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I. Introduction

One of the puzzles about the recent voluntary restraint agreements (VRAs) for steel is whether they remained truly effective in restraining imports toward the end of the 1980s in the face of a substantial depreciation of the dollar after 1984.[2] It is clear that the VRAs initially caused import price to increase

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[2] The steel VRAs started with restrictions on countries of the European Community in 1982 and were considerably expanded in 1984. Eventually, the VRAs limited steel imports from nineteen countries plus the countries in the EC. They expired on March 31, 1992.

and created a quota premium for imports.[3] However, the 36 percent depreciation (trade weighted) of the dollar between 1984 and 1989 increased world price and is believed to have rendered the VRAs ineffective by 1989 (or even earlier).[4]

This paper estimates the effect of the dollar depreciation on the steel VRAs. This is accomplished by using a computable, partial equilibrium model of steel. We cannot determine whether the VRAs were actually binding in the late 1980s because other demand-supply factors, in addition to the external value of the dollar, also changed after 1984. However, we can isolate the impact of the exchange rate on the VRAs.

The principal result of our counterfactual simulations is that the depreciation alone was not sufficiently large to render the VRAs ineffective. This somewhat surprising result is explained by the following.

First, only part of the change in exchange rates is typically passed through to changes in (importing country currency) prices of imported products. There is a growing literature on the exchange-rate-pass-through issue. In recent years economists have turned to various models of imperfect competition to explain partial pass through (e.g., Dornbusch (1987), Feinberg (1986), Hooper and Mann (1989)). We take a different approach. For us

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[3] ITC (1989A), p. 3-7.

[4] According to Arce, Boltuck, et al. (1989), p. 7-9, who posed the question that led to the title of this paper, the decline in the value of the dollar caused the VRAs to become nonbinding in 1987.

partial pass through is a consequence of globalization of markets for the major inputs (e.g., iron ore, metallurgical coal, steel scrap) consumed by all steel firms throughout the world, plus the fact that these inputs are typically priced in U.S. dollars. Our approach thus builds on and extends the work of Harrison (1992), who emphasized the role of dollar pricing of certain steel inputs used by foreign producers, and Grossman (1986), who recognized that certain steel inputs (energy and iron ore) were traded on world markets. Finally, since we can explain partial pass through of exchange rate changes by globalization we can dispense with imperfect competition. Accordingly, we treat domestic industries as perfectly competitive; moreover, we assume they operate under conditions of constant costs.

Second, exchange rate changes have different effects on imports of final goods and intermediate goods. Steel is an intermediate product consumed by numerous metal fabricating industries. These steel-using industries are also subject to competition from imported products. When the dollar's value declines, domestic steel-using industries expand and demand more steel. What happens to steel imports is unclear *a priori*. If the increase in the demand for steel by steel-using industries offsets the substitution effect operating against more costly imported steel, then steel imports will <u>increase</u>. However, this empirical question can be answered by our computable model.

This paper is organized as follows. The next section (II) provides background for the major issues that arise in this paper.

We then present the model (section III) and review some data issues (section IV). Our empirical results are discussed next (section V). The remainder of the paper takes up some extensions (section VI) and has the conclusion (section VII). Attached to the paper are two appendices. They provide technical details about our model (Appendix A) and the data we use (Appendix B).

II. Issues

Steel Import Restraints

In September 1984 President Reagan directed Special Trade Representative William Brock to negotiate voluntary restraint agreements (VRAs) with major foreign suppliers of steel to the U.S. market.[5] The objective of the VRAs was to reduce the share of imports in domestic steel consumption from 26.4 percent in 1984 to 18.5 percent. The VRAs were, in effect, market share import quotas, and followed comparable import restraints agreed with the EC in 1982.[6] The actual share of imports declined steadily after 1984, to 17.9 percent in 1989.[7]

The question, however, is to what extent the decline in steel imports was due to the VRAs. By 1988 and 1989 VRA-restrained

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[5] Howell et. al. (1988), p. 530. Tarr and Morkre (1984), p. 127.

[6] Benyon and Bourgeois (1984), p. 345. For additional background on the U.S.-EC steel trade dispute, see Tarr (1988).

[7] ITC (1990), p. 2.

countries apparently did not export as much steel to the United States as was allowed.[8] In 1988, VRA countries utilized 79 percent of the aggregate limit on steel imports. In the first nine months of 1989, the corresponding utilization ratio was 67 percent.[9] However, these utilization rates are for all steel import categories. In 1989, the utilization rates were much higher for certain country/categories: EC cold rolled strip -- 95 percent; Japanese cold rolled sheet -- 83 percent; South Korean hot rolled sheet and strip -- 88 percent.[10] There is also anecdotal evidence that the VRAs were limiting imports in 1989. For example, there were complaints by several steel consumers, including Caterpillar Inc., that led to a campaign to oppose extension of the VRAs in

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[8] USITC (1992), Quarterly Report on the Status of the Steel Industry, USITC Pub. 2518, June 1992, p. G-5 to G-7. Note also that during the early period of the VRAs, the procedures used by the Department of Commerce ("Commerce") to calculate allowable imports apparently had the effect of making the VRAs marginally more restrictive than they otherwise would have been. Commerce contracted with Data Resources Inc. (DRI) to forecast U.S. consumption of steel products one quarter in advance. VRA countries then used these forecasts together with their VRA market share to determine how much to export to the United States. In the 1987, the DRI forecasts consistently underestimated U.S. consumption, which artificially reduced imports below the true VRA restraint levels. See Cantor (1988), p. 8.

[9] The initial VRAs were for five years, from October 1, 1984 through September 30, 1989. On July 25, 1989, President Bush announced that the VRAs would be extended for an additional two and one-half years, to end on March 31, 1992. U.S. International Trade Commission (1991), Quarterly Report on the Status of the Steel Industry, USITC Pub. 2424, p. xviii.

[10] U.S. Department of Commerce, Office of Agreements Compliance, Imports of Certified Products, 1989.

1989.[11] Overall, it is not clear whether the VRAs restricted steel imports in 1989.[12]

Several explanations for the drop in steel imports have been advanced. The ITC (1990, p. 17), for example, suggests that improvement in the competitiveness of U.S. firms and a strong demand in foreign markets led to the decline in steel imports. Another explanation is the depreciation of the U.S. dollar. Between 1984 and 1989 the value of the dollar fell by 36.4 percent (real trade-weighted exchange rate) on world currency markets. According to the GAO (1989A, pp. 5, 40), the dollar's depreciation was a major factor explaining the decline in steel imports after 1985.

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[11] "Steel consumers form coalition to oppose VRAS," Iron Age, March 1989, p. 13. Several complaints of the steel VRAs by steel users are reviewed by James Bovard, "U.S. Trade Laws Harm U.S. Industries," Regulation, Vol. 16, No. 4 (1994), pp. 51-54.

[12] Even though imports are smaller than permitted under VRA restraints, domestic producers may want the VRAs to be maintained because they provide a kind of insurance against the uncertainty of a surge in imports. However, when uncertainty is introduced to the analysis, import restraints as insurance may also adversely affect domestic industry performance by introducing moral hazard and adverse selection. The argument is that since Government provides the insurance through the VRAs, it is possible that (1) domestic firms will devote less effort to competing with imports because Government is not expected to adequately monitor these efforts (moral hazard) and (2) those domestic firms that are less well suited to compete with imports under free trade (e.g., because of location, specific products produced) receive a relative advantage under the VRAs and this changes the composition of domestic industry toward the inefficient (adverse selection).

For a discussion of the "import protection as tariff argument," see Vousden (1990), p. 73. Note that the 1985 request by the President for the ITC to monitor domestic steel industry adjustment may be, in part, a response to the moral hazard problem. See ITC (1989), p. A-2.

Globalization of Markets for Steel Inputs

There are two reasons to suspect that a depreciation of the dollar will not have a significant negative effect on U.S. steel imports. The first is based on examination of the effects of exchange rate changes on supply prices of domestic vs. foreign industries when producers increasingly use standardized inputs traded in world markets. This is one possible facet of the widely observed trend toward increased globalization and integration of national markets.[13]

Global inputs. The raw materials consumed in steel production collectively account for between 55 and 70 percent of total steelmaking production cost.[14] Moreover, the principal material inputs used by steelmakers, both domestic and foreign, are traded throughout the world and typically priced in terms of U.S. dollars. These material inputs include iron ore,[15] metallurgical coal,[16]

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[13] As explained below, international trade in steel technology and steel inputs has taken place for some time. However, foreign investment and joint ventures are a more recent phenomenon, particularly joint ventures between Japanese and U.S. steel firms with operations in the United States. See Crandall (1981) and ITC (1990), p. 44.

[14] ITC (1990), p. 53.

