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VERs Under Imperfect Competition and Foreign Direct Investment

A Case Study of the U.S.-Japan Auto VER

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and
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Protection of domestic industries through nontariff barriers generally produces unintended effects. The developments that followed the agreement between the United States and Japan on autos demonstrate the complexity of the voluntary export restraint mechanism.

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In 1981, the United States induced the Japanese to agree to a voluntary export restraint (VER) on their exports of autos to the United States. Using a general equilibrium constant return to scale model, de Melo and Tarr first assess the costs of the U.S.-Japan agreement at about $10 billion.

The two countries negotiated the VER against a background of falling U.S. production and employment in the auto industry and several legislative attempts to curb Japanese imports. The Japanese agreed to limit their U.S. exports to 1.68 million vehicles a year for a three-year period.

The study found that U.S. auto dealers captured some of the rents from the VER and that increasing returns to scale in the U.S. auto industry imply that protection has an effect on scale efficiency.

From 1984 to 1987, seven Japanese auto manufacturing firms established assembly plants in the United States. De Melo and Tarr argue that the VER generated pure profits in the domestic auto industry which induced the Japanese producers to enter the U.S. domestic market through foreign direct investment. Their entry then largely eliminated the abnormally high profits.

The study sequentially introduces into the model the important elements of the auto industry and the VER, thereby isolating the impact of each on the estimates of the welfare effects of the VER. In the most reasonable representation with increasing returns to scale, pure profits, internationally mobile capital, and endogenous conjectures, the estimate of the welfare costs of the VER are $9 billion; this is $1 billion or 10 percent less than the estimate from the constant returns to scale model.

The impact of foreign direct investment was to lower the costs of the VER because the greater entry into domestic auto manufacturing resulted in a lower quota rent premium for foreign autos. The costs per job protected in the auto sector, at the expense of employment elsewhere, were high, ranging from $164,000 to $296,000 a job a year.

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VERS UNDER IMPERFECT COMPETITION AND FOREIGN DIRECT INVESTMENT: A CASE STUDY OF THE U.S.-JAPAN AUTO VER

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1. Introduction

In 1981, the US induced the Japanese to agree to a voluntary export restraint (VER) on their exports of autos to the US. Among others, Baldwin (1982) has noted that protection will generally have unintended effects, and the developments that followed the introduction of the auto VER demonstrate the complexity of the VER mechanism. Some have been studied by previous authors. These include: (1) the significant quality upgrading on the part of the Japanese auto producers (Feenstra, 1984, 1988); (2) a spillover effect on US demand for European autos which generated a premium on European autos after adjusting for quality upgrading (Dinopoulos and Kreinin, 1988); and (3) the impact of the VER on imperfectly competitive pricing of the US auto producers (Dixit, 1988; Krishna, Hogan and Swagel, 1989); (4) wage distortions in the auto industry may imply that additional labor employed in the auto industry has second-best benefits (Dixit, 1988; Krishna, Hogan and Swagel, 1989).[1] There are, however, several other aspects of the auto VER that have not yet been systematically investigated and which are the subject of this paper. These are: (5) US auto dealers captured some of the VER rents; (6) US monopsony power in autos will imply a positive optimal tariff, i.e. in the absence of retaliation, there are terms-of-trade gains that reduce the costs of the VER; (7) increasing returns to scale (IRTS) in the US auto industry implies that protection has an effect on scale efficiency; (8) the existence of pure profits (perhaps induced by the VER) in the domestic auto industry, which will induce entry that will also have scale efficiency effects; (9) massive entry into the US auto industry via foreign direct investment (FDI) by Japanese auto producers

shortly after the VER went into effect; and (10) the proper evaluation of rent capture which implies an endogenous treatment of the rent premium.

This paper explores systematically the impact of these effects induced by the VER. We first estimate the effects of the VER under constant returns to scale (CRTS), without wage distortions and without US citizens capturing rents. We then sequentially introduce the elements mentioned above one by one. In this manner we isolate the impact of each of the effects on the welfare estimate of the effects of the VER, ultimately arriving at a representation of the auto industry which we believe yields a better estimate of the costs of the auto VER. The reader is thus able to readily assess the impact of each of the effects or industry attributes on the calculation of the costs of VER protection. Moreover, because our modelling recognizes IRTS and wage distortions, we also estimate separately the welfare gains from applying "optimal" trade and subsidy policy to take these features into account.

Interest in systematic calculations of the costs of the auto VER arises out of the interaction of several ambiguous effects. For example, as shown by Dixit (1986) and by Rodrik (1988), entry to eliminate pure profits will reduce monopolistic price distortion (a benefit), but will reduce scale efficiency (a cost). In addition, if entry occurs through foreign direct investment (FDI), Brecher and Diaz-Alejandro (1977) have shown that the repatriation of the private returns to capital can be immiserizing if the private and social returns to capital are different due to distorted prices, such as would occur under a quota. In addition, increased entry with FDI imposes greater costs through reduced scale efficiency. But the costs of the VER are reduced through another channel. In a world of differentiated products, entry will reduce the price of domestic autos, which in turn will reduce the demand for and the price

of imported autos. Since the rent premium on imported autos is endogenously determined as the difference between the price on the tariff-ridden demand curve at the rationed quantity of autos under the VER and the world price of autos inclusive of transport costs, entry will also reduce the rent premium earned by foreigners. Thus, entry has greater benefits when the rent premium is correctly determined endogenously than when the rent premium is treated exogenously.

We estimate the effects of the VER with a general equilibrium model because three of the items above (4, 6 and 9), are fundamentally general equilibrium effects. As a result, we estimate the combined effects of: (1) the effects of FDI in a second-best environment; (2) the second best gain of labor reallocation when an industry with a wage premium receives protection; (3) the biases likely to occur in a partial equilibrium approach. Our preferred representation of the U.S. auto industry during the VER is one of monopolistic competition on the domestic market with above normal profits caused by the VER and a wage premium paid to auto workers. To anticipate our main results, we find that a perfect competition model which incorporates wage distortions and domestic rent capture results in an estimate of costs of the VER of about $10 billion, and almost $250,000 per job protected in autos at the expense of employment elsewhere. In the preferred monopolistic competition, initial profit model, the estimated costs are reduced by about 10 percent depending on the assumption made regarding oligopolistic conjectures. The ratio of the costs of the auto VER to the benefits (in saved adjustment costs) are between 14 and 26 to 1. Endogenous rent determination results in significantly lower estimated costs of the VER because domestic entry reduces the rent premium. The impact of FDI is to lower the costs of the VER if, and only if, the rent

premium is determined endogenously. Then the greater entry into domestic auto manufacturing lowers the rent premium, which dominate scale efficiency loss and immiserizing effects of FDI.

The remainder of the paper is organized as follows. In section 2, we review the main stylized facts of the U.S. auto industry that are modelled in the remainder of the paper. Modelling specifications and calibration are discussed in section 3. Section 4 reports on welfare cost calculations under the standard traditional assumption of a competitive market in the U.S. auto industry. Estimates of the effects of wage distortions, partial domestic quota rent capture, endogenous terms-of-trade and the partial equilibrium bias are provided. Corresponding calculations under various imperfectly competitive market structures are reported in section 5. Optimal tariff and production subsidy calculations, which are rarely executed in computable general equilibrium exercises, are presented in section 6. Conclusions follows in section 7.

2. The U.S. Auto Industry During the U.S.-Japan VER

In the Spring of 1981, after negotiations with U.S. government officials, the Japanese government announced that it would voluntarily restrain its exports to the U.S. The Japanese agreed to limit their exports of autos to the U.S. to 1.68 million vehicles per year between April 1, 1981 and March 31, 1984. Between April 1, 1984, and March 31, 1985, Japanese auto exports to the U.S. were limited to 1.85 million vehicles. This action was taken against a background of falling U.S. production and employment in autos, and a number of legislative attempts to curb Japanese imports. After the US Administration failed to request an extension of the auto VER, the Japanese government

continued to restrain its auto exports to the US, but at the less restrictive level of 2.3 million vehicles per year.[2] The Japanese action may have been motivated by fear of Congressional pressure to reintroduce a VER, or by their learning they had monopoly power they wished to continue to exploit.

