29	0.00	20.70
Nontraded Services	21.91	0.53	0.91
Traded Services	34.32	0.18	-0.96
Consumer Goods	17.39	0.21	-3.00
Manufactured Goods	78.49	0.10	-14.75

* A positive (negative) number means that employment is estimated to increase (decrease).

** The steel only experiment involves imposing, not removing, steel QRs. The steel VERs did not take effect until 1985 and our benchmark year is 1984.

SOURCE: Estimates from USGETM.

TABLE 8.4A

WELFARE EFFECTS OF REMOVING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES AND STEEL WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	20.900	1.007	+0.04
Medium Labor Elasticity	19.740	1.007	+0.06
High Labor Elasticity	18.701	1.007	+0.07

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.4B

EMPLOYMENT EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	14.26	13.48	12.84
Food	1.64	1.14	0.74
Mining	3.99	3.66	3.38
Textiles	-157.56	-157.89	-158.16
Automobiles	1.95	1.77	1.62
Steel	-16.22	-16.41	-16.57
Nontraded Services	21.60	14.06	7.88
Traded Services	34.28	25.65	18.58
Consumer Goods	17.45	16.33	15.41
Manufactured Goods	78.62	74.18	70.55
Total Employment	0.0	-24.03	-43.73

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.5A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	14.205	0.990	-0.04
Medium Labor Elasticity	13.406	0.990	-0.00
High Labor Elasticity	12.693	0.990	+0.03

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.5B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL, AUTOMOBILES, AND STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	-14.47	-16.62	-18.38
Food	4.09	2.71	1.58
Mining	-2.83	-3.76	-4.51
Textiles	-6.75	-7.71	-8.50
Automobiles	2.37	1.87	1.46
Steel	-1.93	-2.55	-3.05
Nontraded Services	41.27	20.15	2.87
Traded Services	15.17	-8.97	-28.71
Consumer Goods	7.58	4.48	1.94
Manufactured Goods	-44.50	-56.78	-66.82

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.6A

WELFARE EFFECTS OF REMOVING ALL TARIFFS WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	0.937	1.028	+0.28
Medium Labor Elasticity	0.888	1.028	+0.28
High Labor Elasticity	0.844	1.028	+0.28

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.6B

EMPLOYMENT EFFECTS OF REMOVING ALL TARIFFS WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	48.10	48.80	49.38
Food	-0.21	0.23	0.54
Mining	3.77	4.07	4.32
Textiles	-57.19	-56.90	-56.65
Automobiles	1.71	1.87	2.01
Steel	-8.31	-8.13	-7.99
Nontraded Services	-38.48	-31.70	-26.15
Traded Services	-38.48	-31.70	-26.15
Consumer Goods	-4.90	-3.89	-3.07
Manufactured Goods	44.57	48.56	51.82

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.7A

WELFARE EFFECTS OF REMOVING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

Removal of quotas on:	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	13.060	1.007	+0.04
Medium Labor Elasticity	12.335	1.007	+0.05
High Labor Elasticity	11.686	1.007	+0.06

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.7B

EMPLOYMENT EFFECTS OF REMOVING QUOTAS ON TEXTILES AND APPAREL WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	12.33	11.60	11.00
Food	1.28	0.82	0.44
Mining	4.17	3.97	3.71
Textiles	-158.26	-158.56	-158.82
Automobiles	2.68	2.51	2.37
Steel	4.48	4.30	4.16
Nontraded Services	22.42	15.39	9.64
Traded Services	33.15	25.11	18.53
Consumer Goods	14.15	13.11	12.25
Manufactured Goods	63.50	59.36	55.98

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.8A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	7.072	0.996	0.00
Medium Labor Elasticity	6.675	0.996	+0.02
High Labor Elasticity	6.320	0.996	+0.04

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.8B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON TEXTILES AND APPAREL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	-7.16	-8.42	-9.45
Food	2.03	1.23	0.58
Mining	-1.42	-1.95	2.39
Textiles	-3.30	-3.86	-4.32
Automobiles	1.19	0.90	0.66
Steel	-2.17	-2.48	-2.73
Nontraded Services	20.36	8.14	-1.87
Traded Services	7.65	-6.33	-17.78
Consumer Goods	3.92	2.12	0.64
Manufactured Goods	-21.12	-28.28	-34.15

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.9A

WELFARE EFFECTS OF REMOVING QUANTITATIVE RESTRAINTS ON AUTOS WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	6.901	1.000	+0.01
Medium Labor Elasticity	6.520	1.000	+0.01
High Labor Elasticity	6.179	1.000	+0.01

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.9B

EMPLOYMENT EFFECTS OF REMOVING VERS ON AUTOMOBILES WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	0.18	0.16	0.13
Food	0.07	0.05	0.04
Mining	0.01	-0.00	-0.01
Textiles	-0.13	-0.14	-0.15
Automobiles	-1.14	-1.15	-1.15
Steel	0.00	-0.01	-0.01
Nontraded Services	0.50	0.25	0.04
Traded Services	0.18	-0.10	-0.33
Consumer Goods	0.21	0.18	0.15
Manufactured Goods	0.12	0.03	-0.15

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.10A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON AUTOMOBILES BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	6.221	0.996	0.00
Medium Labor Elasticity	5.874	0.996	+0.01
High Labor Elasticity	5.565	0.996	+0.03

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.10B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON AUTOMOBILES BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	-6.31	-7.15	-7.83
Food	1.79	1.26	0.82
Mining	-1.25	-1.60	-1.89
Textiles	-2.90	-3.27	-3.58
Automobiles	1.05	0.86	0.70
Steel	-1.91	-2.12	-2.28
Nontraded Services	17.92	9.81	3.17
Traded Services	6.74	-2.54	-10.14
Consumer Goods	3.45	2.25	1.27
Manufactured Goods	-18.58	-23.33	-27.23

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.11A

WELFARE EFFECTS OF IMPOSING QUANTITATIVE RESTRAINTS ON STEEL WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

	Costs to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	-0.906	.999	-0.04
Medium Labor Elasticity	-0.856	.999	-0.04
High Labor Elasticity	-0.811	.999	-0.04

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.11B

EMPLOYMENT EFFECTS OF IMPOSING VERS ON STEEL WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	-1.75	-1.72	-1.69
Food	-0.29	-0.27	-0.26
Mining	0.30	0.31	0.32
Textiles	-0.80	-0.79	-0.77
Automobiles	-0.41	-0.41	-0.40
Steel	20.70	20.71	20.71
Nontraded Services	1.30	1.59	1.83
Traded Services	-0.95	-0.62	-0.35
Consumer Goods	-3.09	-3.04	-3.01
Manufactured Goods	-15.01	-14.85	-14.71

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.12A

WELFARE EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(in billions of 1984 US dollars)

Removal of quotas on:	Gains to the economy*	Real exchange rate**	Percentage change in the real wage
Fixed Labor Supply	0.777	0.999	-0.04
Medium Labor Elasticity	0.734	0.999	-0.04
High Labor Elasticity	0.695	0.999	-0.04

* The gains (+) or costs (-) are the value of the Hicksian equivalent variation.