[15] Iron ore has been transacted under long-term contracts since the turn-of-the century. However, a domestic spot market developed after International Harvester decided to sell its steel-making operations and dispose of its inventory of iron ore for a price 40 percent below the posted rail-of-vessel prices for delivery to the Lower Great Lakes. Subsequently, a permanent spot-market developed for iron ore.

Beginning in the 1980s, foreign ores entered the Great Lakes region and challenged U.S. ore producers. U.S. companies signed long-term take-or-pay contracts with Brazil's CVRD in the semifinished steel,[17] steel scrap,[18] and other minerals.[19] There have also been several investigations by the U.S. International Trade Commission of various imported steel inputs that were alleged

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mid-1970s. Contract prices are renegotiated annually and track world prices closely. World Steel Dynamics, Core Report KK, "NA Iron Ore Costs Low; Competitive Pressures Remain," June 1990.

[16] The U.S. is a major exporter of metallurgical coal. The EC, Japan, and Canada are the largest customers. U.S. Department of Energy, Quarterly Coal Report, July-September 1992, (Feb. 1993), p. 42.

Steel producers traditionally relied on coal (metallurgical coal) in the form of metallurgical coke for the bulk of their energy requirements. The United States has an abundant supply of high quality metallurgical coal. However, over the past 30 years, coke has become a less important input as it has been replaced by both more energy efficient processes and by other energy sources (e.g., fuel oil and natural gas). See ITC (1994), esp. p. 2-5.

[17] Semi-finished steel imports increased from 0.7 million tons in the late 1970s to 2.3 million tons in 1990. The 1984 VERs limited semi-finished steel to 1.7 million tons, but the Department of Commerce authorized imports above this level to meet domestic shortages (under the so-called "short supply provisions" of the VRAs). See GAO (1989). Domestic trade in semi-finished steel has also risen as domestic producers closed obsolete steelmaking plants and modernized and expanded finishing mills. Some new domestic steel finishing facilities have little or no hot-metal capability (e.g., USS-POSCO, Tuscaloosa Steel).

[18] The U.S. is the leading world exporter of ferrous scrap; U.S. scrap exports are about 20 percent of total domestic production. U.S. Bureau of Mines, Metal Prices in the United States through 1991, p. 74. Also see U.S. International Trade Commission, Quarterly Report on the Status of the Steel Industry, USITC Pub. 2486 (March 1992), pp. i-vii.

The U.S. policy has long regarded steel scrap to be of strategic importance. The Government controlled scrap exports during World War II, the Korean conflict, and in 1973-74. More recently, domestic scrap consumers petitioned the Department of Commerce in 1979 to establish an export control program to monitor prices and prevent foreign buyers from bidding up prices.

[19] Other world traded steel inputs include chromium and manganese. American Metal Market, Metal Statistics 1992, pp. 32 and 83.

to injure domestic competitors, cases that suggest an active international market in steel inputs.[20] Interestingly, since 1975 there have been no antidumping cases involving steel inputs, which suggests a competitive international market in which economic price discrimination is not feasible.

International markets and pricing arrangements vary for steel inputs. For example, the market for steel scrap is worldwide and prices, which are set on a spot basis, adjust rapidly to equilibrate supply and demand.[21] In the case of iron ore, although there are several international prices (typically one year contracts), the bellwether is the price quoted for delivery to Rotterdam and bound for German steel mills. There are several major suppliers (e.g., Australia, Brazil, Canada) but "...information on virtually every price settlement seems to be known to everyone in the iron ore industry almost instantly."[22]

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[20] For example, the U.S. International Trade Commission found that subsidized imports of pig iron from Brazil injured U.S. producers in 1979 and a countervailing duty of 7 percent was imposed in 1983 (USITC Investigation 701-TA-2, April 4, 1980). Other steel-related inputs that were subject to countervailing duty investigations include: ferrochrome, ferromanganese, ferrosilicone manganese, and ferrosilicone (USITC Investigation 701-TA-7, January 2, 1980, affirmative findings of subsidy and injury), certain ferroalloys (USITC Investigation 701-TA-10, petition withdrawn, March 19,1980), iron ore pellets from Brazil (USITC Investigation 701-TA-235, December 20, 1984, final subsidy but no final injury).

Escape clause (section 201) investigations include: low carbon ferrochrome (USITC Investigation TA-201-20, January 21, 1977) and high carbon ferrochrome (USITC Investigation TA-201-35, June 21, 1978).

[21] GAO (1980).

[22] Paine Webber, World Steel Dynamics, June 1990, p. 4-21.

As the value of the dollar declined after 1985, Brazilian and Canadian ore suppliers did not reduce export prices to the United

Analysis of depreciation. Figure 1 shows the effect of exchange rate depreciation on the domestic steel industry. To bring out most sharply the effect of depreciation, we adopt the following structure for expositional purposes. Assume that domestic and imported steel is homogeneous, domestic industry is perfectly competitive, and import supply is infinitely elastic ("small" country assumption). To reveal the role of global inputs two cases are contrasted. In the first case, global inputs are absent; in the second their influence is taken into account.

Global inputs absent. Under perfectly competitive conditions, the usual approach, presented for example by Venables (1990), treats domestic supply and world supply as independent of each other, i.e., assumes an absence of globalization of inputs. Furthermore, the import supply price, in foreign currency, is exogenously fixed. A depreciation causes import supply price in domestic currency to increase by an amount proportional to the magnitude of the depreciation. Figure 1 illustrates the case of a 50 percent depreciation of the dollar. Initially, the exchange rate is $R_o = 1$.[23] The subsequent exchange rate is $R_1 = 2$. The

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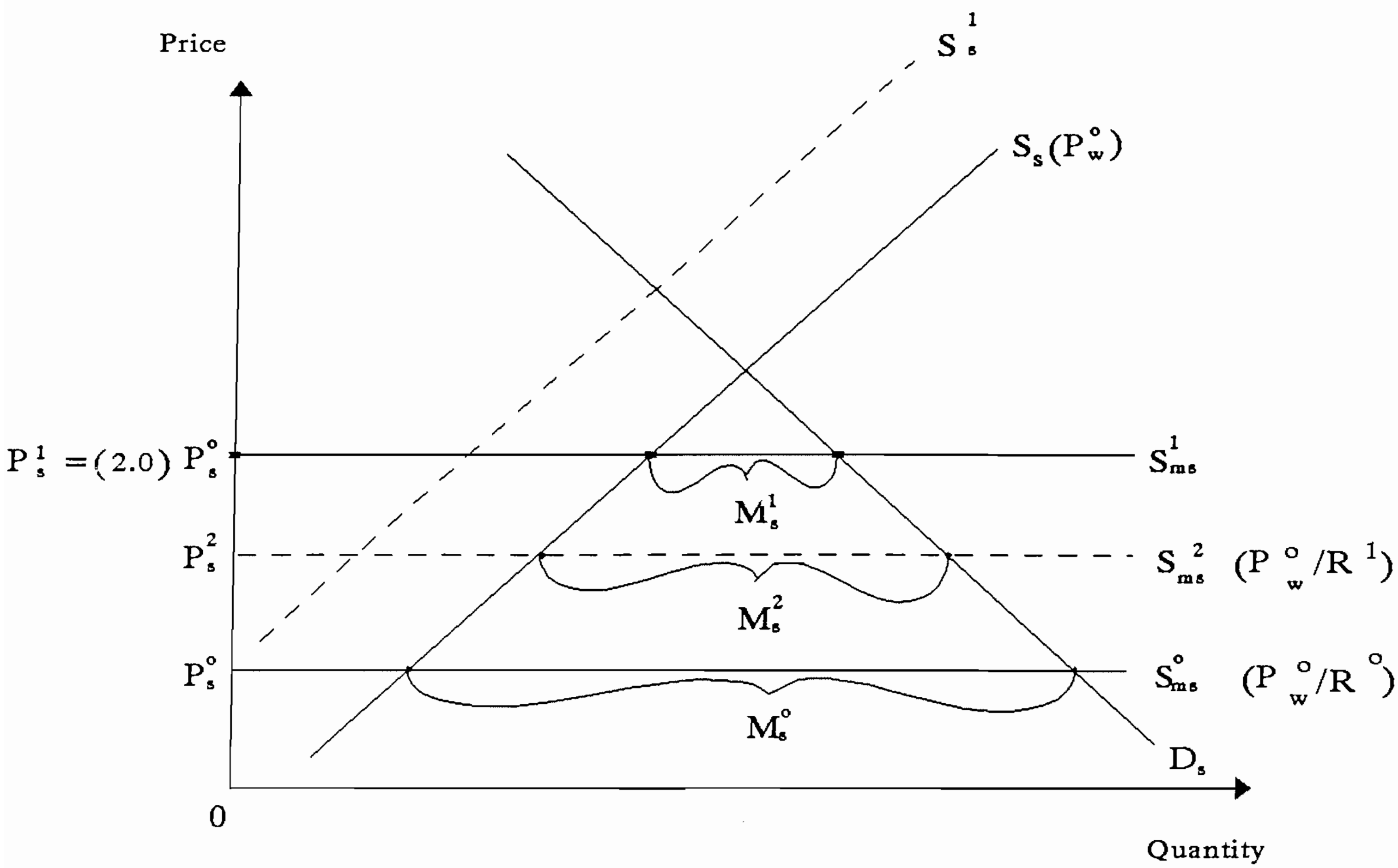
States. In 1990, M.A. Hanna Co. and Picklands Mather (owned by Cleveland-Cliffs) quoted high prices for U.S. sales because of strong demand for ore by European steel firms. Similarly, CVRD would not cut prices for exports to the United States "because their major tonnage contracts are with Europe, Korea and Japan based on the world posted f.o.b. Brazilian port price." World Steel Dynamics, op cit., p. 4-26.