After adjusting for the significant product upgrading that took place, Feenstra (1984 and 1988) found that Japanese manufacturers earned premia on their US sales of over 17 percent in 1984 as a result of the VER. Dinopoulos and Kreinin (1988) also adjusted for product upgrading on European autos (which was less significant), and found a significant spillover effect on the price of European autos. These spillover effects could be explained by a variety of reasons including: (1) new found monopoly power because the VER restrained the Japanese (see Krishna, 1989 on quotas as a facilitating practice); (2) an upward sloping supply curve of a competitive industry; or (3) fear of restraint by the US Congress. As explained in de Melo and Tarr (1990b), combining the estimates of Feenstra and Dinopolous and Kreinin implies that the weighted average premium rate earned by European and Japanese auto exporters on their sales to the U.S. in 1984 was 31.8 percent, yielding $7.87 billion of rents to foreign auto exporters.

In addition, there is evidence that during the VER period, Japanese manufacturers allowed their US dealers to capture part of the rents.[3] One explanation of this phenomenon is that this practice developed a strong US dealer network. Another is that it retained goodwill. A third is the allegation that US auto dealers of Japanese autos threatened collective antitrust action to void the VER if they did not receive a price from their suppliers that would allow them to capture some of the rents. Accordingly, we assume that US dealers of Japanese autos earned $500 of rents per vehicle due

to the VER, but US dealers of European vehicles earned no rents. This implies that there were rents earned on the sale of Japanese autos during the VER period in addition to those estimated by Feenstra. Under this assumption, the weighted average premium paid on all imported autos was 36.4 percent (instead of 31.8 percent) and US residents captured 10 percent of the rents.[4]

After adjusting for human capital and demographic factors such as age, sex, education and race, Krueger and Summers (1988) have estimated that workers in certain industries earn wage premia; in particular, they estimated a 27 percent premium for workers in the transportation sector. This is the premium we apply to auto workers.[5] They, and Katz and Summers (1988), argue that efficiency wage theories generally explain these wage differences, but that in the case of autos, the premia appear to be explained by unionization. Assuming that workers in all industries are employed up to the point where the value of their marginal product equals their wage, this premium, so long as it is exogenous, implies that a reallocation of workers to autos should be efficiency-improving thereby reducing the welfare costs of protection. Since the welfare effect of reallocating labor from other sectors to the auto industry depends on the difference between the value of the marginal product of labor in autos and other sectors, a correct evaluation requires a general equilibrium model.

Should the US be regarded as a country which is unable to significantly influence the price at which foreigners supply autos, or does it possess monopsony power on world auto markets? The results of Dinopolous and Kreinin provide some indirect evidence in support of the latter view. Accordingly, we simulate two extreme alternatives: (1) the US is unable to influence the world price of autos (infinite import supply elasticity); and (2) an import supply

elasticity of five. In the latter case, an elementary model would suggest an optimum tariff of about 20 percent.

All of the above effects can be analyzed in a constant returns to scale (CRTS) model. However, Friedlender, Winston and Wang (1983) and Winston and Associates (1987) have estimated that the US auto industry operates under increasing returns to scale (IRTS). Accordingly, we also evaluate the effects of the VER in a model where the auto sector has IRTS.

Finally, table 1 documents two important facts about the VER period not previously investigated. First, profits in the U.S. auto industry were very high by historical standards from 1983 to 1986, declining, almost monotonically, after reaching their peak in 1984.[6] As mentioned above, the VER was in place until March 31, 1985, after which a Japanese VER remained in effect, apparently without US Administration request. Second, the data show that increased FDI followed the negotiation of the VER agreement and the appearance of high profits in the US auto industry. FDI peaked in 1986.

We believe these series are related and would argue that once the US recession of 1981 and 1982 ended, the VER allowed above normal profits in the U.S. auto industry. The highly profitable US market could, however, be accessed by the Japanese through FDI. [Bhagwati (1987) has referred to this as VER-jumping]. If investment responds to profits with a lag, it is no surprise that the years of large investments began in 1984. The U.S. "Big Three" (GM, Ford and Chrysler), which had very little domestic competition following the exit of other U.S. auto producers (e.g. Studebaker, Hudson, Packard), were suddenly facing stiff competition in the U.S. Between 1984 and 1987, seven Japanese firms (Honda, Toyota, Nissan, Mazda, Isuzu, Mitsubishi, and Fuji) established car assembly plants on U.S. territory. As the Japanese

Table 1

Profits and Foreign Direct Investment in the U.S. Auto Industry

	Profits a/	Foreign Direct Investment b/	
		Assembly	Parts
1979	4.7	200.0	N.A.
1980	-5.0	200.0	N.A.
1981	-1.1	500.0	N.A.
1982	-0.8	65.0	4.0
1983	5.1	101.4	32.0
1984	9.9	487.5	48.0
1985	6.8	628.0	71.0
1986	2.2	850.8	234.8
1987	0.5	435.5	53.7
1988	2.4	419.5	850.8
1989	-1.4	N.A.	N.A.

Notes.-

N.A.: Not available.

a/ Billion of current dollars.
Source: U.S. Department of Commerce, Survey of Current Business, July, various issues.

b/ Millions of current dollars. Includes plant and other investment. Prior to 1982, data cover only FDI in assembly plants above $50 million.
Source: U.S. Department of Commerce, Foreign Direct Investment in the United States, various issues and unpublished data of the Office of Trade Investment, U.S. Department of Commerce.

followed their practice of vertical integration, FDI in parts continued to rise, even after FDI in assembly plants tapered off when the market became saturated with producers.[7] In sum, we believe that the VER generated pure profits in the US auto market which were then largely eliminated by Japanese entry. Consequently, we also estimate the effects of the VER under the assumption that it induced pure profits in 1984 that were eliminated by entry including FDI.

3. Modelling the Auto Industry

We now describe briefly how we model the auto industry under IRTS. Following Harris (1984) and Cox and Harris (1985), we assume that output is produced by N identical firms indexed over i so that sectoral output is $X = Nx_i$ where x_i is the output of the ith firm, and we have suppressed sector subscripts. We define total costs, TC, and average costs, AC, in terms of fixed costs, FC, and variable costs, VC, where fixed costs are defined by:

$$(1) \qquad FC \equiv (N/\bar{N}) / (\overline{KF}R + \overline{LF}W)$$

where a bar over a variable indicates that it is exogenous, $\bar{N}$ is the initial number of firms, $\overline{KF}$ and $\overline{LF}$ are the amount of capital and labor required to keep a firm open, and W and R are the prices (relative to the numeraire) of labor and capital respectively. (In the simulations reported here, the model is calibrated so that labor and capital shares in fixed costs are the same.) Unit variable costs are constant.

Each firm produces identical products which are differentiated from (identical) imports. This national product differentiation is also applied to

export sales which are differentiated from domestic sales. This symmetric treatment of imports and exports is modelled by assuming CES and CET aggregation functions for imports and domestic output on the one hand, and domestic output and exports, on the other hand.

For pricing, we assume that US auto firms price competitively in export markets because they face stiff foreign competition. The assumption is plausible, and not crucial empirically because exports accounted for less than 4 percent of total industry sales (see table 2).