** A value greater than one represents a depreciation of the US dollar, relative to the initial equilibrium.

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

TABLE 8.12B

EMPLOYMENT EFFECTS OF MAINTAINING QUANTITATIVE RESTRAINTS ON STEEL BUT CAPTURING QUOTA RENTS FROM FOREIGNERS WITH LABOR-LEISURE CHOICE

(change in employment by industry in thousands of jobs)*

Sector	Fixed Labor Supply	Medium Labor Elasticity	High Labor Elasticity
Agriculture	-0.81	-0.88	-0.93
Food	0.22	0.18	0.15
Mining	-0.16	-0.18	-0.20
Textiles	-0.37	-0.40	-0.42
Automobiles	0.13	0.11	0.10
Steel	-0.11	-0.12	-0.14
Nontraded Services	2.27	1.65	1.14
Traded Services	0.85	0.14	-0.44
Consumer Goods	0.41	0.32	0.25
Manufactured Goods	-2.43	-2.80	-3.09

* A positive (negative) number means that employment is estimated to increase (decrease).

Note: All elasticities, except for labor supply elasticity, are for the central elasticity case.

SOURCE: Estimates from USGETM.

CHAPTER 9

OVERALL ASSESSMENT

9.1 Costs Per Job

We have shown that protection does not increase employment in the aggregate. Rather it shifts employment around among industries. Moreover, protection does not increase the economy-wide real wage. That is, the evidence from this model is that the McDonalds effect thesis should be rejected.

In view of the fact that protection is obtained through the political process, some might argue that Congress has decided to value a job in the protected sectors more highly than jobs elsewhere in the economy. In that case, however, we should ask: "What is the cost per job protected in the quota protected sectors, knowing that overall employment is not increased?"

We consider the case of simultaneous removal of quotas on textiles and apparel, autos and steel, with the central elasticities. Our estimate is that removal of these quotas would result in the US economy gaining $20.9 billion in 1984 dollars. The three sectors subject to quotas would collectively lose 174 thousand jobs to sectors in the rest of the economy. Thus, the annual cost per job protected in these three sectors is about $120 thousand per year. This is approximately 8 (3) times the annual total compensation of workers in the textile and apparel (steel) sector.

9.2 Adjustment Costs

If quotas are removed some workers in import-protected domestic industries will lose their jobs and have to shift to other industries.

Economists studying the effects of trade liberalization traditionally consider labor adjustment as involving costs to the economy that need to be subtracted from the benefits of liberalization to obtain the net benefits (Baldwin 1984). Adjustment of displaced workers takes time and often involves a number of activities including job search, relocation, and training (see, for example, Mussa, 1978; 1984). This is a complex process and raises a number of factual questions. What are the characteristics of workers who are displaced (how old are they, what skills do they have), how long does it take them to find new jobs, what is the wage they receive in their new jobs, and how far do they have to move to find new jobs? We do not have good estimates of these values, and therefore do not have fully satisfactory measures of labor adjustment costs. A proxy for these costs is the discounted value of the displaced worker's earnings losses over his lifetime. That is, we compare the lifetime earnings stream of the worker who has been displaced with the earnings stream of workers who were not displaced.1/ This measure has the advantage that it allows us to estimate how much gainers from a trade liberalization will have left after compensating displaced workers for their earnings losses.

The estimates are that earnings losses are significant in the first two years after displacement, decline considerably in the subsequent four years after displacement, and are essentially zero more than six years after displacement. Workers in high wage industries lose more than workers in low wage industries.2/ We take the present value of the worker's earnings losses over six years and compare that with the present value of

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1/ See Morkre-Tarr (1980, chapter 3) for a discussion of the merits of this measure versus the alternative unemployment cost measure.

2/ See Jacobson (1978).

the benefits over six years.3/ This will yield a conservative estimate of the net benefits because earnings losses are zero after six years, while benefits do not decay. That is, we take as our measure of net benefits:

$$(9.1) \qquad NB = \sum_{t=0}^{5} [20.9 - C_t] / (1 + r)^t$$

where 20.9 is the annual benefit or gain from removing QRs (from table 7.1A), r = 7% is the discount rate and C_t are estimated earnings losses in year t.4/ The present value of the earnings losses (or adjustment costs of workers) are $1.64 billion, whereas the present value of the benefits of quota removal are $106.6 billion. Thus, the net benefits from removal of the quotas in these three industries is $105 billion. The associated benefit-cost ratio is 65. That is, for every dollar of earnings losses of displaced workers, the economy gains $65 from quota removal in the three industries.

3/ To be conservative, we measure total compensation losses, which exceed earnings losses by the amount of fringe benefits.

4/ Based on various Bureau of Labor Statistics publications, we estimate that the average textile and apparel (steel) worker received $14,507 ($42,563) in total compensation in 1984. Based on data in Jacobson (1978, table 7), we estimate that the average textile and apparel (steel) worker loses 13.3% (46.6%) in the first two years after displacement, and 2.1% (12.6%) in the subsequent four years after displacement. Thus, the present value of the earnings losses of the average displaced textile and apparel (steel) worker is $4,697 ($55,348). Since there are 157,560 (16,220) displaced textile and apparel (steel) workers as a result of the removal of quotas, the economy-wide present value of the earnings losses is $1.64 billion.

9.3 Comparison With Earlier Estimates

Partial Equilibrium Estimates

In chapter 2 we argued that partial equilibrium estimates are upward biased because they fail to account for the effect of trade liberalization on the balance of trade and the exchange rate, i.e., they fail to hold the overall balance of trade unchanged when import restrictions are removed. We can obtain an estimate of the magnitude of this bias by allowing the balance of trade to vary in our model and fixing the real exchange rate. This would correspond to what is typically done in partial equilibrium studies. For the central elasticity specification, removing quotas in all three sectors would lead to a current account deterioration of $11 billion, and an estimate of a welfare gain to the US economy of $33 billion. This estimate is about one and one-half times the estimate obtained when the balance of trade is properly taken into account. Welfare analysis based on this scenario assumes that the rest of the world will provide the US with a permanent free lunch of $11 billion annually; this is not realistic. Thus, economy-wide welfare estimates obtained by adding up individual industry partial equilibrium estimates are likely to be significantly upward-biased.5/

In chapter 2, we presented a summary of the partial equilibrium estimates of the costs of protection in the textile and apparel, auto and steel sectors. Despite the balance of trade bias in the partial equilibrium

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5/ Our individual sector estimates have adjusted for balance of trade and other general equilibrium effects. Thus, the sum of our estimates for quota removal in the three sectors individually differs by only $30 million from our estimate for removal of the quotas in all three industries simultaneously.

studies, our estimates of the welfare costs of protection are larger than most of these estimates. The main explanation for this difference is that our study has benefitted from the detailed work on quota-induced premia estimates of Hamilton (1988), Feenstra (1985a) and Dinopolous and Kreinin (1988).6/ Our premia estimates are higher or cover a wider portion of the industry than most of the studies surveyed.

Many of the partial equilibrium studies obtain larger estimates of the costs to consumers than we obtain for the costs to the economy. In a full view of the economy, consumers are also workers and capital owners, who obtain the income they use for consumption expenditures from their labor and capital income. Thus, our estimates have not distinguished costs to the economy from costs to consumers. Since partial equilibrium studies cannot account for the flow of funds from labor and capital income to consumers, many of the partial equilibrium studies separate individuals from their role as consumers and their role in the economy as workers and capital owners. These studies estimate the costs to consumers as a larger number than the costs to the economy, because consumers are presumed to lose what firms earn as profits (or what the government takes as tariff revenue). In the context of general equilibrium, however, it is not appropriate to make this distinction.