[23] R is the number of U.S. dollars per unit of foreign currency.

Figure 1
Effect of Depreciation of Dollar on Imports

If world price of imports is constant (expressed in foreign currency), a 50% depreciation of US dollar shifts import supply from S^{o}_{ms} to S^{1}_{ms} and doubles USD price of imports (full pass through of exchange rate). Quantity of of imports declines from M^{o}_{s} to M^{1}_{s}.
In contrast, if domestic and foreign producers both use a common world-traded input (W), the depreciation has a smaller effect on imports. Assuming the price of W is denominated in USD and exogenous, a 50% depreciation shifts import supply from S^{o}_{ms} to S^{2}_{ms} (partial pass-through of exchange rate). Quantity of imports declines from M^{o}_{s} to M^{2}_{s}.



depreciation shifts import supply curve from S_{MS}^{o} to S_{MS}^{1} and the domestic price of imports doubles. There is thus "full pass through" of the exchange rate change, and the quantity of imports declines from M_S^{o} to M_S^{1}.

Global inputs present. However, as emphasized above, steel supply, both domestic and foreign, depends on world traded inputs. Denote the price of these inputs by P_W. Domestic supply, S_S, and import supply, S_{MS}, are linked as both depend on P_W. As noted above, evidence suggests that P_W is denominated in U.S. dollars. Furthermore, we assume that P_W is exogenously fixed. A depreciation of the dollar then reduces the cost of traded inputs to foreigners (in foreign currency). Import supply shifts to S_{MS}^{2}, not S_{MS}^{1} as under full pass through. The extent of the upward shift in import supply depends on the relative importance of traded inputs in the total cost of steelmaking. There is thus less than full pass through of the exchange rate change, and the quantity of imports declines from M_S^{o} to M_S^{2}. By extension, an increase in the degree of globalization, where traded inputs account for a greater share of total production costs, will be accompanied by a smaller pass through of exchange rate changes and a smaller effect on imports.[24]

[24] Finally, while we choose to emphasize exchange rate pass through in examining the effect of exchange rate changes on imports, the key feature in our approach is globalization of steel inputs. Our choice is based on industry practice, where contracts for traded steel inputs are denominated in U.S. dollars. However, it is important to note that the specific national currency in which inputs are priced does not alter our principal argument. To illustrate (Figure 1), suppose that P_W were expressed in foreign currency (and exogenously fixed). Although depreciation of the

A Widely Used Intermediate Product

Even with full pass through of an exchange rate change, there is second reason to expect there will be only a modest decline in (and possibly even an increase in) steel imports. Steel is an input to a large number of industries that are themselves subject to competition from imports. A depreciation of the dollar increases domestic prices of both imported steel and imported steel-using final products. The consequent output expansion of domestic steel-using products increases domestic steel consumption. This lessens, and possibly reverses, the adverse effect of the depreciation on steel imports.

These results are conveniently illustrated using a geometric technique first used by Corden (1971) to analyze effective rates of protection (Figure 2). There are two perfectly competitive industries, S and a S-consuming good A, and it is assumed that each unit of A requires one unit of S (constant input-output coefficient). Imports and their domestic substitutes are homogeneous and import supply is infinitely elastic. Moreover, supply of the domestic and imported products are independent (i.e., there are no globalized inputs for the S and A industries).

Initially, the S and A import supply curves are indicated by $S_{MS}°$ and $S_{MA}°$ respectively. Domestic supply of S is S_S and,

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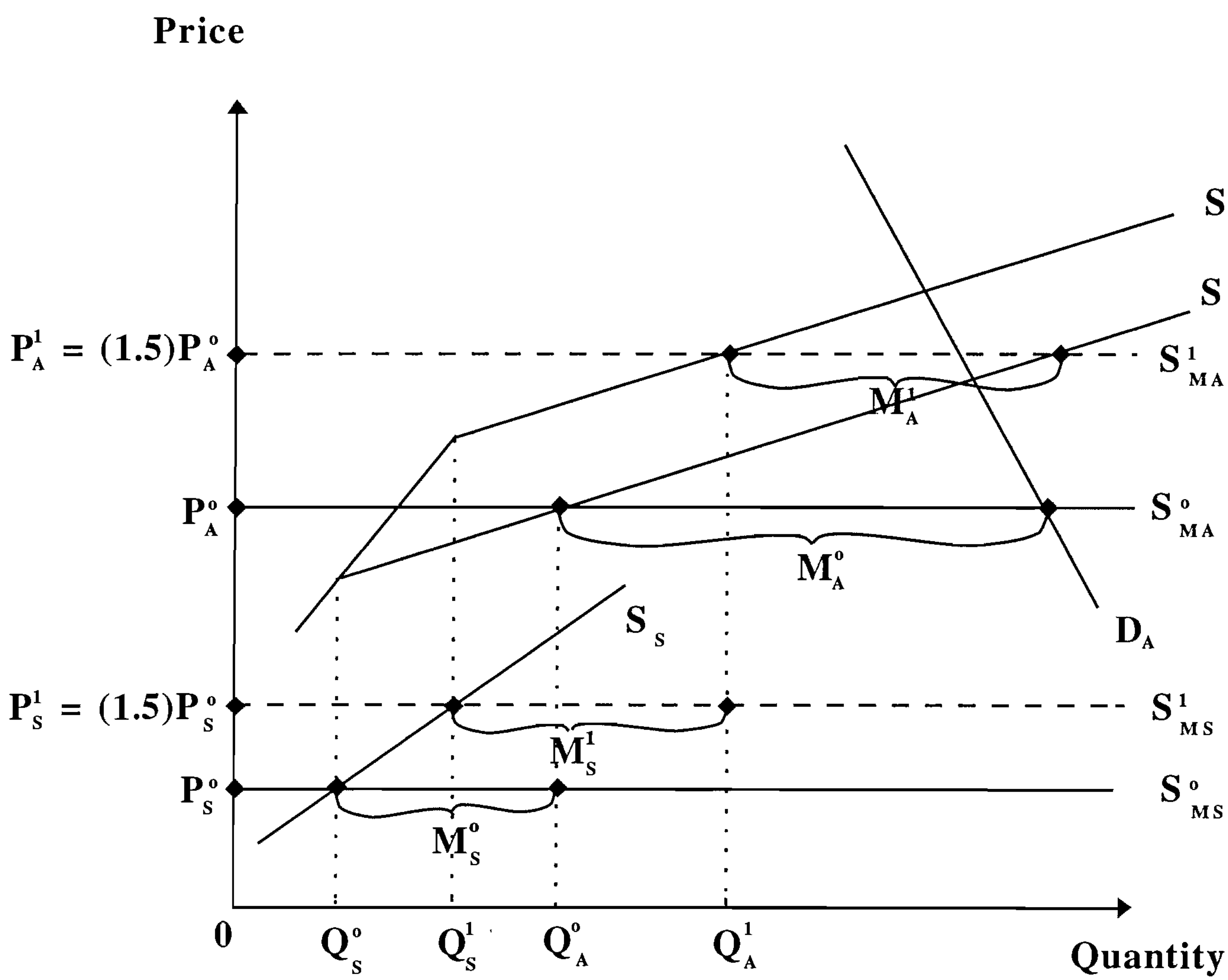
dollar shifts import supply from $S_{MS}°$ to S_{MS}^1 (full pass through) there is a contraction in domestic supply from S_S to S_S^1 because the cost (in dollars) of traded inputs increases. Thus, the contraction in domestic supply diminishes the negative impact of a depreciation in the value the dollar.