Our preferred pricing rule for domestic sales is to assume that each firm behaves in the domestic market as an oligopolist facing a downward sloping demand curve. Firms form conjectures regarding the output reactions of their domestic competitors. Denote by Ω_i^d, the ith firm's conjecture with respect to the change in domestic industry output when it changes its output by one unit. By symmetry, the marginal costs and conjectural variation parameters are equal for all firms in the industry. Profit maximization then implies that, at equilibrium, each firm sets marginal revenue equal to marginal costs, MC, so that:

$$(2) \qquad (PD - MC)/PD = \Omega_d/(N\ \epsilon^d)$$

where ϵ^d is the market elasticity of demand. Note that in the simulations, the number of firms N and the market elasticity of demand are endogenous variables, where the latter is a share weighted average of the elasticities of demand for final and for intermediate sales implied by functional forms for consumer behavior and technology.

Equation 2 defines the percentage markup over marginal costs in terms of N, Ω^d and ϵ^d. Given data on prices, costs and elasticities, only the ratio of Ω^d to N is identified. Given ϵ^d and N equal to 3 in 1984 (General Motors, Ford and Chrysler), we calibrate Ω^d at 0.72, i.e., pricing was more competitive than Cournot. An equivalent approach, followed by Dixit (1988) is to enter Cournot conjectures (Ω^d=1), and calibrate N, the "Cournot equivalent number of firms."[8] Dixit calibrated the Cournot equivalent number of firms in 1979, 1980 and 1983. If domestic firms are counted by corporation (rather than by division), then Dixit's results indicate that pricing was more competitive than Cournot in all three years he examined, and, of the three years, pricing was the most competitive in 1980 and least competitive in 1979.[9] In their estimates during the period 1979 to 1984, Krishna, Hogan and Swagel (1989) found that pricing was the least competitive in 1984. They also find that pricing was more competitive than Cournot in all years they examined. We conclude that our calibrated conjecture is a reasonable estimate.

It is likely that conjectures will change as a result of firm entry. Intuitively, as the number of firms increases, in the limit, the industry becomes competitive and conjectures should approach competitive ($\Omega^d = 0$).[10] To capture this effect, in some simulations, we estimate the effect of additional competition by adding the following <u>ad hoc</u> equation:

$$(3) \qquad \Omega^d = \Omega^d_o / [N/\bar{N}]$$

where Ω^d_o is the conjecture in the initial calibrated equilibrium. When we use equation (3), we say that conjectures are endogenous.

The conjectural variation approach has been criticized because it involves applying a static concept to an inherently dynamic problem. It can, however, be defended as an equilibrium to a dynamic game, and, in any case it is used by most authors dealing with imperfect competition models in applied trade problems. We also assume that domestic firms form Cournot conjectures with respect to foreign rivals so that the output reaction of foreign firms does not appear in (2).

To isolate scale efficiency effects from entry effects, we also consider a contestable markets pricing rule, in which case the threat of entry forces incumbent firms to price at average costs:

(4) $PX = AC$

where PX is a weighted sum of domestic and export sales prices. Because of the evidence of entry, contestable markets is not our preferred pricing rule.

When we assume that the VER leads to pure profits, drawing on the data in tables 1 and 2 and related data on profits, we assume pure profits in 1984 of $9.4 billion.[11] This yields a rate of profit of 8 percent.

As suggested by the evidence in section 2, firm entry was the mechanism by which excess profits were eliminated. This implies that the following equation is added:

(5) $PROFITS = 0$

will determine the number of firms in the monopolistic competition case described above.

When there are initial profits, the calibration must be decomposed into two parts: (1) how much do average costs depart from marginal costs; and (2) what is the mark up of price over average costs (due to imperfect competition). Independently of initial profits in autos, the amount of fixed costs is determined by the value of the cost-disadvantage ratio given in table 2. To incorporate fixed costs while replicating observed prices and quantities in the CRTS case, the primary variable cost component of total cost is reduced by the amount of fixed costs.

When there are initial profits, in a first step we carry out the same allocation of total costs into fixed and variable components described above. In a second step, given the profit rate per unit of domestic sales and the quantities and foreign prices (expressed relative to the numeraire), we solve for the vector of prices that satisfies the constraint that the firm earn the rate of return given by the initial data.[12] As before, the calibration of Ω^d is obtained by solving (2) but with the newly calculated set of domestic prices.

Finally, is the issue of modelling capital mobility. We consider two polar cases. When capital is internationally immobile, the rental rate on capital is determined endogenously and the aggregate capital stock is fixed. When capital is internationally mobile, we assume perfect mobility. Then, the rental rate on capital is fixed in terms of the numeraire by an infinitely elastic supply of capital available on international markets and the capital stock is variable. When there is perfect capital mobility, the rental income from FDI accrues to the foreign owners of capital who repatriate the rental income. Capital inflow and outflow are treated symmetrically. Thus, the

domestic economy achieves additional output from the use of foreign capital, but it loses the rentals.

The remaining features of the model are standard to computable general equilibrium (CGE) models. The model includes two factors, capital and labor, mobile between sectors. Labor is always in fixed supply.[13] Domestic demand includes two components, final and intermediates. The government sector's role is limited to lump-sum redistributions to and from the representative consumer. In the simulations reported below, the auto sector is embedded in the static ten-sector model described in de Melo and Tarr (1990b). In the calibration to 1984, tariffs are set at their levels in 1984 (an economy wide average of 3.5 percent) and the quotas in textiles and apparel resulting in a premium rate of 40.5 percent are also maintained at their base year level.

Table 2 describes the structure of the U.S. auto industry in 1984. Imports represented 26 percent of domestic output, the bulk of which went to final demand. As mentioned above, exports were negligible. The measure of scale economies captures the degree of multiproduct scale economies at the level of output achieved by General Motors, Ford and Chrysler in 1983. Price elasticities of demand are taken from Levinsohn (1988).[14]

4. Welfare Cost Estimates under CRTS

4.1 Benchmark Estimates

We begin with the benchmark estimate of the auto VER under CRTS in table 3. Welfare is evaluated by the Hicksian equivalent variation measure. We decompose the total costs of the VER into two components: rent costs (reported in column 2) and distortion costs (reported in column 3).[15] We evaluate these components by estimating the total costs of the VER and

separately estimating the benefits of capturing rents from foreigners. The distortion costs are defined as the difference between the two estimates.

The simulated estimate of the gain from rent capture is close to the initial exogenous estimate (see table 2), but is slightly lower than the initial value of rents because capturing rents results in an income increase that will lead to an increase in demand for imported autos. This increase gets translated into a higher rent premium (now captured domestically) which increases the distortion costs of the VER.

Although auctioning quota rights is often recommended as a device to capture quota rents (e.g., Bergsten et al. (1987)), in this instance quota right auction will likely be ineffective. First, since a significant portion of the rents were captured by Europeans, and there was no explicit VER or quota against the Europeans, it is doubtful that auctioning quota rights would have resulted in rent capture. In addition, to the extent that there is monopoly power in exporting, Krishna (1990) has shown that auctioning quota rights may not capture rents. This is because the price at which the exporters with monopoly power are willing to supply the market will increase with a binding quota, thereby reducing the value of a license to import. In this setting, a tariff at the rate of the quota premium from each region, would be the instrument best suited to capture rents.