General Equilibrium Estimates

Our estimates are significantly higher than most previous general equilibrium welfare estimates of the benefits of quota removal. For

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6/ The estimates of Dinopolous and Kreinin, who use comparable premia estimates, are comparable to ours.

example, Deardorff and Stern (1986, table 4.6) obtain small welfare gains from quota removal. Moreover, Whalley (1985, table 10.2), finds that the US, as well as the other regions of the world in his model, all lose welfare if they unilaterally remove their tariff or their nontariff barriers.

These studies, however, have treated quotas by their tariff equivalent. That is, they estimate the amount by which quotas raise prices and increase the tariff rate by this amount to capture the effects of the quotas. This procedure may be satisfactory in countries where the importing country captures the rents from the quotas. In the US, however, we have emphasized that a crucial aspect of the method of quota allocation is that the exporting country captures the quota rents in the products we have analyzed. In the central elasticity case, we have estimated that the US economy would gain $20.9 billion from quota removal in the three industries. Of this gain, $14.2 billion is recaptured quota rents, and the remaining $6.7 billion is the distortion costs. If we had treated the quotas by their "tariff equivalent," we would have obtained a gain to the US of quota removal in the three industries of only $6.7 billion. Thus, the majority of the difference between our estimates and previous general equilibrium estimates derives from the fact that we have properly accounted for the $14.2 billion in rent transfer associated with the US system of quotas.

Our estimates of the distortion costs of the quotas are also high in relation to the previous general equilibrium estimates. The reason for this is that our estimates are not dominated by terms-of-trade effects, a problem that has plagued previous general equilibrium models. As discussed above, if a country has monopoly power in a particular export market, or monopsony power in an import market, it can influence the price it receives (pays) for the exported (imported) product in foreign currency units. It that case, some departure from free trade is optimal, though it may be small. It is highly unlikely that very small countries, such as Israel or Luxembourg, are large enough in relation to world markets, that they can have a significant effect on world prices over a broad range of products that they trade. That is, these countries do not have significant monopoly or monopsony power. This implies that trade barriers of any significance are welfare reducing for these countries. Yet terms-of-trade effects are so strong in some of the previous models that Israel and Luxembourg have been found to lose welfare from unilateral trade liberalization. As a result of this fact, some authors have questioned the theoretical assumptions underlying these models, and suggested that models that give smaller terms-of-trade effect estimates are to be preferred (de Melo, 1986; Brown, 1987; Deardorff and Stern, 1986, p.41).7/

What is desired is a model that allows for the incorporation of monopoly and monopsony power and resulting terms-of-trade effects to the full extent that the evidence indicates they are present, but which does

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7/ It is conceivable that the US would have monopoly and monopsony power in all the sectors in which she trades. Although this seems unlikely because the US market share is usually small in her main import and export markets, we have experimented with generalized terms-of-trade across all sectors for the central elasticity case by assuming constant import supply for consumer goods imports and export demand elasticities of 5 for all sectors except autos (import supply elasticity of 3) and agriculture (export demand elasticity of 2). The gains from QR removal are smaller, but still substantial ($16.2 billion). However, because of the terms-of-trade effects, which result in expanded trade volume at higher foreign currency import prices and lower foreign currency export prices, the share of distortionary costs in total QR costs falls from 32 percent to 8 percent of total costs. Finally, adding unilateral tariff reduction now results in a welfare loss of $2.9 billion because of the dominating terms-of-trade effect, a result similar to those found in the global simulations mentioned in section 2.

not require the specification of monopoly power otherwise. That is precisely the structure of our model, and that difference from previous models is the reason for our higher estimates of the distortion costs.8/

9.4 Tariff Equivalent of the Quotas

Another way of evaluating the quotas is to ask: "What tariff structure would be required to induce the same costs on the economy as the quotas in the three sectors?" Return again to the central elasticity estimates. The total welfare costs are estimated at $20.9 billion. Of this $20.9 billion, $6.7 billion is distortion costs and $14.2 billion are rent transfers to foreigners. To impose costs on the economy equal to the distortion costs alone of the quotas, would require raising all tariffs by 3.8 times their rates in 1984. This would amount to an average (import weighted) tariff of 15%. To impose costs on the economy equal to the total costs of the quotas, would require multiplying all tariffs by 6.9 times their 1984 level, to an average level of tariff protection of 25%.9/ Since

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8/ Our approach, of treating exports and domestic products analogously with imports and domestic products through the constant elasticity of transformation production function in each sector, would not solve the problem of excessive terms-of-trade effects in a world model of the Whalley or Deardorff and Stern variety. See Brown (1988) for a step in this direction.

9/ In this experiment, we are increasing the variance of the nominal tariff by 3.8 and 6.9 times the variance prevailing in 1984. Since the distortion costs of tariff protection are positively related to the average level of protection and to the variance of protection (see Johnson, 1962), another hypothetical experiment would begin by first taking the tariff rate to be equal in all sectors. Then starting from the common tariff rate equivalent to uniform protection in 1984 (3.5%), the distortionary cost of the quotas would require average uniform protection of 24%. Adding the rent transfer element of the quotas would mean raising tariffs to 48%. With linear, rather than constant elasticity, demand and supply curves welfare calculations would yield lower estimates, as the corresponding elasticities would increase as one moves up the demand and supply curves.

we have estimated the costs of quotas in only three sectors, the costs of quotas in all sectors of the US is greater than the estimates we have provided. The average tariff rates on manufactured goods pre-Kennedy round, post-Kennedy round, and post Tokyo round were 10, 7, and 5 percent, respectively (Balassa and Balassa, 1984). Thus, in terms of the welfare costs of quotas, it is not an exaggeration to conclude that quotas have taken us back to pre-World War II tariff levels. 10/

10/ See USITC (1988) for detailed calculations of the average duties paid in the US, back to 1900.

APPENDIX

DATA SET CONSTRUCTION

Introduction

This appendix summarizes in some detail the data set construction for this study. Section A.1 presents the input-output data sources and aggregation scheme. Section A.2 details how the 1982 interindustry flow matrix was updated to 1984, the equilibrium benchmark year for our study. Section A.3 provides data sources for imports and exports and the procedures used to transform export data into producers prices. Since our updating procedure implies that consumption demand is determined residually, we explain in section A.4 how consumption was calculated and, when necessary, modified. Section A.5 presents the social accounting matrix for 1984. Section A.6 indicates how the total interindustry flows were disaggregated into their respective domestic and imported interindustry flows. The treatment of exogenous current account elements is summarized in section A.6. Finally data sources for employment is presented in section A.7.

A.1 Interindustry Flows and Aggregation Scheme

In this report, experiments are conducted with a ten sector model of the US economy. However, it would also be useful to have a data set that would allow experiments on two other sectors of concern to US trade policy: crude oil and natural gas extraction; and petroleum related products. Thus, we also prepared a data set for a twelve sector model of the US economy that included crude oil and natural gas extraction and petroleum related products as separate sectors, in addition to the ten sectors mentioned above. The twelve sector model allows trade policy experiments on crude oil and natural gas or petroleum products.[1] Thus, what is described below, is the construction of the data set for a twelve sector model. For this report, crude oil and natural gas extraction was aggregated into mining; and petroleum related products was aggregated into other manufacturing to obtain the ten sector data set utilized in this study.

The model requires a 12x12 matrix of interindustry flows, where each row or column is one of our industries. Since each sector demands both domestic and foreign inputs, we actually need two 12x12 interindustry flow matrices: one for domestic usage only, and one for import usage.