Figure 2

Effects of Depreciation of Dollar on Vertically Related Industries

Since steel is an intermediate product and required in fixed amount per unit of "autos" produced (i.e., fixed input-output coefficient), both products can be shown in the same diagram. Depreciation of USD shifts import supply curves steel and "autos," from S_{MS}^{o} to S_{MS}^{1} and from S_{MA}^{o} to S_{MA}^{1} respectively. The shifts also indicate increases in domestic prices of steel and "autos." If expansion in domestic production of "autos" (Q_A^o to Q_A^1) exceed expansion in domestic steel production (Q_S^o to Q_S^1) then depreciation increases steel imports. This is the case illustrated, M is greater than M .
Also, a 33% depreciation of USD is illustrated.



initially, curve S_A^o indicates domestic supply of A.[25] Domestic demand for A is D_A. Domestic production of S and A are Q_S^o and Q_A^o, and S imports and A" imports are M_S^o and M_A^o.

Assuming full pass through of the exchange rate change, the import supply curves shift upward, to S_{MS}^1 and S_{MA}^1. (The diagram illustrates the case where the external value of the dollar declines by 33 percent.) Domestic supply of S is not affected but domestic supply of A shifts to S_A^1. A imports fall to M_A^1. However, S imports increase to M_S^1 because the increase in domestic A production (Q_A^1-Q_A^o) exceeds the increase in domestic S production (Q_S^1-Q_S^o).

Figure 2 illustrates the point that the direction of the effect of a depreciation of the dollar on S imports is ambiguous. This follows from that fact that S is an input into final products that are traded.

III. MODEL

The model we use to estimate the effect on steel imports of changes in the foreign exchange rate is a computable, two sector, partial equilibrium model. In addition to the steel sector, we have a sector that comprises the collection of all steel-using

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[25] The bend in the domestic supply curve of "autos" indicates the output rate where the rising domestic supply price of steel equals the world price. At this point "auto" producers switch from domestic steel to imported steel.

industries. For convenience, this is called the "auto" sector. We invoke the small-country assumption for steel and "autos" and also assume that all markets are perfectly competitive.[26] For reasons given above, the model is designed to capture the fact that steel is (1) produced using world traded inputs and (2) a widely-used and traded intermediate product. Finally, regarding product differentiation, we assume that there are three varieties each of "autos" and steel. The varieties are distinguished by whether they are imported, domestic, or exported. A schematic of the model is given in Figure 3.

"Autos"

Consumers are assumed to have a constant elasticity demand for overall or composite "autos," where composite "autos" is an aggregate of domestic and imported varieties. Further, preferences of consumers are assumed to be weakly separable so that the demand for either variety of "auto" depends only on "auto" prices and total spending on "autos."[27] Thus, domestic consumers choose between domestic and imported "autos," which they view as being close but not perfect substitutes, where the degree of substitutability is measured by an elasticity of substitution. Composite "autos" is a constant elasticity of substitution (CES)

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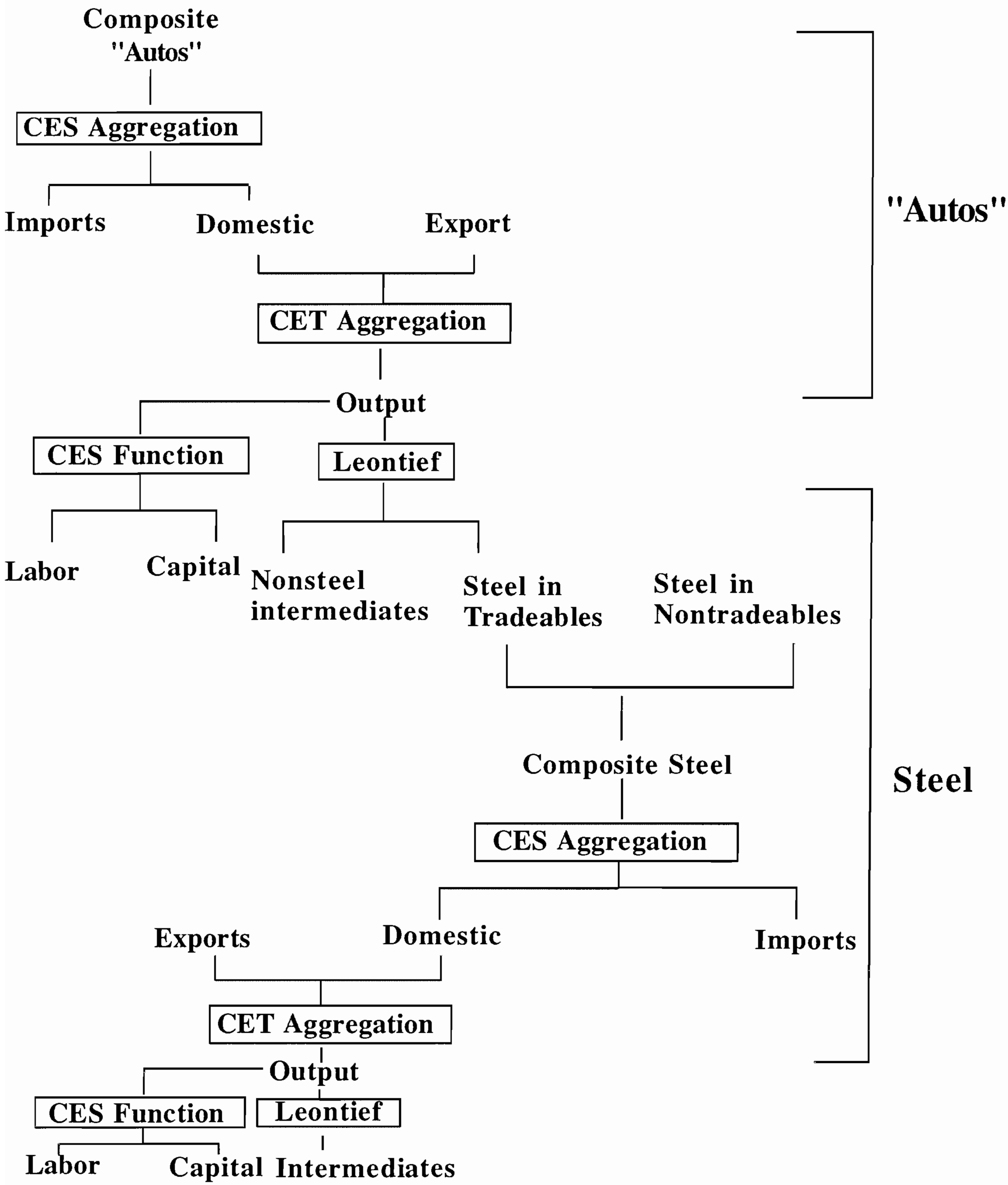
[26] We analyze a "large" country case in Appendix C, i.e., where import supply has finite elasticity. The qualitative results derived there are essentially the same as those obtained from the "small" country case.

[27] For a discussion of weak separability, see Deaton and Muellbauer (1980), chap. 5.

Figure 3
Schematic of Model



function of imported and domestic "autos." Finally, we assume that domestic and imported "autos" are gross substitutes, which requires that the elasticity of substitution is greater than (the absolute value of) the price elasticity of demand for composite "autos."

The domestic "auto" industry is assumed to produce an aggregate output under conditions of constant costs, i.e., the supply curve of aggregate "autos" is horizontal. The production function of "autos" is a CES function of value added (labor and capital) and a Leontief function in intermediate products, steel and other (nonsteel) inputs.

Aggregate "auto" output consists of two distinct varieties -- one type of "auto" for the domestic market and another type for the export market. Moreover, we assume that aggregate auto output is a constant elasticity of transformation (CET) function of the two varieties. Given an endowment of resources employed in the sector, the ability of domestic producers to convert domestic into foreign variety is described by a (finite) elasticity of transformation. Further, under this resource constraint, each variety displays increasing marginal cost, measured in terms of number of units of the other variety that must be sacrificed.

A notable consequence of our production and supply specifications is that the two "auto" varieties are cost complements and therefore production of autos involves economies of scope.[28] The source of economies of scope is the presence of

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[28] Baumol, Panzar, and Willig (1988), p. 75. Also see de Melo and Tarr (1992), pp. 38-9.

several inputs in the overall production process that are shared by both specific products (the domestic variety and the export variety).[29] *Ceterius paribus*, an increase in the price of the export variety causes an increase in the supply of the domestic variety.

Steel

The total demand for steel by the domestic auto industry derives from the Leontief function linking steel to domestic auto production. In addition, steel is demanded by domestic industries making final nontradable products. The latter is treated as fixed exogenously. As with autos, there are three varieties of steel: imports, domestic, and exports. From the standpoint of domestic auto producers, domestic steel and imported steel are substitutes, and we assume that these two varieties of steel can be aggregated using a constant elasticity of substitution (CES) function, to form composite steel.