Sensitivity of the welfare cost estimates to systematic variation in demand and supply elasticities in the first three rows indicates that the estimates of the distortion costs of the VER increase with demand and supply elasticities. This is because the price decrease from removing the VER induces a larger increase of auto purchases with larger elasticities, i.e, a larger

Table 2

Production, Demand Structure, and Elasticities in the Auto Industry

Premium Rate on Imports	36.4%	(31.8%)
Rents Accruing to Foreigners[a/]	7.87	(7.87)
Rents Accruing to US Citizens	0.87	(0.0)
Wage Distortion in Autos[b/]	27.0%	
Production and Demand[a/]		
Gross Output	124.2	
Domestic Final Demand Sales	111.0	
Intermediate Sales	8.3	
Exports	4.9	
Imports		
Intermediates	2.3	
Final Demand	30.3	
Elasticities and Parameters[c/]		
Capital-Labor Substitution	0.8	
Import-Domestic Substitution Elasticity[d/]	1.9	
Composite Final Demand	0.8	
Export-Domestic Transformation Elasticity[d/]	2.9	
Calibrated Domestic Conjecture (Ω^d)	0.72	
Derived Price Elasticity of Demand (ϵ^d)	1.37	
Cost Disadvantage Ratio[e/]	0.11	

Notes: Second column estimates assume no rent capture by US dealers of Japanese auto imports.

a/ 1984 US$ billion.

b/ Krueger and Summers (1988).

c/ Sources for demand and supply elasticities are detailed in de Melo and Tarr (1990a).

d/ The selected CES (CET) functions imply that the corresponding substitution (transportation) elasticities are compensated import demand (export supply) elasticities.

e/ Friedlaender, Winston and Wang (1983); and Winston and associates (1987).

deadweight loss triangle. On the other hand, rent cost estimates are insensitive to changes in elasticities. In the remainder of the paper, we report only simulations with central elasticity estimates.[16]

In row 4 we recognize that US dealers of Japanese autos captured some rents over and above the rents captured by the Japanese. The gain from removing the price wedge caused by the VER increases by about $500 million. This is because there is now a greater price wedge between the price paid by US consumers and the price at which imported autos are available on world markets.

In row 5, we add the effects of a 27 percent exogenous wage distortion in the auto industry. Now auto workers have a higher marginal product value than workers in other industries, so the reduction of auto employment when the VER is removed reduces the magnitude of the gain. The second best effect is, however, quite small since the estimated gains from removing the VER are only reduced by $200 million relative to row 4.

In row 6, we assume the US has monopsony power in autos with an elasticity of import supply of autos of 5. Now when the VER is removed, U.S. importers pay a higher price. This terms-of-trade effect reduces the benefits of VER removal substantially. In fact, due to the terms of trade loss, the economy gains $500 million more from rent capture (which does not significantly affect import quantities or the terms of trade) than it does from removing the VER. We report this as a negative distortion "cost" of the VER.

4.2 Quantifying the Partial Equilibrium Bias

Partial equilibrium analysis typically ignores the pressure that protection removal and increased imports in one sector impose on the

Table 3

Welfare Cost of Auto VER under CRTS
($ 1984 billion)

Column	Total Costs 1=(2+3)	Rent Costs 2	Distortion Costs a/ 3	Employment Change in Autos b/ 4
1. Low Elasticity c/	8.92	7.71 (33.9)	1.21	-22.8
2. Central Elasticity	9.82	7.80 (32.5)	2.02	-36.2
3. High Elasticity c/	10.84	7.83 (32.2)	3.01	-34.1
4. Central Elasticity with US capturing some rents	10.28	7.77 (37.1)	2.51	-40.9
5. Central Elasticity with US capturing some rents and exogenous wage distortions	10.08	7.77 (37.1)	2.31	-40.9
6. Central Elasticity with US capturing some rents, exogenous wage distortions and endogenous terms of trade	7.27	7.77 (37.1)	-0.50	-30.7

a/ Distortion costs are calculated as the difference between total costs and rent costs.

b/ Thousand man years.

c/ Low (high) elasticity estimated are obtained by lowering (increasing) central elasticity values by one standard deviation.

equilibrium real exchange rate via the balance of trade constraint. We simulate the bias of omitting the balance of trade constraint by fixing the real exchange rate and allowing the trade balance (expressed in foreign prices relative to the numeraire) to be endogenously determined. Otherwise, assumptions are those for the simulation reported in row 5. Now the welfare gain is $17.7 billion. The increase in welfare gain of $7.6 billion (relative to row 5) is accounted for almost fully by an increase in the trade deficit of $7.5 billion. Since an increase in the trade deficit is a permanent free lunch from the rest of the world, we interpret the additional $7.6 billion as an estimate of the magnitude of the partial equilibrium bias. If, in addition, the US has monopsony power in auto imports at the level assumed in the simulations reported in row 6, then a failure to adjust for endogenous terms-of-trade will increase the bias by an additional $2.8 billion. Thus, these estimates decompose the separate terms-of-trade effect and partial equilibrium bias of ignoring the balance of trade constraint which are sometimes confused as one effect.

5. Welfare Cost Estimates under IRTS and International Capital Mobility

So far, the more realistic estimate of the cost of the VER is the case in which U.S. citizens capture some rents and there is a wage premium paid to U.S. auto workers. It is reproduced as the reference case in row 0 of table 4.

Start with the contestable market pricing scenario (row 1) which isolates scale efficiency effects since there is no firm entry. Compared with the reference CRTS case, the distortionary cost estimate is cut by 48 percent. This is because removing the VER induces a reduction of domestic auto output. With contestable markets there is no firm exit which forces existing firms to

Table 4
Welfare Cost of Auto VERs under IRTS and International Capital Mobility
(Exogenous Wage Distortions and Partial Rent Capture by US in all Simulations)
($ 1984 billion)

	Total Costs	Removal Profits	Rent Costs[f]	Distortion Costs	Employment a/ Change in Autos	Entry/Exit (% change) (+)	(-)
col	1=-2+3+4	2	3	4	5	6[b]	7[c]
0. CRTS reference case	10.08		7.77 (37.1)	2.31	-40.9		
1. Contestable Market Pricing	9.00		7.79 (37.1)	1.21	-24.5	-	-
2. Monopolistic Competition	9.77		7.79 (37.1)	1.98	-22.1	-	-5.4
3. Monopolistic Competition and Initial Profits (MCIP)	10.39	-1.91	7.00 (33.4)	1.48	-35.47	33.7	-6.0
4. MCIP and International Capital Mobility	10.23	-1.88 (157.1)d/	6.85 (32.8)	1.50	-34.54 (-1.5)e/	33.9	-5.9
5. MCIP and Endogenous Terms of Trade	7.99	-1.91	7.00 (33.4)	-0.92	30.4	33.7	-4.5
6. MCIP and International Capital Mobility under Endogenous Terms of Trade	7.86	-1.88 (157.1)d/	6.85 (32.8)	-0.87	29.7 (-0.7)e/	33.9	-4.4
7. MCIP with International Capital Mobility and Endogenous Conjectures	7.90	-0.06 (168.3)d/	6.63 (31.9)	1.21	39.5 (-1.5)e/	21.8	-3.5
8. MCIP with International Capital Mobility Endogenous Conjectures and Endogenous Terms of Trade	5.66	-0.06 (168.3)d/	6.63 (31.9)	-1.03	34.6 (-1.50)	21.8	-2.6

a/ Thousand man years. Employment change from removing the VER starting from solution with no initial profits plus the negative of the employment change from the simulation to eliminate initial profits.
b/ Remove profits.
c/ Remove QRs from zero profits solution.
d/ Net capital inflow from removing profits ($ million).
e/ Net capital inflow from removing QR starting from solution with initial profits ($ million).
f/ Figures in parentheses next to rent cost estimates are endogenous premia rates.

operate at a lower scale. However we have argued that monopolistic competition is the more realistic behavioral assumption for the auto industry. In that case (row 2), the reduction in demand for domestic autos induces firm exit which nearly compensates for the scale efficiency loss from reduced output, so that the distortionary cost component is larger than with contestable markets. Note, however, that the distortion cost with monopolistic competition is less than with CRTS. Thus, contrary to the result emphasized by Horstman and Markusen (1986), in this scenario, protection induces a slight movement down the average cost curve because the effect of protection removal on the reduction of demand for domestic output dominates the effect of inefficient firm entry. Despite a firm exit rate of 5.4 percent, average output of remaining firms decreases.