Since the data are not available in the 12x12 form required, we obtained the data in more disaggregated form and then aggregated. The US Department of Commerce has published the interindustry flows, in over 500x500 form, based on the 1977 census data. It would be better, however, to use a more recent data set, if one is available. The US Department of Commerce has also published an 85x85 matrix based on 1981 data; unfortunately, the matrix is organized as commodity by industry, rather than in the industry by industry form we require. Fortunately, the US Forest Service has contracted to have an 80x80 matrix of interindustry flows developed for 1982. This update of the interindustry flows to 1982 is based on the 1977 Census but also draws on data from the 1982-Census. We

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1/ See de Melo, Stanton and Tarr (1988) for experiments with the 12 sector data set. This paper, through exploiting the power of GAMS/MINOS, calculates the optimal combination (in terms of least welfare cost) of excise taxes and tariffs in the energy sectors to raise an additional $20 billion in US government revenue.

chose this matrix for our study.[2] The mapping from 80 sectors to 12 sectors is listed in table A.1.

A.2 Updating to 1984

Given that the interindustry table was available for 1982, it would have been convenient to use 1982 as our base year, since a very good data set for that year is available for most of the variables in our model. The year 1982, however, was a recession year. Estimates based on 1982 would likely bias downward the results. Thus, 1984 was selected as the base year for the model. This required updating the 1982 flow data. This section explains how interindustry flows were updated.

Define VA_i as the value added of sector i. The definition of value added is the value of the output of sector i less its expenditures on intermediate inputs, i.e.:

$$(A.1) \qquad VA_i = PS_i X_i - \sum_{j=1}^{n} PC_{ji} V_{ji} \qquad i = 1, \ldots, n$$

where the other variables have been defined in table 3.1. Based on the Leontief assumption, we may substitute for V_{ij} and rearrange to obtain an expression for the composite output of sector i:

2/ We thank Sherman Robinson for providing us with the data set, and helping us with data reconciliation with the National Income and Products Accounts (NIPA).

$$(A.2) \quad X_i = VA_i/(PS_i - \sum_{j=1}^{n} PC_{ji}a_{ji}) \qquad i = 1, \ldots, n$$

where a_{ij} are the input-output coefficients.

The US Department of Commerce publishes national income and product account (NIPA) data, including value added data by sector, annually. These are available in the July, 1986 issue of the Survey of Current Business (Table 6.1, Gross National Product by Industry). With three exceptions (where the data are more aggregated than desired), the data are in a more disaggregated form than desired, so again it was necessary to define a mapping from the disaggregated Commerce Department arrangement into our twelve sectors. The exceptions are that the NIPA data are available for: motor vehicles and equipment rather than motor vehicles; primary metal products, rather than iron and steel; and electric and electronic equipment contains both consumer goods and part of our other manufactured goods. Through data available from the Federal Reserve Board's industrial production indexes, we allocated the value added of these three aggregated sectors into the sectors of our 12 sector model.[3] The mapping of

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3/ Allocating the more aggregated value added data into component parts was done by a three step procedure, which again maintained consistency with our original industry classification scheme, as follows. First, we obtained the value added of each of the component parts in 1982 from our fundamental data set, the 1982 US input-output table. For example, in the case of motor vehicles and equipment, the value added of motor vehicles was $15.087 billion in 1982 and the combined value added of trucks and buses with motor vehicle parts and accessories was $18.054 billion. Second, based on data from the Federal Reserve Board's indexes of industrial production (that allow us to determine the percentage increase in production of each of these categories between 1982 and 1984) we obtain interim updated value added estimates for 1984. These value added estimates will be used only for the purpose of obtaining shares of total value added. For example, the Federal Reserve Bulletin (July 1983, A48, index 11; July 1985, A47,
Continued on next page

the NIPA value added data into our 12 sectors is listed in table A.2; the mapping maintained consistency in the decisions between the mappings of tables A.1 and A.2.

The input-output coefficients for 1982 are simply calculated from our 12x12 matrix of interindustry flows for 1982; that is, define a_{ij} as:

$$a_{ij} = V_{ij} / X_j \qquad i,j = 1, \ldots, n$$

Continued from previous page

index 11) tells us that automobile production in 1982 and 1984 was 86.6 and 135.3 percent, respectively, of automobile production in 1967. (Recall that from the Leontief assumption, value added is a constant multiple of output, so the percentage increase in production is equal to the percentage increase in value added.) From these data we calculate the value added of motor vehicles in 1984 at $23.571 billion; an analogous calculation gives the value added of motor vehicle parts and trucks and buses as $20.966 billion. The share of motor vehicles value added of the total is thus: 23.571/(23.571 +20.966) = .529. Third, we use the shares obtained in step two to allocate the value added of the more aggregated category in the NIPA data. Thus, for motor vehicles, we take motor vehicle value added to be .529 * $50.3 billion = $26.621 billion. Value added for motor vehicle parts and trucks and buses is thus $23.679 billion = ($50.3 - $26.621) billion.

In the primary metal category, there were just two categories: iron and steel and other primary metals. Iron and steel was determined to be 65.2 percent of the value added of the category.

In the case of electric and electronic equipment: radio, television and phonograph and household appliances were classified as consumer goods; electrical equipment, electrical wiring, electronic tubes, miscellaneous electrical equipment, radio and television communication equipment, semi-conductors and other electronic components were classified as other manufactured goods. Based on the above outlined procedure, the share of electric and electronic equipment value added accounted for by the consumer category was 10.8 percent.

where all variables are from the 1982 data set. Then equation (A.2) holds for the observed data set in 1982. We shall assume that the input-output coefficients a_{ij} did not change from 1982 to 1984. Moreover, we shall choose units such that all prices in the initial equilibrium are unity. Given that we have data on value added in 1984, we may thus calculate gross output by sector from equation (A.3):

$$\text{(A.3)} \qquad X_i^{84} = VA_i^{84} \;/\; (1 - \sum_{j=1}^{n} a_{ji}^{82}) \qquad\qquad i = 1, \ldots, n$$

where the superscripts denote observations of the variables in the respective year.

Given gross output by sector in 1984 from equation A.3, we may use the Leontief assumption to calculate interindustry flows in 1984:

$$\text{(A.4)} \qquad V_{ji}^{84} = a_{ji} X_i^{84} \qquad\qquad i,j = 1, \ldots, n$$

where no superscript on the a_{ji} is indicated, due to the assumption of ji constant input-output coefficients over the time period. The V_{ji} of equation A.4 are the composite use by industry i of input from industry j, regardless of foreign or domestic source; see equation 8. We need to obtain the domestic and foreign breakdown of V_{ji} which is dependent on import and export data calculated below.

A.3 Import and Export Data

The US Customs Service publishes data (down to the seven digit level) on US imports and exports. These data are reported to the United Nations, which makes these data available on-line. These on-line data were our basic data source for US imports and exports for 1984.[4] It was necessary, however, to aggregate the Custom's data into our 12 sector format. The aggregation, which was done in a manner that maintained consistency across aggregations, is defined in table A.3.

For a number of reasons, however, these data are not fully adequate for our purposes, and need to be supplemented from other sources. First, the US Customs Service does not publish data on traded services. Data regarding traded services are available from the balance of payments part of the NIPA accounts (Survey of Current Business, June, 1986, table A.1). Services exports and imports are reported under two categories: 1) factor income and 2) other services. Factor income exports refers to labor and capital services of US factors abroad for which US residents receive payments. Factor income imports are defined analogously for foreign factors. The bulk of these factor income exports are interest payments on US capital loaned abroad. Since we are not explaining capital flows, we treat factor income exports and imports as exogenous remittances. Then "other services income" from the NIPA accounts is exports (receipts) and

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4/ Although the data appeared generally accurate, an exception was that the import and export data for iron and steel was taken from the US Census publication FT-990, because the on-line data for iron and steel exports appeared inaccurate.

imports (payments) of the traded services sector (subject to one further adjustment).