Aggregate output of the domestic steel industry is produced under conditions of constant costs. The industry produces two varieties of products, one for the domestic market and one for the export market. For a given aggregate output, the ability of domestic producers to switch between the two varieties is described by a CET function. Therefore, as with autos, steel production enjoys economies of scope. The export variety of steel is also sold to the world market at an exogenously fixed price. The

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[29] Baumol, Panzar, and Willig (1988), p. 77.

production function of aggregate steel is a CES function of value added and a Leontief function of a composite intermediate input.

IV. Data

The model is calibrated to 1984 using data for steel and "autos" derived from publications of the U.S. Department of Commerce. Details are provided in Appendix B. The elasticity parameters are based on estimates available in the literature. Table 1 gives the elasticity values we use and explains where they were obtained. Each elasticity has three values: low, central, and high. The central estimates are our "best estimate" values. Accordingly, we focus on the results obtained when the central elasticities are used. The sensitivity of these results to alternative elasticity values are revealed by running the model using the low and high elasticity cases.

V. Test and Results

Test

A two step procedure is adopted to determine whether the depreciation of the dollar rendered the steel VRAs ineffective. First, from the 1984 benchmark, the effect of the VRAs is simulated. Second, from the counterfactual equilibrium for the

TABLE 1

ELASTICITIES USED IN COUNTERFACTUAL SIMULATIONS

Demand Elasticities	Low	Central	High
Own price elasticity of demand for "autos" (ε_{AC})	-0.8	-1.0	-1.2
Elasticity of substitution in consumpution between domestic and imported "autos" (σ_{AC})	0.9	2.06	5.0
Elasticity of substitution in steel-using firms between domestic and imported steel (σ_{SC})	1.1	3.05	5.0
Supply Elasticities			
Elasticity of transformation between domestic and exported "autos" (σ_{AX})	1.6	2.9	4.2
Elasticity of transformation between domestic and exported steel (σ_{SX})	1.6	2.9	4.2
Production Function Elasticities			
Elasticity of substitution for domestic "auto" industry (σ_{AD})	0.5	0.81	1.12
Elasticity of substitution for foreign "auto" industry (σ_{AF})	0.5	0.81	1.12
Elasticity of substitution for domestic steel industry (σ_{SD})	0.84	1.0	1.16
Elasticity of substitution for foreign steel industry (σ_{SF})	0.84	1.0	1.16

Notes: The central elasticity estimates were obtained primarily from De Melo and Tarr (1992), who have surveyed the results of researchers, and from Shiells, Stern and Deardorff (1986). The central values for steel are taken directly from the literature. The central values for "autos" are averages of the elasticity estimates available for the industries that comprise "autos." The principal industries used to develop central estimates for "autos" are: metal products (excluding machinery), machinery (excluding electrical), and transportation equipment. The low and high elasticities are, where possible, one standard deviation from the central estimate.

VRAs, the effect of the depreciation of the dollar is simulated. If the quantity of steel imports is less than the level permitted by the VRAs, then the VRAs are ineffective.

The objective of the VRAs was to reduce the share of steel imports in domestic consumption on a volume basis from 26 percent in 1984 to 18.5 percent. Alternatively, import volume was 35.1 percent of domestic volume in 1984 and the objective was to reduce this percentage to 22.7. However, on a value basis the share of imports was only 18.6 percent in 1984, and import value to domestic value was 22.8 percent. Thus, the price ratio of imported to domestic steel was 0.65 (22.8/35.1). In our model, quantity units are chosen such that prices of products are unity in the benchmark. Accordingly, the corresponding objective of the VRAs is to reduce the ratio of imports to domestic steel from 22.8 percent to 14.8 percent (=0.65x22.7), or to reduce the share of imports from 18.6 percent to 12.8 percent.

Effects of VRAs on Steel Imports

The simulated effects of the VRAs are given in Table 2. This table also has the actual 1984 benchmark data for steel and "autos."

The results in Table 2 show that the most apparent effects of the VRAs concern the steel variables. The "auto" variables change only modestly. Figures 4 and 5 are employed to facilitate interpretation of the results for steel and, in particular, to

TABLE 2

EFFECTS OF VRAs ON STEEL IMPORTS
(benchmarked to 1984 data)

Variable	Initial Data (billions of 1984 dollars)	Counterfactual Estimates for Market Share VRA's Imposed on Steel Imports		
		Low Elasticity Case	Central Elasticity Case	High Elasticity Case
Imported Steel				
Price	1.00	1.51	1.16	1.09
Quantity	12.67	8.71	8.73	8.74
(share in domestic consumption)	(18.56)	(12.83)	(12.83)	(12.83)
Domestic steel for home market				
Price	1.00	1.00	1.00	1.00
Quantity	55.60	60.03	59.63	59.53
Domestic steel for export market				
Price	1.00	1.00	1.00	1.00
Quantity	1.32	1.42	1.41	1.41
Imported "autos"				
Price	1.00	1.00	1.00	1.00
Quantity	137.95	138.02	138.21	138.50

TABLE 2

EFFECTS OF VRAs ON STEEL IMPORTS--Continued
(benchmarked to 1984 data)

Variable	Initial Data (billions of 1984 dollars)	Counterfactual Estimates for Market Share VRA's Imposed on Steel Imports		
		Low Elasticity Case	Central Elasticity Case	High Elasticity Case
Domestic "autos" for home market				
Price	1.00	1.007	1.002	1.001
Quantity	612.84	609.32	611.24	611.33
Domestic "autos" for export market				
Price	1.00	1.00	1.00	1.00
Quantity	93.15	91.57	92.32	92.41
Aggregate consumption of "autos"				
Price	1.00	1.006	1.002	1.001
Quantity	750.78	747.34	749.44	749.83

Sources: The 1984 benchmark data were obtained from U.S Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, July 1991, pp. 30-71. The steel industry is BEA industry 37; the "auto" industry comprises 26 BEA industries (13, 22, 23, 39 to 61).

reveal the interrelationships between the imported, domestic, and exported steel products.

The demand/supply diagrams in Figure 4 for steel show that VRAs create a shortage of imports, which increases their price (panel A). The higher price of imports causes an increase in the demand for the substitute domestic product (panel B). Higher output of the domestic product causes export supply to increase, due to economies of scope, which has a feedback effect increasing supply of domestic product, also due to economies of scope. Thus, the VRAs on imports causes output of both domestic and exported products to increase.

The diagrams in Figure 5 complement those in Figure 4 and show how the VRAs affect the optimum output ratio of producers and the optimum consumption ratio of consumers. The unit revenue of aggregate production (panel D) and unit cost of composite consumption (panel E) are dual to the CET function for domestic and export products and the CES function for domestic and imported products, respectively.[30] We exploit the property of the unit revenue curve that the slope of a line tangent to the curve is the optimum supply ratio of the export product to the domestic product.

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[30] Unit revenue and unit cost are price indices and are independent of physical quantities because the CET and CES functions are linear homogeneous. On his point, see Varian (1984), p. 28 and de Melo and Tarr (1992), p. 52. Furthermore, unit revenue is a CET function of domestic and export prices and unit cost is a CES function of domestic and import prices. Finally, since unit cost of composite consumption is CES, it is also homothetic in prices of domestic and imported products.

Figure 4
Effects of VRAs on Steel Imports

VRAs increase price of import product from P_m^0 to P_m^1, which increases demand for domestic product from D_d^0 to D_d^1. Consequent expansion in output of domestic product increases supply of export product from S_x^0 to S_x^1, due to economies of scope, which has feedback effect, also due to economies of scope, increasing supply of domestic product from S_d^0 to S_d^1.