Now allow for the profits due to the VER. We model the VER as creating a profit that induces firm entry until profits are eliminated, but as long as the VER remains in effect, the traditional rent and distortion costs remain. Firm entry is required to eliminate profits. Consequently, we simulate the costs of the VER under this scenario by decomposing the costs into two components. First, we estimate the costs of firm entry to eliminate profits caused by the VER. Second, we estimate the remaining costs of the VER by removing the VER from this counterfactually created zero profit equilibrium. The total costs of the auto VER are then the sum of the two component costs with the second component disaggregated, as before, into a distortionary cost and a rent cost.[17]

In row 3, we allow for profits, but assume no international capital mobility and retain exogenous conjectures. Firm entry to eliminate profits results in estimated costs of $1.91 billion. The estimate is negative because

the required firm entry -- 33.7 percent in column 6 -- results in a loss in scale efficiency, which dominates the two beneficial effects of a reduction in monopolistic price distortion and a reduction in the quota rent to foreigners.[18] Because of this reduction in the rent premium, when we estimate the costs of the VER from the counterfactually created zero profit equilibrium, we find that the rent costs are significantly reduced and now amount to 67 percent of the total costs. However, despite the reduction in rent costs, the total costs exceed the corresponding CTRS estimate because of the significant loss of scale efficiency, as emphasized by Hortsman and Markusen.

Now introduce the realistic assumption of international capital mobility (row 4). With perfectly mobile capital, the rental rate is fixed in terms of the numéraire and the returns from FDI are repatriated to foreign capital owners. Clearly removing profits involves firm entry so there will be net FDI into the US with the returns of that investment accruing to foreigners. Comparing rows 4 and 3, the costs of eliminating profits are $30 million <u>less</u> when there is international capital mobility. This is the result of three offsetting effects: reduction of rents to foreigners, loss of scale efficiency, and the Brecher and Diaz-Alejandro effect. The dominant effect is the reduction of rents caused by the slight increase in firm entry with international capital mobility (33.9 percent vs. 33.7 percent in rows 3 and 4 of Table 4). More entry occurs because the auto sector is relatively capital intensive. (Entry without international capital mobility raises the rental rate on capital, which reduces the profitability of capital intensive sectors such as autos thereby retarding entry.) More entry, because of no increase in the rental rate, raises domestic supply which lowers the demand for imported

autos, thereby reducing the endogenously determined premium rate and hence, the rents to foreigners.

To further decompose these effects, we also estimated the effects of firm entry to eliminate profits, with and without international capital mobility under the assumption of exogenous quota rent premium. Then, the costs of firm entry are $120 million more with international capital mobility. This derives from two effects. First, greater entry reduces scale efficiency. Second, as shown by Brecher and Diaz-Alejandro (1977), FDI can be immiserizing if the marginal product of imported capital (valued at world prices, to reflect the value of the social marginal product) is less than the rental rate on capital, as would be expected to occur when a quota distorts upward the value of the private marginal product. Thus, while the scale efficiency and Brecher and Diaz-Alejandro effects from international capital mobility are immiserizing, they are dominated by the beneficial effect international capital mobility has on the reduction of the quota rent premium.

Also note that with capital mobility, distortion costs are slightly higher and rent costs are slightly lower. As explained above, capital mobility induces more firm entry, but it also increases the elasticity of domestic supply. Since entry reduces the endogenous rent premium, rent costs, which are estimated from the zero profit equilibrium, are lower. Estimated distortion costs are lower because removing the VER induces an inward shift of the demand curve for domestic autos which results in a smaller decrease in the domestic price with a more elastic domestic supply curve. In turn, the demand for imported autos shifts less inward. Consequently, the "triangle" of consumption distortion of imported autos is greater with capital mobility than without.[19] This is the result predicted by Neary (1988) and by Neary and Ruane (1988),

namely that the benefits of eliminating tariff protection (in our case the tariff equivalent of a VER) are greater with international capital mobility than without.

The results of the simulations presented in rows 5 and 6 incorporate strong US monopsony power in autos and correspond to rows 3 and 4, respectively. We saw earlier in the CRTS case that endogenizing the terms-of-trade resulted in the total costs of the VER being less than the rent costs, i.e., there was an efficiency gain from the VER because the terms-of-trade costs were greater than the distortion costs of the VER by $500 million. In column 4 of rows 5 and 6, we see that the efficiency gain from the VER is about $900 million, which is larger than under the CRTS case. This is because, as discussed above, with monopolistic competition there is a loss of scale efficiency when the VER is removed.

Finally, consider the effects of endogenous conjectures (row 7), so that firms price more (less) competitively as entry (exit) occurs. With endogenous conjectures, it takes less entry to eliminate profits (21.8 percent compared to 33.9 percent in row 4) because, as firms enter, the markup is reduced. Less entry implies less scale efficiency loss. Thus, the welfare costs of entry to eliminate profits results in losses of only 60 million from entry to eliminate profits. By inverse reasoning, when the VER is removed, there is less exit with endogenous conjectures. Hence the gain from VER removal is less.[20] Adding endogenous terms of trade (row 8), further lowers the estimated gain for reasons discussed above.

6. "Optimal" Interventions for the Auto Industry

So far we have calculated the costs of the auto VER with Japan. However, as long as there is either IRTS or an unremovable distortion, e.g., a distortionary wage differential under CRTS or IRTS, the question of optimal industrial policy arises. We now consider the potential welfare gains from industrial policy in a non-strategic context. Although Bhagwati (1971) has shown that under perfect competition the optimal policy instrument is the one that acts directly on the relevant margin, no general theorem has been established under imperfect competition. Consequently, given the presence of IRTS and a wage distortion in the auto industry, it appears useful to examine the "optimal" use of either a tariff, a production subsidy or a wage subsidy. Due to the algorithmic difficulties and the possibilty of multiple equilibria, efforts to calculate numerically the optimal values of policy instruments in applied general equilbrium are virtually non-existent.[21] We maximize the utility function (non-central Stone-Geary) underlying the final demand system of the model, using as instruments a combination of a tariff, a wage subsidy and a production subsidy in the auto sector. So that the results will not be dominated by second best effects, we first counterfactually create an equilibrium that is distortion free, except for the wage distortion in autos. All welfare gain estimates are relative to this equilibrium.

The results are presented in table 5. Consider first CRTS results. If only one instrument is available, the first best policy to counteract the exogenous wage distortion is the wage subsidy. If a wage subsidy is not available, then the second best instrument is the production subsidy. The production subsidy is considerably inferior to the wage subsidy because it creates the by-product distortion of overuse of the non-labor inputs in auto

Table 5: Optimal trade and industrial policies for the US auto industry[a]

Instrument\Model	CRTS	Contestable Market	Monopolistic Competition
1. Wage Subsidy			
Welfare gain	167.0	815.0	99.0
Relative wage in autos[b] (wage subsidy)	1.0 (27)	.7 (57)	1.6 (-33)
			-5.9[c]
2. Production Subsidy			
Welfare gain	24.0	977.0	264.0
Production subsidy	1.8	10.0	5.4
			3.3[c]
3. Tariff			
Welfare gain	4.0	182.0	30.0
Tariff	1.2	8.3	3.3
			0.6[c]
4. Wage and Production Subsidies			
Welfare gain	167.0	1224.0	655.0
Relative wage in autos[b] (wage subsidy)	1.0 (27)	.87 (40)	1.8 (-53)
Production subsidy	0.0	7.2	8.1
			-4.8[c]
5. Tariff and Production Subsidy			
Welfare gain	36.0	1364.0	367.0
Production subsidy	2.1	11.0	6.2
Tariff	2.2	12.2	6.4
			5.0[c]

a. Welfare gain estimates are in millions of dollars. All subsidies and tarifs are in percent.
b. Relative wage in autos under optimal wage subsidy or tax. Wage subidy or tax in percentage in parentheses. A tax rate has a negative sign. All rates are calculated from an initial condition with a relative wage in autos of 1.27.
c. Percentage change in the number of firms.

production. The third best policy is the tariff because it also creates a consumption distortion between domestic and imported autos. When the tariff and production subsidy instruments are available together, both the benefits as well as the tariff and subsidy rates are larger than when the instruments are used separately. This illustrates the principle stated by Corden (1974, p. 23): "If a second best policy is used to correct one divergence, hence creating a by-product disortion, it may create the need for a supplementary policy designed to correct, at least partially, the newly created distortion." Finally, note that when the available instruments are a wage and production subsidy, the algorithm verifies that the second best policy instrument is redundant.