A second problem is that since the Census import and export data are not exactly the same as the NIPA account data, it was necessary to impose aggregate consistency. Since our source of data on imports and exports of services is the NIPA accounts, and the NIPA accounts are our source of value added data, we required the aggregate import and export data to conform to the NIPA data. This was done by a three step procedure. First, obtain aggregate merchandise import and export data from the NIPA accounts: exports equal $224.1 billion and imports equal $336 billion in 1984. Second, calculate each sector's share of aggregate imports and exports from the Customs' data, i.e., calculate: $s_i = E_i^C / (\sum_{j=1}^{n} E_i^C)$ and $s_i^* = M_i^C / (\sum_{j=1}^{n} M_i^C)$, where E_i^C and M_i^C are exports and imports of sector i taken from Customs' data. Third, multiply each sector's share times the total imports and exports from the NIPA accounts to get imports and exports corrected for aggregate inconsistency, i.e. calculate: s_i * \$224.1 billion $= E_i^N$ and s_i^* * \$336 billion $= M_i^N = M_i$, $i = 1, \ldots, n$.

A third problem is that it is necessary to make adjustments such that everything in our model is measured in US producer prices (either paid for inputs or received for outputs). We cannot compare an interindustry flow where the producer receives the whole amount, with an export value where the producer does not receive the whole amount. That is, the Census data on exports reports the price of the product at the port of export. The producer of the product, say a manufactured good exporter, receives something less than this amount because the transportation and the wholesale and retail trade sectors receive part of this value. We have defined both transportation services and wholesale and retail trade as part of the traded services sector in our 12 sector model. Thus, when a manufactured good, for example, is exported, some portion of the export should be classified as the export of traded services. What we need to do is adjust the export data of each sector for the share of traded services embodied in the value of the item at port of export.

Fortunately, the US Department of Commerce publishes data on the share of transportation and wholesale and retail trade embodied in the export data of a number of sectors (Survey of Current Business, Table A, May, 1984). We aggregated these sectors into the 12 sectors of our model. It was then possible to calculate the share of traded services (defined to be the sum of the shares of transportation and wholesale and retail trade) embodied in the value of exports of each sector in our model; call this share $\hat{s}_i$. Except for traded services, the export data of each sector were then reduced to $E_i = (1-\hat{s}_i)E_i^N$, where E_i^N are the exports of each sector in the Customs' data adjusted to be consistent with the NIPA data according to step two immediately above. Traded services exports were correspondingly increased to $\sum_{i \neq TS} (1-\hat{s}_i) E_i^N + E_{TS}^N = E_{TS}$, where TS is the index for traded services.[5] We collected the import data on a "c.i.f." rather than "f.a.s." basis; that is, the value at the US port of entry rather than the foreign port of export was taken. This, combined with the fact that the interindustry flows already account for wholesale and retail trade and

5/ According to Commerce Department officials who produce the data, the value added numbers are adjusted analogously. That is, lumber value added, for example, does not include transportation or wholesale and retail trade margins. Thus, by this adjustment we are treating the export data and the domestic data symmetrically.

transportation margins in the use of inputs, means that no further adjustments to the import data are required to obtain imports in US producer's prices of appropriate categories.

Data on tariffs was obtained from US Department of Commerce publication FT-990, December 1984, p. A-17. It was necessary to aggregate the categories in this table into the 12 sectors of our model. We then obtained the ratio of the "calculated duty" to general imports (c.i.f.) in each of our sectors. This is the value we take for the tariff rate, t_i. This tariff rate is then multiplied by each sector's imports, M_i, which was calculated in step two above, to obtain the value of import duties.

A.4 Final Demand (Consumption)

Given the above data, it is possible to calculate final demand for each sector residually. This follows from the fact that, in the initial equilibrium, we have:

$$(A.5) \qquad X_i = \sum_{j=1}^{n} V_{ij} + C_i + E_i - M_i - t_i M_i \qquad\qquad i = 1, \ldots, n$$

Recall that we choose units so that in the initial equilibrium all prices are equal to unity. Thus, equation A.5 holds in value terms, despite the fact that prices do not enter explicitly. The left hand side (lhs) of A.5 is the value of domestic gross output for sector i. The right hand side (rhs) of A.5 is the demand for the output of sector i from all sources. The first two terms on the rhs of A.5 are the shipments of the output of sector i for intermediate use and final (or consumption) demand, respectively. V_{ij} is composite intermediate use of the output of sector i; that is, it includes imports from sector i for intermediate use. Similarly, we are interpreting C_i in equation A.5 as consumption of the output of sector i, regardless of whether it is domestic or imported. Since the lhs of A.5 is domestic output only, and the rhs includes the imports of sector i in the first two terms, it is necessary to subtract the value of imports (in producer's prices) to preserve the identity. This is done by subtracting imports and import related taxes. Exports of sector i are the other element of demand for the output of sector i.

We may rearrange A.5 to:

$$C_i = X_i - \sum_{j=1}^{n} V_{ij} - E_i + M_i + t_i M_i \qquad i = 1, \ldots, n \tag{A.6}$$

The data on the rhs of A.6 are available from the work done above. Thus, we may calculate final demand for the output of each sector, regardless of domestic or foreign origin, from A.6.

After performing the calculations to derive C_i for each sector, a problem emerged: two sectors, which are pure intermediate sectors, steel and oil and gas extraction, had values of final demand which were very small in absolute value as desired; however, final demand was slightly less than zero. As we discuss below, these negative values partly reflected a reduction of inventories, which are not included as a separate component of final demand. Negative values of consumption are not admissable in the model. Furthermore, recall that we have assumed that the input-output coefficients are unchanged between 1982 and 1984. As we now explain, in the cases of steel and crude oil and natural gas extraction, this assumption appears to be inaccurate and needs to be modified.

Take steel as an example. If the import and export data are accurate, a negative value of the rhs of A.6 means that more steel was shipped for intermediate use than was produced. Since this is impossible, it must mean that the input-output coefficients reflecting steel use throughout industry are not accurately measured and are too large. The input-output coefficient for 1982 was calculated as the ratio of steel shipments to production (in 1982):

$$a_{ji} = V_{ji}/X_i \qquad i,j = 1, \ldots, n$$

1982, however, was a recession year, and firms, most likely, added to their inventories of steel. Thus, the coefficient a_{ij} did not entirely reflect steel usage, but a combination of steel usage and inventory accumulation. In the year 1984, when firms were not adding to their inventories of steel, simply multiplying the 1982 input-output coefficient a_{ij} by gross output of sector i in 1984, will overestimate the steel usage in sector i. Thus, we reduce the input-output coefficients across the steel and crude oil and natural gas rows as follows:

$$a_{ij}^{84} = a_{ij}^{82} \ / \ 1.264 \qquad \text{for } i = \text{steel}, \ j = 1, \ldots, n$$

and

$$a_{ij}^{84} = a_{ij}^{82} \ / \ 1.0625 \qquad \text{for } i = \text{crude oil}, \ j = 1, \ldots, n$$

These changes in the input-output coefficients result in the elimination of negative values of consumption for steel and for crude oil and natural gas extraction. The calculated values of final consumption of steel and crude oil and natural gas extraction, however, are very small. The adjustment coefficients were calculated so as to obtain positive but small values of final consumption. Thus, these sectors can be regarded as pure intermediate sectors.