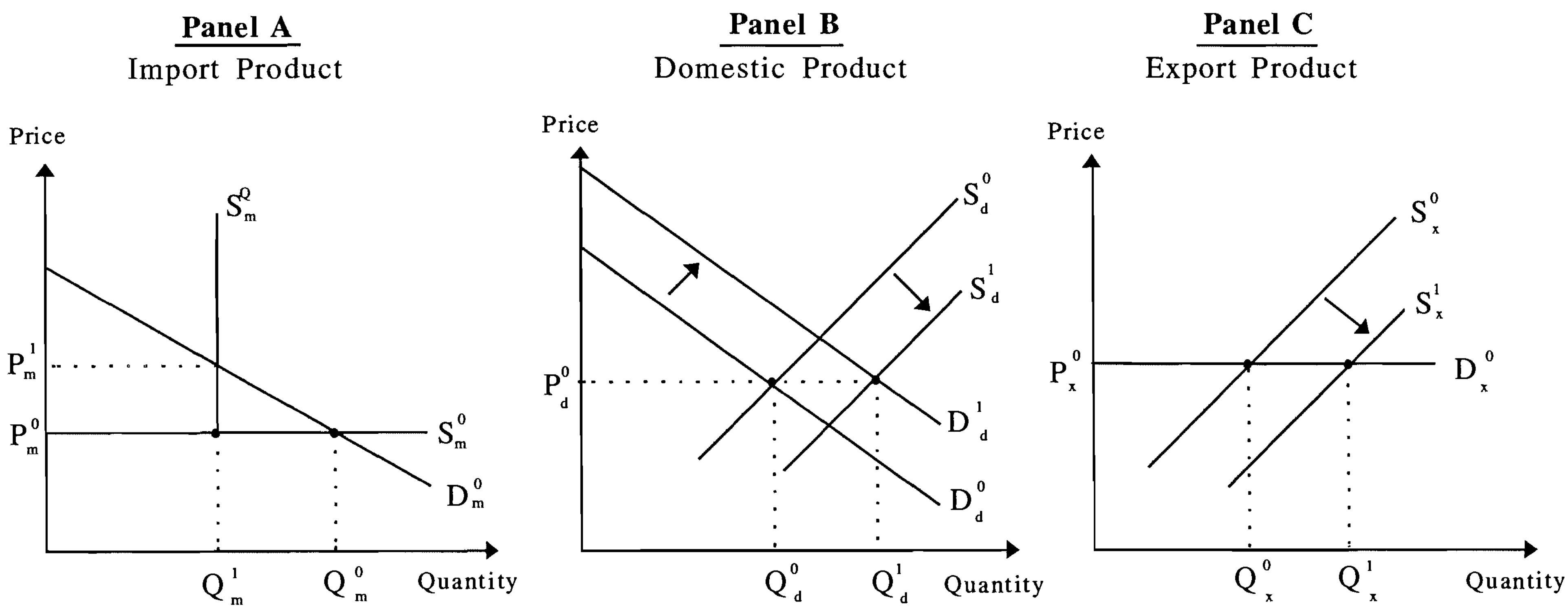
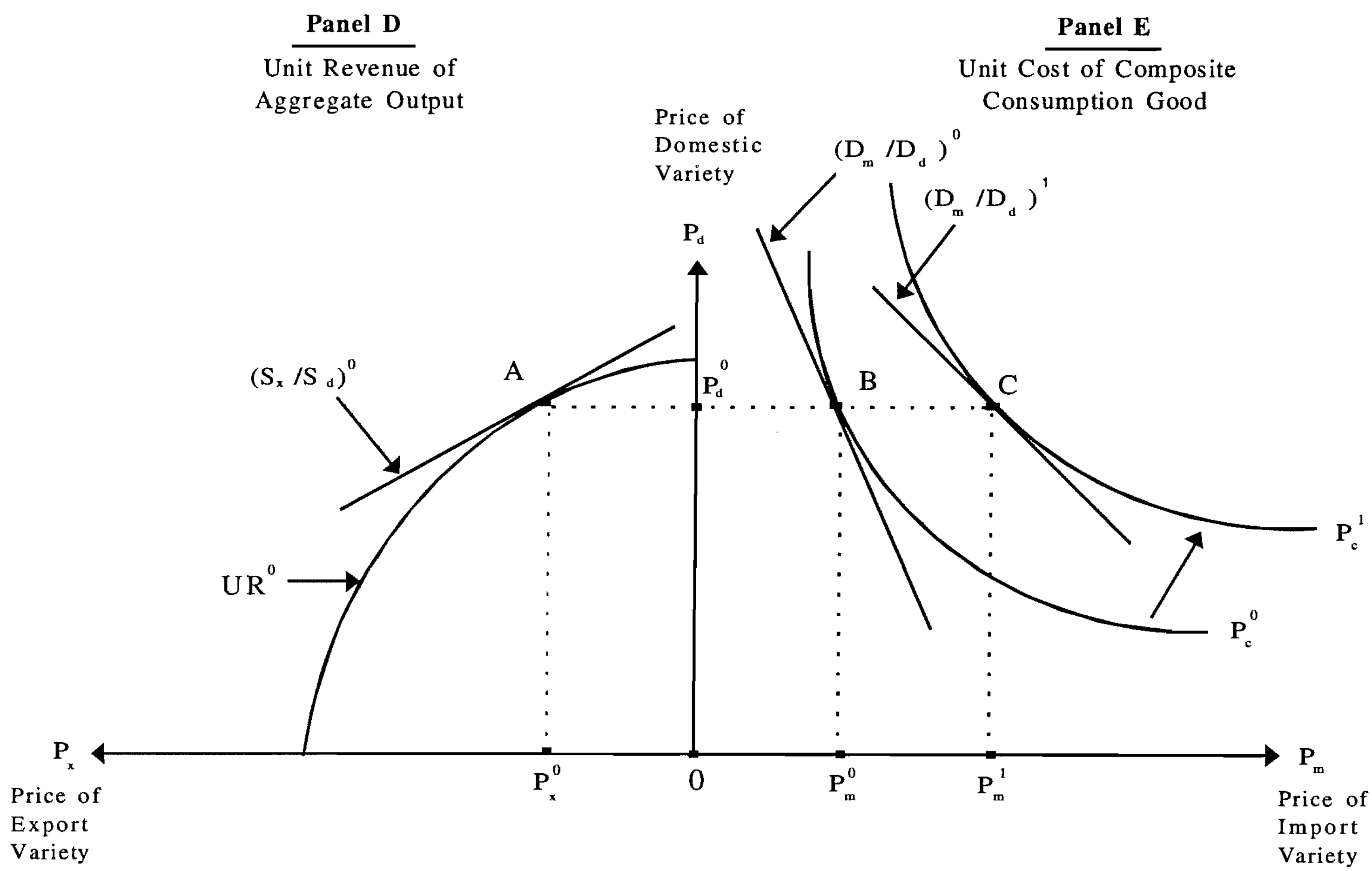


Figure 5
The Effect of Import Restraint on Exports

Increase in price of import product increases the price of composite consumption good from P_c^0 to P_c^1. Optimal consumption mix shifts against import product, $(D_m/D_d)^0$ to $(D_m/D_m)^1$. Unit cost of aggregate domestic output is constant (constant returns to scale) and an average of unit costs of domestic and export products. Price (unit cost) of domestic product (P_d^0) remains the same because price of export product is exogenous (P_x^0). Optimal domestic output mix (S_x/S_d) is unchanged; production of domestic and export products expand proportionately.



Similarly, the slope of a line tangent to the unit cost curve is the optimum demand ratio of import product to domestic product.[31]

As indicated in panel D, unit revenue of aggregate output is constant. In competitive equilibrium unit revenue equals unit cost. And unit cost is constant owing to our assumption of constant returns to scale. Moreover, unit revenue is an "average" of the prices of the export and domestic products. Since the price of the export product is exogenously determined in the world market, the price of the domestic product will not change when the VRAs are imposed. Domestic producers will therefore have the same optimum ratio of export product to domestic product. In panels B and C, the output levels of domestic and export products both increase by the same proportion.

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[31] These results can be obtained by taking the total differentials of the unit cost and unit revenue functions. For example, the unit cost function is a sum of prices times the quantities of imported and domestic products yielding one unit of the composite consumption good. Specifically,

$$P_c^0 = P_d * Q_d + P_m * Q_m$$

where P_c^0 is unit cost of the composite consumption good, and Q_d and Q_m are the number of units required to produce one unit of composite consumption good. The total differential of P_c^0 is

$$dP_c^0 = P_d * dQ_d + Q_d * dP_d + P_m * dQ_m + Q_m * dP_m$$

Setting $dP_c^0 = 0$, and noting that the sum of the first and third terms on RHS are zero (from cost minimization), yields

$$(dP_d/dP_m) = -(Q_m/Q_d)$$

which is illustrated in panel E by the slope of the tangent lines to points B and C.

As indicated in panel E, the increase in import price under the VRAs increases both the price of import product relative to the price of the domestic product and the average cost of the composite consumption good. This change in relative prices induces consumers to reduce consumption of import product relative to domestic product.

The implications of Figure 5 are reflected in results reported in Table 2. Specifically, prices of domestic and export products are unchanged. Moreover, shipments of domestic product and export product are both 7 percent higher than in the benchmark (59.63/55.60 = 1.41/1.32 = 1.07).