Consider now IRTS. There is now also the possibility of welfare gains from increasing scale efficiency or from reducing consumption distortion by narrowing the difference between price and marginal costs. Regardless of the combination of instruments, welfare gains are always larger under contestable markets than under monopolistic competition because there is no entry under contestable markets to reduce scale efficiency. When only one instrument is available, the production subsidy yields the most benefits because scale efficiency benefits (which are most directly achieved with a production subsidy) dominate labo reallocation benefits with our parameters. When two instruments are available, by-product distortions are partially corrected by the second instrument, so the welfare gains are increased as in the CRTS case.

Note that under monopolistic competition the optimal wage policy is a tax. This is because the tax on auto employment induces exit of 5.9 percent from the auto sector, and the benefits this brings in terms of improved scale efficieny dominate the costs of additional labor misallocation. On the other hand, with contestable markets, because the wage subsidy does not induce entry, the optimal

wage policy shifts from a 33 percent tax to a 57 percent subsidy. This is the type of result Eaton and Grossman (1986) derived, i.e., the optimal policy shifts from a subsidy to a tax depending on imperfect competition modelling assumptions (in our case entry conditions). These results confirm the need for caution before designing optimal industrial policies in imperfect competition.[22]

Moreover, government adoption of these "optimal" policies, may be counterproductive due to strategic considerations. If industries or unions perceive that the government's policy is to give subsidies or tariffs to counteract distortions, the distortions are likely to increase. For example, union wage demands will increase and management resistance will diminish. Moreover, retaliation by (or GATT required compensation to) foreign trade partners will likely eliminate the benefits of the policies.[23] Consequently, one should not conclude that these models are appropriate for the definition of optimal industrial policy.

7. Conclusions

How much is gained by a careful modelling of the U.S. auto industry under the U.S.-Japan auto VER? Of the previously unexamined features regarding the auto VER that were discussed in the opening paragraph, one of the most significant empirically is the endogenous determination of the quota rent premium; compared to calculations with exogenous premia rates, the estimated reduction in costs of the VER are up to $1.9 billion. This highlights the crucial and often dominant role that rents play in the welfare analysis of VERs. The impact of foreign direct investment is also to lower the costs of the VER, but for non-obvious reasons: the greater entry into domestic auto manufacturing results in a lower quota rent premium for foreign autos. We saw that

"traditional" estimates based on a CRTS technology in autos yielded welfare costs of about $10 billion. In the most reasonable representation with IRTS, pure profits, internationally mobile capital and endogenous conjectures (between fixed and our particular assumption about endogenous conjectures) then the estimate of the welfare costs of the VER are reduced by about $1 billion or 10 percent.

It is also instructive to note that the costs per job protected in the auto sector (at the expense of employment elsewhere) are very high, ranging from $164,000 to $296,000 per job per year. Alternatively, obtaining the ratio of the welfare benefit calculations to the adjustment costs, proxied by the present value of the lifetime earnings losses of displaced auto workers displaced by VER removal, there are between 14 and 26 dollars of benefits for every dollar of worker adjustment costs saved.[24]

Finally we have illustrated the use of industrial policies to exploit scale economies and to counteract wage distortions. The results under IRTS call for caution regarding the use of industrial policy because the optimal policy may shift from a subsidy to a tax depending on behavioral assumptions.

ENDNOTES

1. Goto (1986) examined the impact of wage distortions in the auto industry. But he simulated a change from US autarky to integration into a single economy with Japan, rather than the effects of the VER in autos. De Melo and Tarr (1990b) examined separately effects (1), (2), (4), (5) and (6).

2. These restraints continued into 1990. See General Agreement on Tariffs and Trade (1990, p. 221).

3. Consumers Union, for example has reported that, when the quota was in effect, many dealers charged in excess of the sticker price, using such devices as charging high prices for decal stripes, rustproofing and undercoating. Its readers indicate that this was especially prevalent among Toyota, Honda and Mazda dealers. Consumer Reports, August 1983, 391. See also the statement by Senator Chafee, Congressional Record, February 29, 1984, S. 1966; Fortune, "Can Detroit Live without Quotas," June 25, 1984, 20; and Washington Post, "Car Dealer Markups Raise Questions," Washington Business, November 19, 1984, 1, 34, 35.

4. See de Melo and Tarr (1990b) for the details of this calculation.

5. Using a different methodology, de Melo and Tarr (1990b), find a similar estimate of the premium earned by auto workers. On the other hand, the wage premium used by Dixit and by Krishna et al. is about double the actual wage premium because they did not adjust for the human capital differences between auto workers and the average manufacturing worker.

6. An alternate series for data on profits in motor vehicles and equipment is available from the Quarterly Financial Statistics, published by the US Federal Trade Commission until 1982 and the US Bureau of the Census for years after 1982. The Survey of Current Business and Quarterly Financial Statistics series differ mainly insofar as the former considers profits on US operations only, whereas the latter includes income from all sources including foreign operations. Both series would include profits of US subsidiaries of foreign corporations in their US operations, i.e., profits of companies like Honda USA earned on US sales are included in both; but only the Quarterly Financial Reports includes profits of Honda USA on its sales to Japan.

Between 1979 and 1984, both series are very close. From 1985 on, however, the Quarterly Financial Reports series shows much higher profits. This principally reflects the increase in FDI (shown in table 1) and the profits of US subsidiaries on their foreign sales. Since we are principally interested in the profits

in the US market, we focus on the Survey of Current Business series. We thank Paul Zareth of the US Bureau of the Census for clarifying these distinctions.

7. Faced with domestic competitors who are more vertically integrated, the Big Three have begun to copy the Japanese practice of greater vertical integration among parts suppliers, suggesting some efficiency enhancing properties of the practice in the auto industry. See Lawrence (1990).

8. Our approach is followed by Krugman (1987) and Krishna, Hogan and Swagel (1989). Devarajan and Rodrik (1989) follow the approach of Dixit. Calibration procedures which differ substantively from ours are Smith and Venables (1988), who adjust elasticities to be consistent with Cournot conjectures, and the suggestion of Saloner (1989) that marginal cost data should be adjusted.

9. Dixit calibrated N=13.9 for 1983. If we choose $\Omega^d=1$, we obtain N=4.2. Since the industry is more competitive the higher the value of N, our calibration yields a less competitive auto industry than represented by Dixit.

10. Of course, perfectly competitive conjectures are not possible in the presence of fixed costs and increasing returns to scale because firms will incur losses. Novshek (1980) notes that simply adding more firms drives Cournot output to zero in the limit. He shows, however, that if the minimum efficient scale becomes small in relation to demand as the number of firms goes to infinity, then Cournot equilibria with free entry exist and they approach perfect competition.

11. In addition to the estimate of table 1, The Quarterly Financial Reports indicates that profits in motor vehicles and equipment were $10.8 billion in 1984 and the US International Trade Commission indicates that the industry's profits were $10.4 billion in that year. We assume any excess of profits over $9.4 billion were normal.

12. Because of interindustry linkages, this step involves solving simultaneously for the entire vector of prices that satisfies firms' budget constraints in all sectors.

13. As shown in de Melo and Tarr (1990c), endogenous aggregate labor supply has a very small impact on the welfare costs of protection in our formulation.

14. Unlike previous elasticity estimates, Levinsohn clusters autos into groups that take into account characteristics, prior to econometric estimation of the price elasticity of demand. Hence, the price elasticities of demand in this study are likely to be

more accurate than previous estimates.

15. All results in the tables are reported with endogenous quota rent premium determination. See the appendix for results under exogenous quota rent premium determination.