The results of the data calculated so far are presented in table A.4.

A.5 A Social Accounting Matrix for 1984

The "Social Accounting Matrix" (SAM) is the basic accounting tool, underlying all economywide models. In a SAM, the receipts of an institution are listed across a row, and its expenditures are listed down the corresponding column. The defining characteristic of a SAM is that each row sum must equal the corresponding column sum. Thus, the data is consistent if the resulting SAM is balanced in the sense described above.

Here we focus on each sector of the economy as elements of the SAM.[6] Each sector receives income from the sale of its output. The output is sold to other domestic firms as intermediate input, to domestic consumers and sold for export. Its expenditures are its payments to other firms for intermediate goods, and its payments to labor, the government and capital. The latter three are its value added. By accounting convention, whatever it receives in income, which is not paid out to intermediate factors, labor or the government, is considered a payment to capital.

6/ A complete SAM would include factors of production, the government sector and households. This would account for the circular flow of wealth in the economy. Thus, although our model is SAM based, the table that we are describing is not a full SAM.

Thus, receipts of each sector must equal expenditures of each sector, i.e., each row sum must equal the corresponding column sum.

Will our data set satisfy this requirement? From the way we have constructed the data set, it must. This can be seen from the following. From A.3 we have:

$$X_i = \sum_{j=1}^{n} a_{ji}X_i + VA_i \qquad i = 1, \ldots, n \tag{A.7}$$

or

$$X_i = \sum_{j=1}^{n} V_{ji} + VA_i \qquad i = 1, \ldots, n \tag{A.8}$$

Equation A.8 tells us that the expenditures of sector i, its payments for intermediate products plus its value added (which goes to labor, capital and taxes) equals the value of its output X_i. As we have explained above, the rhs of equation A.5 represents the receipts of sector i. Since C_i was calculated to assure that A.5 holds, we have that both receipts and expenditures of sector i equal to X_i in the initial equilibrium, and are thus equal to each other. The reader can verify that for each sector in table A.4, receipts (the row sum) equal expenditures (the column sum).

A.6 Domestic and Foreign Interindustry Flow Matrices

The model requires observations of domestic and foreign intermediate purchases by each sector, as well as consumption demand of domestic and foreign goods. The interindustry flow matrix $[V_{ji}]$, is a matrix of composite domestic and foreign intermediate input use by each sector. The US does not publish data on separate domestic and foreign intermediate use. Thus, we adopt the following procedure to separate composite intermediate use into domestic and foreign. Define d_i by

$$\text{(A.9)} \quad d_i = [X_i - E_i] \;/\; [X_i + (1 + t_i)\, M_i - E_i]. \qquad i = 1, \ldots, n$$

We interpret this variable as the domestic use ratio. The numerator is domestic shipments to the domestic market, and the denominator is the apparent domestic consumption of the product. Thus, the ratio is the share of domestic consumption accounted for by domestic shipments. This domestic use ratio will, in general, vary across sectors.

Given the data on d_i and V_{ij}, we define VD_{ij}, in the initial equilibrium, as follows. Given any sector i, i = 1,...,n, define VD_{ij} such that:

$$\text{(A.10)} \quad VD_{ij} = d_i * V_{ij} \qquad \text{for all sectors } j \qquad j = 1, \ldots, n$$

Consider steel as an example. We are given data on the economy's overall use of domestic versus foreign steel. Suppose the economy uses 75 percent domestic steel and 25 percent imported steel, i.e., d_i = .75 for i = steel. What we assume through equation A.10 is that all steel using sectors use domestic and foreign steel in this ratio. Thus, it means that automobiles use 75 percent domestic steel and 25 percent imported steel. In addition, agriculture and all other sectors use domestic and foreign steel in these same proportions. Equation A.10 holds for all sectors, but the domestic use ratio, d_i, will vary across origin sectors.

We allocate domestic and foreign consumption in an analogous manner. Define domestic consumption in the initial equilibrium as:

(A.11) $C_i^d = d_i * C_i$ $\quad i = 1, \ldots, n$

Dervis, de Melo and Robinson (1982) derive the conditions under which (A.10) and (A.11) will hold.

Equation (A.10) defines the domestic interindustry flow matrix:

(A.12) $VD_{ij} = d_i * V_{ij}$ $\quad i,j = 1,\ldots,n.$

The foreign interindustry flow matrix is calculated residually:

(A.13) $VM_{ij} = V_{ij} - VD_{ij}$ $\quad i,j = 1,\ldots$ ij ij

Equation (A.13) requires some explanation. Since V_{ij} is a CES aggregator of domestic and imported intermediates, it is not clear we can simply take the arithmetic sum of domestic and imported intermediates to obtain the appropriate aggregation. Recognize, however, that the firm wishes to minimize the cost of purchasing any composite commodity level V_{ij}. Set up a Lagrangian to determine the firm's first order conditions:

(A.14) $L = \sum_{j=1}^{n} [PD_{ji}VD_{ji} + PM_{ji}VM_{ji}] + \lambda\, [V_{ji}^* - V_{ji}],$

where V_{ji}^* is a given fixed level of V_{ji}. The first order conditions are:

(A.15) $PD_{ji} - \lambda\, \partial V_{ji} / \partial VD_{ji} = 0$ and $PM_{ji} - \lambda\, \partial V_{ji} / \partial VM_{ji} = 0$.

Since V_{ji} is homogeneous of degree one, it follows from Euler's theorem that:

(A.16) $(\partial V_{ji} / \partial VD_{ji})\, VD_{ji} + (\partial V_{ji} / \partial VM_{ji})\, VM_{ji} = V_{ji}$.

Substitute from the first order conditions, (A.15), into (A.16) to obtain:

(A.17) $PD_{ji}VD_{ji} + PM_{ji}VM_{ji} = \lambda V_{ji}$.

The lhs of A.17 is the cost of obtaining the composite output V_{ji}. Therefore, λ = the price of the composite output V_{ji} and we have:

(A.18) $PD_{ji}VD_{ji} + PM_{ji}VM_{ji} = PC_{ji}V_{ji}$.

In the initial equilibrium, we chose units such that all prices are equal to unity. Equation (A.13) follows. Analogously, consumption of domestic and foreign goods can be calculated from:

(A.19) $C_i^d = d_i * C_i$ $i = 1, \ldots, n$

and

(A.20) $C_i^m = C_i - C_i^d$ $i = 1, \ldots, n$

A.7 Balance of Payments and Transfers

Data on foreign transactions in the NIPA accounts was taken from the Survey of Current Business, Table A.1, June 1986. We defined the category "other service" exports and imports in this table as the exports and imports of traded services in our model. Factor income exports and imports were treated as an exogenous remittance.

Total exports and imports of goods and services were then calculated from merchandise plus other services exports and imports. Total exports were $224.1 + $58.9 = $283; total imports of goods and services for 1984 were $336 + $54.3 = $390.3. (All numbers are in billions of US dollars.) The difference of -$107.3, is the deficit in the US balance of trade on goods and services.

Remittances are defined as net factor income plus net transfer payments plus interest paid by government to foreigners. In 1984, US resident factors received $101.6 billion from foreigners, and factors resident in foreign countries received $53.6 billion from the US. Thus, the US received $48 billion in net factor income. The US paid out $12 billion to foreigners in net transfer payments, and $19.8 billion in interest by government to foreigners. Thus, remittances are: 48 - 12 - 19.8 = 16.2; that is, on balance, the US received remittances of $16.2 billion in 1984.