Effects of the Depreciation of the U.S. Dollar, given VRAs

The effects of the depreciation of the dollar are given in Table 3. We present results for two situations. Under what we call partial pass through, all intermediate inputs used by the steel and "auto" industries are modelled as traded on world markets. Moreover, prices of intermediate products are expressed in U.S. dollars and invariant to changes in exchange rates. In contrast, under what we call full pass through, all inputs used by the steel and "auto" industries are modelled as purely domestic, or nontraded. These two situations are extremes. We suspect, however, that truth lies closer to partial pass through and will

TABLE 3

EFFECTS OF DEPRECIATION OF US DOLLAR ON STEEL AND "AUTOS"
WITH PRE-EXITING VRAs RESTRICTING STEEL IMPORTS
(benchmarked to 1984 data)

Variable	All Intermediate Products are Traded Internationally and Priced in U.S. Dollars: Partial Pass Through of ER Change			All Intermediate Products (except steel) are Nontraded: Full Pass Through of ER Change		
	Low Elasticity Case	Central Elasticity Case	High Elasticity Case	Low Elasticity Case	Central Elasticity Case	High Elasticity Case
	(-----------------------------------percent change from benchmark that has VRAs---------------------------------)					
Steel VRAs: Binding/Not Binding (Y/N)	Y	Y	Y	Y	N	N
Market share of steel imports by quantity (%)	12.83	12.83	12.83	12.83	7.92	4.28
Imported steel: price (USD)	-0.36	-0.39	-0.43	-1.14	18.01	24.91
quantity	5.45	12.52	24.76	17.64	-5.58	-10.05
Domestic steel for home market: price (USD)	-0.36	-0.39	-0.43	-1.14	-1.46	-1.91
quantity	5.45	12.52	24.76	17.64	63.64	201.21
Domestic steel for export market: price (USD)	13.62	13.56	13.49	36.40	36.40	36.40
quantity	30.09	64.55	116.15	96.89	320.16	1,102.98

TABLE 3 (Continued)

EFFECTS OF DEPRECIATION OF US DOLLAR ON STEEL AND "AUTOS"
WITH PRE-EXITING VRAs RESTRICTING STEEL IMPORTS
(benchmarked to 1984 data)

Variable	All Intermediate Products are Traded Internationally and Priced in U.S. Dollars: Partial Pass Through of ER Change			All Intermediate Products (except steel) are Nontraded: Full Pass Through of ER Change		
	Low Elasticity Case	Central Elasticity Case	High Elasticity Case	Low Elasticity Case	Central Elasticity Case	High Elasticity Case
	(--------------------------------------percent change from benchmark that has VRAs----------------------------------)					
Imported "autos": price (USD)	14.92	14.78	14.64	36.40	36.40	36.40
quantity	-11.72	-24.79	-51.25	-24.43	-49.78	-87.37
Domestic "autos" for home mkt: price (USD)	-2.59	-2.91	-3.26	-7.70	-10.54	-16.40
quantity	2.43	6.17	13.92	7.40	19.72	46.06
Domestic "autos" for export mkt: price (USD)	14.92	14.78	14.64	36.40	36.40	36.40
quantity	33.43	72.50	132.41	100.64	306.78	1,041.48
Aggregate consumption "autos": price (USD)	0.43	-0.08	-0.93	-0.73	-4.55	-12.71
quantity	-0.35	0.08	1.12	0.58	4.77	17.72

devote more attention to it below.[32]

Table 3 shows that the VRAs continue to bind steel imports under partial pass through but cease to bind under full pass through. At one level, these results can be explained as follows. As shown in Table 2, the VRAs cause the price of steel imports to increase by 16 percent. Under full pass through, the 36 percent depreciation of the dollar results in an increase in the supply price (in USD) of imports by 36 percent. In this situation the depreciation negates the effect of the VRAs. However, under partial pass through the import supply price of steel increases by only 13.56 percent, the same as the increase in the demand price (in USD) for the domestic steel export product. In this situation, the depreciation does not negate the VRAs.

The above explanation is not complete, however. For example, it ignores what happens to the "auto" industry and the consequent effects on steel. The depreciation is a boon to domestic "auto" producers. Import supply to the home market contracts while world demand for the domestic export product expands. Both developments increase demand for domestic "autos." Thus, Table 3 shows that

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[32] Note that it may also be appropriate to treat labor as a traded input. In addition to the situation where workers are physically able to move across national frontiers, there is also the case where institutional arrangements have the effect of making labor internationally mobile with respect to exchange rate changes. Consider, for example, the wage-price-incomes policy of the United Kingdom during the 1960s and 1970s. Because the import content of wage goods was high, a devaluation of the British pound initially lowered real wage rates. Subsequent pressure by labor unions increased nominal wage rates and (largely) offset the effect of the devaluation on real wage incomes. This outcome closely resembles a case where labor is internationally mobile at a given world wage rate (in foreign currency).

shipments of domestic "autos" for the home market and that exports of "autos" both increase. The increase in "auto" production increases the demand for steel. This is illustrated in Figure 6.

The increase in composite steel demand is represented by the shift from curve Q_{sc1} to curve Q_{sc2} (panel F), where Q_{sc} designates quantity of composite steel. The VRA constraint is represented by ray OR, whose slope is the maximum ratio of imported steel to

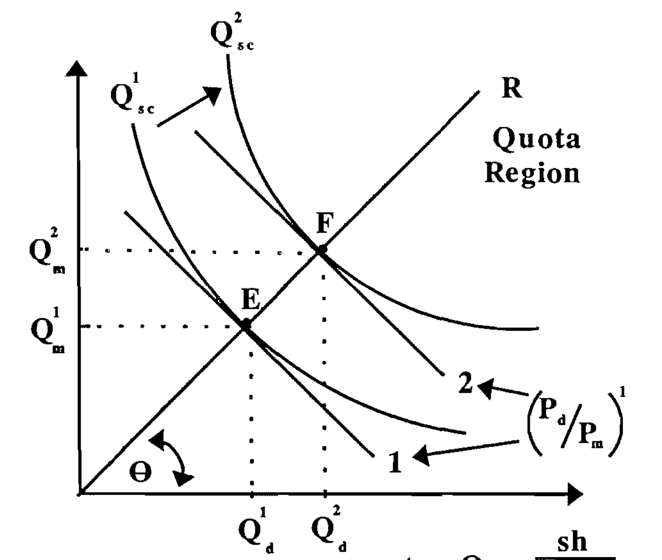
Figure 6
Effects of U.S. Dollar Depreciation on Steel Imports

Depreciation of USD increases domestic "auto" output. Consequently, demand for aggregate steel increases from Q_{sc}^1 to Q_{sc}^2. Assuming VRAs continue to bind (along ray OR), demand for both import and domestic steels increase, D_m^1 to D_m^2 and D_d^1 to D_d^2, respectively. Relative price of import to domestic steels is unchanged. (Line 1 is parallel to Line 2.)

Depreciation decreases supply of steel imports from S_m^0 to S_m^2, and increases demand for steel exports from D_x^0 to D_x^2. Increased output of export product generates beneficial effect on supply of domestic product, S_d^1 to S_d^2 (due to economies of scope), which has beneficial effect on supply of export product, S_x^1 to S_x^2. Domestic prices of import and domestic steels decline proportionally, to P_m^2 and P_d^2 respectively.

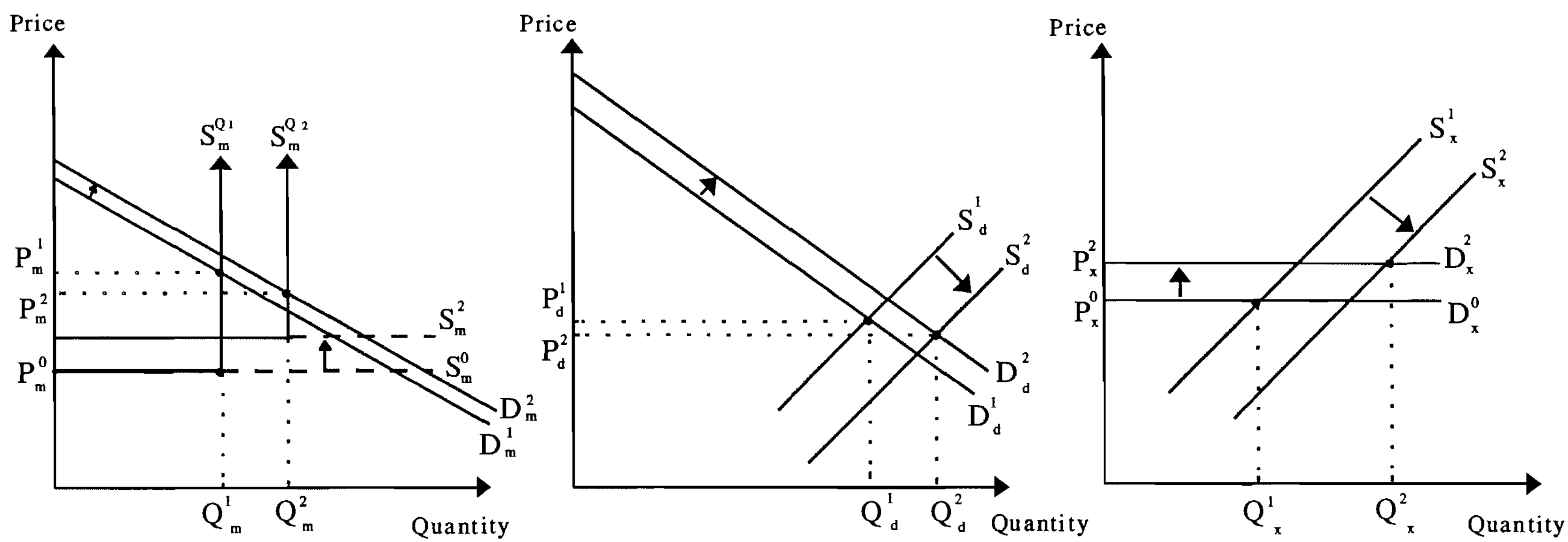
Panel F

Aggregate Steel Demand



$\tan \Theta = \frac{sh}{1 - sh}$ where sh = market share quota for imports.