16. Employment loss in autos is less in the high elasticity case compared to the central elasticity because imported and domestic autos are not as close substitutes in the high elasticity case. This is because the extent to which imported and domestic autos are gross substitutes depends on the difference between two elasticities: (1) the elasticity of substitution between imported and domestic autos in the CES nest of composite autos; and (2) the elasticity of demand for composite autos. Although both elasticities increase in the high elasticity case, the relevant difference decreases. See de Melo and Tarr (1990b) for an elaboration.

17. Analogously, in estimating the job protection in autos due to the VER, we add the jobs generated in the domestic auto industry due to entry and the jobs protected by the VER. That is, auto workers have jobs protected while the VER is in effect, plus additional jobs due to entry.

18. To decompose these effects, we have simulated the effects of firm entry under the inappropriate (but normally employed) assumption that the rent premium is exogenously fixed at the initial level. In that case, the costs of firm entry to eliminate profits increase to $2.59 billion so that firm entry induces benefits of $0.7 billion due to the reduction in the rent premium, thereby partially defraying the loss of scale efficiency. The total cost of the VER with an exogenous rent premium is $11.96 billion. Thus, the assumption of an exogenous or endogenous rent premium has a very strong effect on the results.

19. Graphical expositions of both this result and of the bias involved in using exogenous versus endogenous quota rent premia determinations are available, upon request, in an appendix. The appendix also replicates tables 3 and 4 with exogenous rent premium determination.

20. Another effect operating in all simulations with monopolistic competition is the increase in the value of the market elasticity of demand (ϵ^d in equation 2) when protection is removed. The increase of about 3 percent contributes to lowering the mark-up rate, but is generally dominated by entry or exit in the mark-up determination.

21. We use the MINOS5 algorithm available in the GAMS programming language (see Brooke et al. (1988)). An early example of optimal numerical solutions, which the authors characterized as

illustrative because it was not a full numerical model of an actual economy, was that of Harris and MacKinnon (1979). Based on the CRTS version of the model of this paper, de Melo, Stanton and Tarr (1989) calculated optimal tariffs and taxes in the US oil and petroleum products sectors.

22. Dixit (1988) and Krishna et al. investigated optimal policies in their models. They did not have a wage subsidy instrument available, but they found a similar pattern of results to table 5 when production subsidies or tariffs are used alone in their scenarios with labor rent present. Dixit finds little use for a tariff when both a tariff and a production subsidy are available; but his model considers only distortion costs in autos. Krishna et al. find that the optimal policy is a subsidy to imports not a tariff when there is no labor rent, a result that led them to also call for caution in recommending optimal industrial policy.

23. See Fernandez (1989) for additional strategic considerations which are likely to make the achievement of optimal industrial policies problematical.

24. In de Melo and Tarr (1990b) we present data, based on Jacobson (1978), that indicate that the present value of the lifetime earnings losses of a displaced auto worker is about $57 thousand. Using this as a proxy for worker adjustment costs, 35 thousand displaced auto workers yield about $2 billion of adjustment costs. The benefits of quota removal (the avoidance of the quota costs) discounted conservatively over 6 years (at 7 percent), are between $29 billion (row 8) and $53 billion (row 4). See de Melo and Tarr (1990b) for details on the methodology.

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Appendix

In the main body of the paper, we argued that calculations of the costs of rent transfers occasioned by VERs are usually calculated imprecisely. We also argued that the estimated distortion costs of VERs are larger with FDI, because FDI raises the elasticity of supply. Section A1 explains graphically why endogenous rent premium determination will make an important difference. We then report results of simulations in which it is assumed, inappropriately, that the rent premium in autos is exogenously fixed. All of the simulations in tables 3 and 4 are replicated with exogenous rent premium determination as tables 3A and 4A.

Section A2 describes how the model is modified to accommodate exogenous wage distortions and international capital mobility. It also provides a graphical exposition of the elasticity effect of international capital mobility described in the text.

A1. Endogenous Versus Exogenous Quota Rent Premium Determination

VERs allow the exporting firms to capture rents. As illustrated in figure A1, the rent premium, however, is determined residually. For simplicity, consider a pure final good in partial equilibrium where the imported and domestic goods are differentiated. Given the rationed quantity of imports, q_o, a price p_o clears the market, where d(q) is inverse demand for imports. Since tariffs must be paid on the imports (tm is the ad valorem rate), the rent premium is the difference between the price that clears the inverse tariff-ridden demand curve, $d(q)/(1 + tm)$, and the foreign supply price, i.e., $p_o/(1 + tm)$ - PW ER.

Since rent determination depends only on the tariff-ridden demand curve, in figure A2 we delete depiction of the demand curve. In panel A, we depict endogenous rent determination and in panel B, exogenous rent determination. Consider a decrease in demand for auto imports that would occur as a result of an increase in entry into domestic auto production, with the VER quota fixed. This is depicted as an inward shift in the tariff ridden demand curve from $d^o(q)/(1 + tm)$ to $d^1(q)/(1 + tm)$. Assuming the VER remains binding, the decrease in demand reduces the per unit rent premium, to p_1 - PW ER on the same total amount of imports. This is depicted in panel A. Panel B depicts rent determination in the case of exogenous rent premia. Since the model requires market clearing and a fixed rent premium, the quantity of imports is reduced to accommodate the decline in demand. Without allowing the quantity to vary, the model is overdetermined. The equilibrium is shown in panel B. The difference between panels A and B is that in B the quantity of imports is endogenous as opposed to the rent premium in A. Since with a binding quota, it is the quantity not the rent premium that is exogenous, the appropriate method is to assume an endogenous rent premium as in panel A.

Tables 3A and 4A replicate the simulations of tables 3 and 4 in the main text with exogenous rent premium determination. This allows the reader to assess the extent of bias resulting from the assumption of an exogenous rent premium coupled with an endogenous import level.

A2. Wage Distortions and International Capital Mobility

Wage Distortions

When we assume there are wage distortions in autos, we assume the premium earned by auto workers ϕ is exogenous. Then throughout the system of

equations in table A.1 we replace the auto sector's wage rate W with W_i i = autos, where $W_i = W\phi$ (W is the wage rate earned in sectors where workers do not receive rents).

International Capital Mobility

In simulations with international capital mobility, we assume the United States has an infinitely elastic supply of capital at a fixed interest rate and the proceeds from foreign direct investment accrue to the owners of the capital stock.

The distortion costs of removing the VER are greater because, as explained in the text, introducing capital mobility raises the elasticity of domestic supply. Figure A3 shows the welfare effects of removing a VER in partial equilibrium when domestic and foreign goods are imperfect substitutes. When the VER is removed (panel B), the reduction in the price of imported autos from p_o to $P\bar{W}$ ER, induces an inward shift in the demand curve for domestic autos (D_o to D_1 in panel A). A higher elasticity of supply results in a smaller price decrease (p_e instead of p_I) when there is capital mobility. In turn, this implies a smaller inward shift of the demand for imported autos in panel b (d_J^1 instead of d_I^1). The result is a larger welfare gain with capital mobility (area ABD) than without (area ABC). This is the result predicted by Neary (1988) and by Neary and Ruane (1988), namely that the benefits of eliminating tariff protection (in our case the tariff equivalent of a VER) are greater with international capital mobility than without.