The remittances reduce the deficit on goods and services so that the current account deficit is: 283 - 390.3 + 16.2 = -91.1. That is, the US ran a current account deficit of $91.1 billion in 1984, which, of course, was exactly offset by foreign capital inflow.

In the policy simulations, unless otherwise stated, we shall allow the real exchange rate to vary so as to hold the trade balance deficit constant at its 1984 level. When we fix the real exchange rate, the trade balance becomes an endogenous variable.

A.8 Employment

We obtained data on employed civilians by industry for 1984 from the US Department of Labor publication Employment and Earnings, January 1985, pp.186-189. It was necessary to aggregate the data in Employment and Earnings into the 12 sectors of our model. This aggregation was done in a manner that was consistent with the agregation of the input-output tables, and was straightforward with one exception.

The exception was motor vehicles. The data were reported as motor vehicles and equipment. Thus, it was necessary to determine what proportion of motor vehicle and equipment employees are employees in motor vehicles alone. Data available in other issues of Employment and Earnings allowed us to determine the proportion of employees in motor vehicles and equipment (SIC 371) accounted for by employees in motor vehicles (SIC 3711). That proportion is .452. Thus, we allocated .452 of the employees in motor vehicles and equipment to motor vehicles, and the remainder to "other manufacturing." The results of these tabulations are presented in table A.5.

A.9 Rental Rate on Capital

The average rental rate for the economy is obtained as follows. The return to capital R is defined as the annual return to capital divided by the capital stock. The 1984 dollar value of the net stock of fixed private residential plus nonresidential capital is $6,936 billion. (Survey of Current Business, August 1986, p. 36).

To obtain the return to capital, we utilize data available in the Survey of Current Business, July 1987, p. 25, and subtract from national income that which capital does not receive. National income is $3028.6

billion; employee compensation is $2213.9 billion; depreciation (or the capital consumption allowance) is $254.5; and we estimate labor's share of proprietors income at $157.1 billion.[7] Subtract the latter three numbers from national income to obtain the value of the return to capital in 1984 as $403.085 billion.[8]

The return to capital is: R = 403.085/6936 = .058.

7/ Labor's share of overall income in our base data is 2/3. Proprietor's income in 1984 is $234.5 billion. Some portion of proprietor's income is due to the labor services of the proprietor. We assume this share is also 2/3. Thus, labor's share of proprietor's income is (2/3)*$234.5 billion = $157.1 billion.

8/ It would, of course, have been equivalent to add up the return to capital items in the Survey of Current Business table directly, and then subtract depreciation.

TABLE A.1

MAPPING OF EIGHTY SECTOR INPUT-OUTPUT MATRIX INTO TWELVE SECTORS

	Sectors in 80 Industry I/O Table	Map Into
1.	Dairy, Livestock, Foodgrains, Feedgrains, Cotton-Oil, Fruits Vegetables, Tobacco-Sugar	Agriculture
2.	Food, Tobacco Products Food	Food
3.	Mining	Mining
4.	Petroleum & Gas Extraction	Crude Oil & Natural Gas Extraction
5.	Apparel, Fabric-Yarn, Textiles- Misc., Textiles-Fabricated	Textiles & Apparel
6.	Motor Vehicles	Motor Vehicles
7.	Iron & Steel	Iron & Steel
8.	Petroleum Related Products	Petroleum Related
9.	Construction-Nongovt., Construction- Government, Real Estate, Health & Education Services, Personal Services, Government Business, Electricity Gas & Water	Non-traded Services
10.	Telephone-Telegraph, Communications- Radio T.V., Transportation-Communication, Trade-Wholesale & Retail, Banking & Insurance, Business Services, Rest of World Industry	Traded Services

TABLE A.1

MAPPING OF EIGHTY SECTOR INPUT-OUTPUT MATRIX INTO TWELVE SECTORS--Continued

	Sectors in 80 Industry I/O Table	Map Into
11.	Munitions, Lumber & Wood, Trucks & Buses, Wood Containers, Paper & Allied Products, Paper Containers, Printing, Chemicals, Plastics, Paints, Rubber, Glass & Stone, Non-Ferrous-Metals, Metal Containers, Heating & Plumbing Products, Screw-Machines, Other Fabricated-Metals, Engines & Turbines, Farm Machinery, Construction Machinery, Materials & Machinery, Metalwork Machinery, Special Industrial Machinery, General Industrial Machinery, Misc. Machinery, Computing Equipment, Other Office Equipment, Service Machinery, Electrical Equipment, Electric Wiring, Electronic Tubes, Semi-Conductors, Other Electronic Components, Electronics-Misc., Parts-Motor, Aircraft, Other Transportation Equipment, Professional Science Equipment, Optical & Photo Equipment, Non-Comparable Imports, Other Industry	Other Manufacturing
12.	Furniture-Household, Furniture-Other, Drugs, Leather Goods, Household Appliances, Radio-T.V.-Phonographs, Footwear	Other Consumer Goods

SOURCE: Author's definition.

TABLE A.2

MAPPING OF NATIONAL INCOME AND PRODUCT ACCOUNT (NIPA) VALUE ADDED DATA INTO THE TWELVE SECTOR AGGREGATION

(Values in parentheses are value added in billions of 1984 U.S. dollars)*

	Sectors in NIPA Accounts	Map Into
1.	Farms (79.0), Agricultural Services (15.0)	Agriculture (94.0)
2.	Food (67.7), Tobacco (12.4)	Food (80.1)
3.	Metal mining (3.1), coal mining (17.3), Nonmetallic minerals (5.6)	Mining (26.0)
4.	Oil and gas extraction (99.1)	Oil & Gas Extraction (99.1)
5.	Textiles Mill Products (17.3), Apparel and other textile products (21.3)	Textiles and Apparel (38.6)
6.	.529* Motor Vehicles and equipment (50.3)	Motor Vehicles (26.62)
7.	.652* Primary Metal Products (35.7)	Iron and Steel (23.28)
8.	Petroleum and Coal Products (29.6)	Petroleum and Coal Products (29.61)
9.	Electric, gas and sanitary services (112.6), Construction (171.1), Federal Government (132.0), Federal Government Enterprises (27.9), Real-Estate (409.9), Hotels (27.4), Personal Services (24.8), Auto repair (29.9) Miscellaneous Repair Service (12.5), Movies(7.5), Recreation Services	Nontraded Services (1492.6)

TABLE A.2

MAPPING OF NATIONAL INCOME AND PRODUCT ACCOUNT (NIPA) VALUE ADDED DATA INTO THE TWELVE SECTOR AGGREGATION--CONTINUED

(Values in parentheses are value added in billions of 1984 U.S. dollars)*

Sectors in NIPA Accounts	Map Into
(18.4), Health Services (168.8), Educational Services (22.6), Social Services (35.7), Private Households (9.1), State and Local Government (258.9), State and Local Government Enterprises (23.5)	
10. Railroad transportation (24.0), Local Transit (7.5), Trucking (56.7), Water Transportation (7.9), Transportation by Air (26.2), Pipelines (4.9), Transportation Services (8.5), Telephone and Telegraph (92.2), Radio and Television Broadcasting (10.4), Wholesale trade (262.1), Retail Trade (348.3), Banking (72.3), Credit Agency (10.2), Security and Commodity Brokers (21.0), Insurance Carriers (34.7), Insurance Agents (20.7), Holding Companies (8.2), Business Services (125.7), Legal Services (41.7), Miscellaneous Professional Services (57.3), Statistical Discrepancy (-1.9), Rest of the World (47.5)	Traded Services (1286.1)

TABLE A.2

MAPPING OF NATIONAL INCOME AND PRODUCT ACCOUNT (NIPA) VALUE ADDED DATA INTO THE TWELVE SECTOR AGGREGATION--CONTINUED

(Values in parentheses are value added in billions of 1984 U.S. dollars)*

	Sectors in NIPA Accounts	Map Into
11.	Rubber and Plastic Products (24.7), Leather and Leather Products (3.5); Furniture and Fixtures (12.8), .108* Electric and Electronic Equipment (76.1)	Other Consumer Goods (49.2)
12.	Lumber and Wood Products (23.6), Stone, Clay, and Glass Products (23.4), Primary Metal Industries (35.7), Fabricated Metal Products (53.6), Machinery, except electrical (88.9), Motor Vehicles and Equipment (50.3), Other Transportation Equipment (45.4), Instruments and Related Products (24.9), Miscellaneous Manufacturing Industries (11.9), .892* Electric and Electronic Equipment (76.1), Paper Products (32.1), Printing and Publishing (47.5), Chemicals and Allied Products (64.3), .471* Motor Vehicles and Equipment (50.3), .348* Primary Metals (35.7)	Other Manufacturing Goods (519.6)

* Due to rounding, in the presented data, the value of the aggregate category may not always equal the sum of the parts.

Source: *Survey of Current Business*, July 1986; and author's aggregation.

TABLE A.3

MAPPING OF STANDARD INTERNATIONAL TRADE CLASSIFICATION (SITC) DATA INTO OUR TWELVE SECTOR MODEL

	SITC Categories	Map Into
1.	00, 01, 031, 041, 042, 043, 045, 046, 047, 051, 052, 054, 061, 071, 072, 08, 21, 22, 29, 41, 42	Agriculture
2.	02, 032, 048, 053, 055, 062, 073, 09, 11, 12, 43	Food
3.	2311, 241, 27, 283, 284, 285, 286	Mining
4.	331, 3411	Crude Oil & Natural Gas Extraction
5.	26, 65, 84	Textile & Apparel Products
6.	7321	Motor Vehicles
7.	332, 3412	Petroleum Related Products
8.	54, 55, 6291, 7241, 7242, 7292, 7294, 7331, 7334, 82, 83, 85, 86, 94, 96	Other Consumer Goods
9.	2312, 2313, 2314, 242, 243, 244, 25, 32, 35, 51, 52, 53, 56, 57, 58, 59, 61, 6210, 6293, 6294, 6299, 63, 64, 66, 68, 69, 71, 7221, 7222, 7231, 7232, 7249, 7250, 7261, 7262, 7291, 7293, 7295, 7296, 7297, 7299, 7324, 7325, 7326, 7327, 7328, 7329, 7333, 734, 735, 81, 89, 95, 7322, 7323	Other Manufactured Goods
10.	281, 282, 67	Iron & Steel

Source: Author's definition.

Table A.4

TWELVE SECTOR INPUT-OUTPUT MATRIX FOR THE UNITED STATES
(in billions of 1984 US dollars)

	Intermediate Flows							
	Agriculture	Food	Mining	Oil & Gas	Textiles	Motor Vehicles	Steel	Petroleum Products
Agriculture	69.73	88.58	0.01	0.01	3.32	0.00	0.00	0.00
Food	19.96	52.83	0.01	0.02	0.05	0.01	0.03	0.09
Mining	0.27	0.24	7.06	0.02	0.08	0.04	5.00	0.43
Oil & Gas	0.51	0.17	0.10	16.73	0.05	0.02	0.16	122.24
Textiles	0.55	0.14	0.10	0.04	47.16	4.22	0.04	0.02
Vehicles	0.01	0.00	0.01	0.00	0.00	8.45	0.03	0.01
Steel	0.09	0.02	0.29	0.62	0.02	1.38	7.28	0.07
Petroleum Product	12.03	2.21	1.80	1.42	1.23	0.37	1.38	24.11
Nontraded Services	27.07	11.39	4.79	27.38	5.16	1.61	5.64	11.29
Traded Services	26.53	37.65	4.69	5.98	11.42	10.43	7.42	19.33
Consumer	0.82	1.58	0.02	0.04	0.74	1.49	0.06	0.65
Manufactures	21.88	41.44	6.65	5.98	14.98	69.55	7.19	9.34
Total Intermediate Use	179.45	236.25	25.53	58.24	84.20	97.58	34.23	187.58
Value Added	94.00	80.10	26.00	99.10	38.60	26.62	23.28	29.60
Total Expenditures	273.45	316.35	51.53	157.34	122.80	124.20	57.51	217.18

Table A.4

TWELVE SECTOR INPUT-OUTPUT MATRIX FOR THE UNITED STATES-CONTINUED
(in billions of 1984 US dollars)

	Nontraded Services	Traded Services	Consumer	Manufactures	Total Intermediate Demand	Imports + Duties	Exports	Final Demand	Total Receipts
Agriculture	12.22	1.36	0.25	8.19	183.66	17.26	29.41	77.64	273.45
Food	56.20	1.17	1.88	1.36	133.61	8.75	4.70	186.78	316.35
Mining	17.10	0.02	0.13	13.65	44.05	3.53	2.17	8.83	51.53
Oil & Gas	52.89	1.88	0.08	5.14	199.98	43.59	0.86	0.0818	157.34
Textiles	7.33	1.27	2.26	6.82	69.96	23.62	6.76	69.71	122.80
Vehicles	0.73	0.13	0.00	1.24	10.62	32.61	4.86	141.34	124.20
Steel	7.73	0.59	2.19	48.59	68.85	12.71	1.36	0.0057	57.51
Petroleum Products	53.75	51.85	2.39	31.39	183.93	21.19	4.23	50.21	217.18
Nontraded Services.	271.21	201.43	7.41	95.53	669.91	0.00	0.00	1773.41	2443.32
Traded Services	251.66	343.03	19.46	181.51	919.10	54.30	88.03	1041.52	1994.35
Consumer	14.66	1.80	8.16	4.09	34.12	29.01	10.44	109.98	125.54
Manufactures	205.24	103.71	32.14	447.64	965.73	156.70	130.18	425.56	1364.77
Total Intermediate Use	950.72	708.25	76.33	845.17	3483.54	403.27	283.00	3885.07	7248.34
Value Added	1492.60	1286.10	49.20	519.60	3764.80*				
Total Expenditures	2443.32	1994.35	125.54	1364.77	7248.34				

*The entry $3764.80 billion is the sum of the value added for all sectors.

Source: Author's calculations based on data sources explained in the text.

TABLE A.5

US CIVILIAN EMPLOYMENT BY SECTOR IN 1984

(numbers are in thousands of employees)

Sector	Number of Employees
Agriculture	3,321
Food	1,752
Mining	338
Oil & Gas Extraction	619
Iron and Steel	531
Textiles and Apparel	1,969
Petroleum Products	204
Motor Vehicles	536
Traded Services	42,043
Nontraded Services	37,689
Other Consumer Goods	2,599
Other Manufactured	13,404
Total Employment	105,005

Source: Author's calculations based on data obtained from the US Department of Labor, Bureau of Labor Statistics, Employment and Earnings, January 1985, pp. 186-189.

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