Figure A1
Rent Determination from a VER: Initial Situation

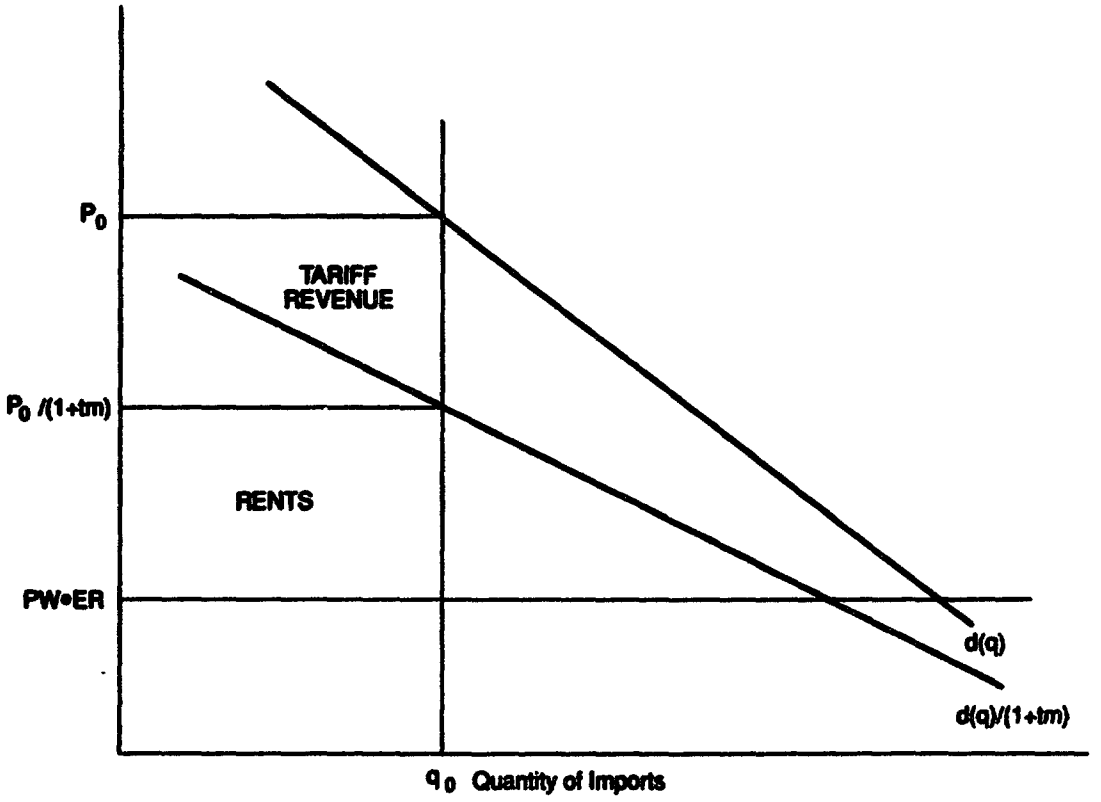

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Figure A2
Rent Determination from a VER After a Shift in Demand:
Endogenous versus Exogenous Determination

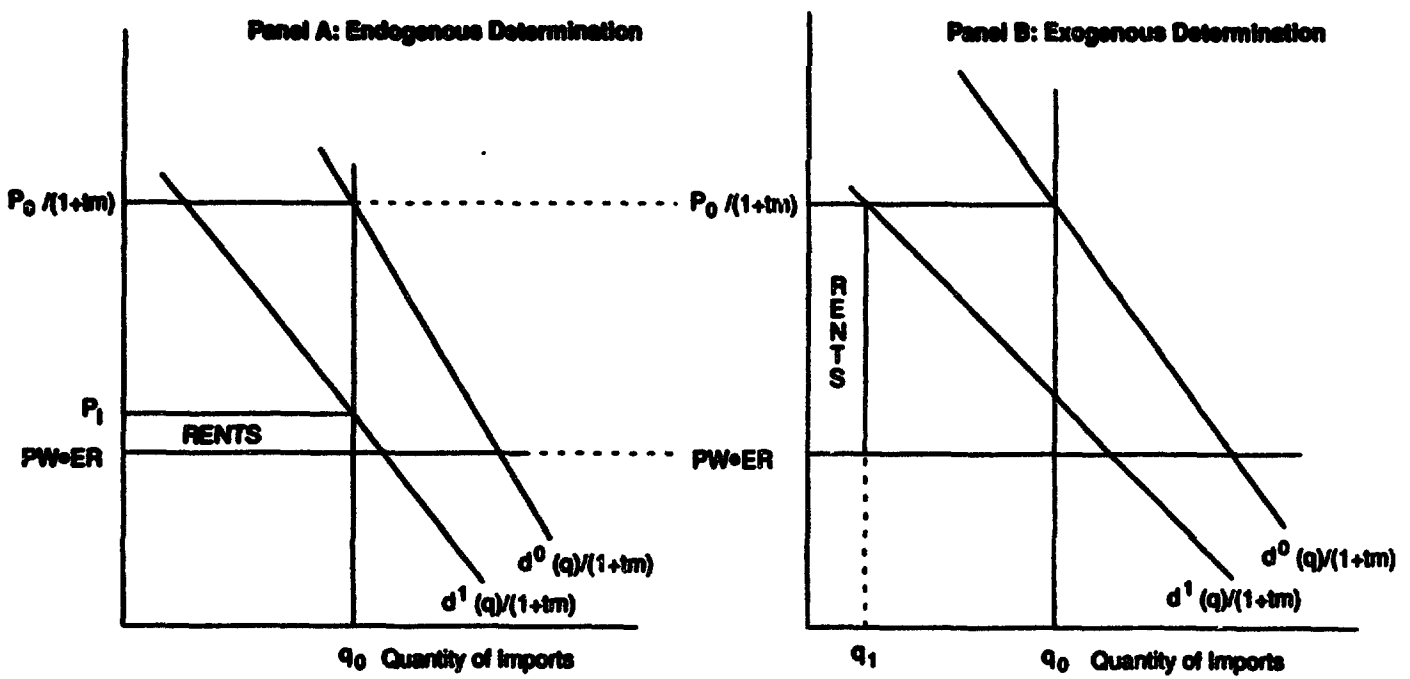

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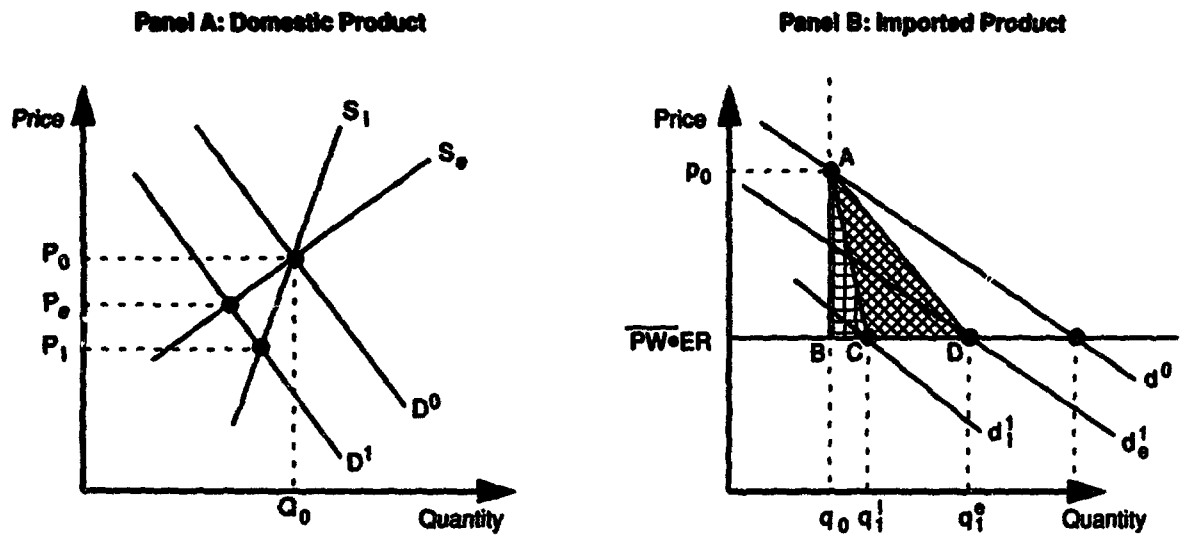
Figure A3
Benefits of Quota Removal Depending on Supply Elasticity
Differentiated Product



Welfare Gain

International Capital Mobility: ABD
Immobile International Capital: ABC

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