Panel G Import Product | **Panel H** Domestic Product | **Panel I** Export Product



domestic steel permitted by the VRAs.[33] The area labeled "Quota Region" is combinations of imported steel and domestic steel that are allowed under the VRAs. If the VRAs continue to bind after the depreciation there is a shift from point E to point F, along ray OR. Moreover, the price ratio of domestic to imported steel remains unchanged. This ratio is indicated by the slopes of lines 1 and 2, which are parallel.[34]

Panel F thus explains the results reported in Table 3 for the imported and domestic steel products. In particular, when the VRAs are binding, prices as well as quantities of the two products move proportionately. For example, with partial pass through (central elasticity case) both quantities increase by 12.52 percent. However, somewhat surprisingly, both prices <u>decline</u> by 0.39 percent.

This surprising result is explained with the aid of Figure 7. The depreciation exogenously increases the price of the exported product, but unit revenue of steel (UR^{o}) remains unchanged. Thus the price of the domestic steel product must fall (panel J). We have seen that domestic and import prices change proportionately (panel F), and panel K shows that this preserves the same optimal demand mix, along ray OZ, whose slope is the price ratio (domestic product to import product).

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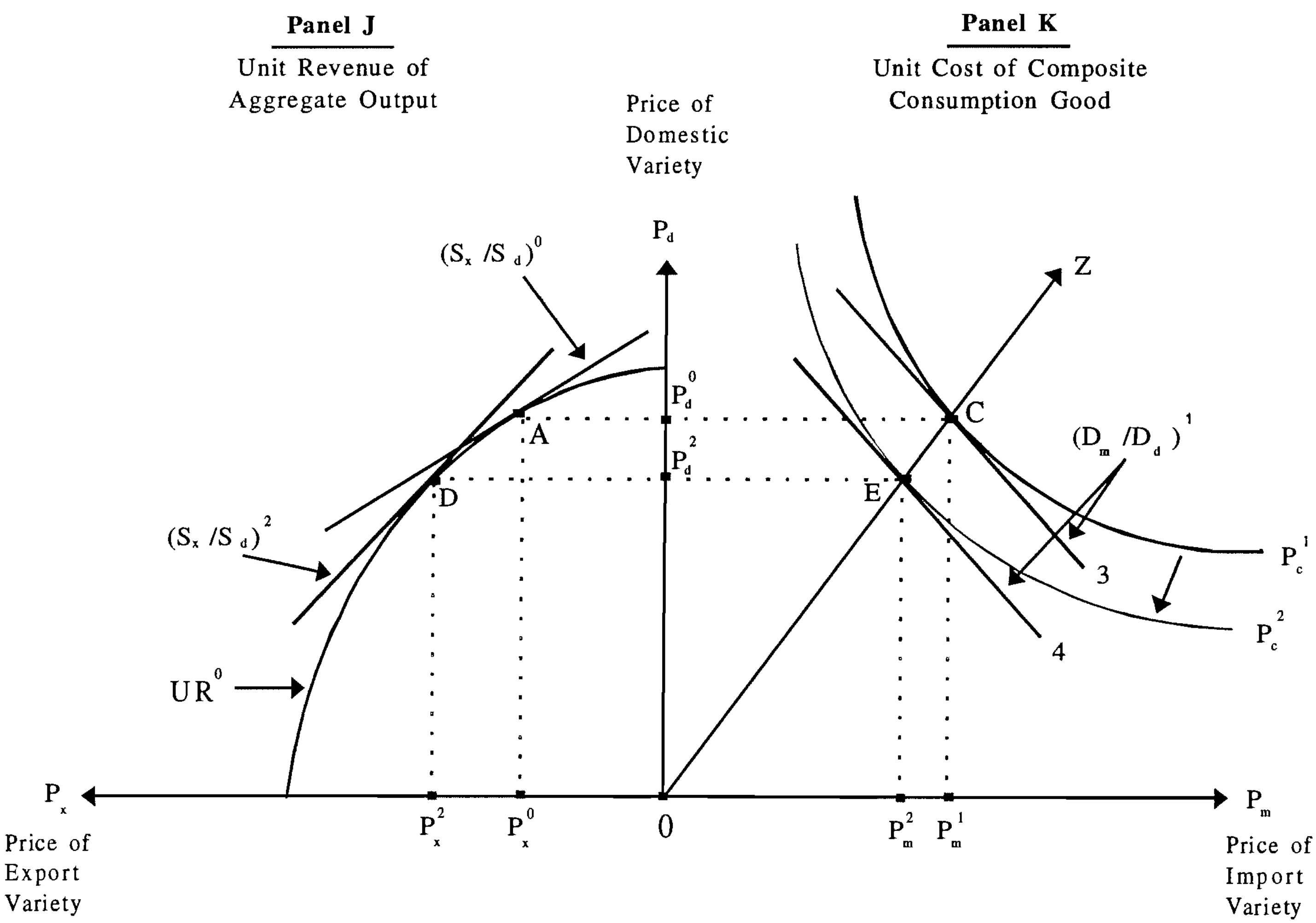
[33] As explained earlier, in our case the slope of ray OR is .148.

[34] The tangent lines 1 and 2 are parallel because composite steel is a CES function of imported and domestic steel.

Figure 7
Effects of Dollar Depreciation on Relative Demands and Supplies

Depreciation of USD increases domestic price of export product. Since unit revenue is unchanged (UR^{o}), price of the domestic product falls from P_d^1 to P_d^2. When VRAs are binding, domestic price of import steel falls proportionately, from P_m^1 to P_m^2, along ray OZ. (Line 3 is parallel to Line 4.) Optimum consumption ratio of import steel to domestic steel remains unchanged, $(D_m/D_d)^1$. The shift along unit revenue curve from point A to point D changes optimal domestic output mix in favor of exports as shown by the slopes of tangent lines to points A and D, $(S_x/S_d)^{o}$ vs. $(S_x/S_d)^1$.



Finally, it should be emphasized that there is some magnitude of exchange rate depreciation that will eliminate the effects of steel VRAs, even with globalized inputs. We can use our model to solve for this threshold exchange rate, which is found to be 41 percent. If the exchange rate depreciation were 41 percent or greater the steel VRAs would cease to bind imports.

Reality Check

One test of the exchange rate pass through issue (full vs. partial), and more generally of our model itself, is to compare the simulation results of our model with actual data for 1989. However, the usefulness of this test depends on the extent to which the VRAs on steel imports and the depreciation of the dollar were the only significant events affecting the steel industry during the mid 1980s. Unfortunately, there were many other important forces affecting the industry during this period, which are documented elsewhere.[35] Nonetheless, we provide the requisite information in Table 4 to give perspective and perform a crude test.

The results in Table 4 do not point to the superiority of partial pass through over full pass through. On the one hand, the partial pass through simulations seem more accurate for domestic shipments and domestic price. On the other hand, the full

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[35] These developments include, for example, modernization by the industry, plant closings, improvements in labor productivity, increase in importance of minimills, increase in foreign joint ventures. For elaboration, see the annual surveys of the steel industry by the U.S. International Trade Commission, ITC (1988), ITC (1989), and ITC (1990).

TABLE 4

COMPARISON OF ACTUAL DATA WITH SIMULATIONS OF MODEL BASED
ON PARTIAL PASS THROUGH AND FULL PASS THROUGH OF EXCHANGE RATE
(Central Elasticity Case)

	Before VRAs and Depreciation of U.S. Dollar	After VRAs and Depreciation of U.S. Dollar		Percent Change 1984 to 1989
	1984 Actual	1989 Actual	1989 Simulation	
Steel Imports				
quantity (Mn tons)	26.16	17.32		-33.8%
quantity (Bn 1984 USD)	12.67		9.83*	-22.4%
			8.25**	-34.9%
Domestic Steel for US Market				
quantity (Mn tons)	73.74	84.10		+14.0%
quantity (Bn 1984 USD)	55.60		67.10*	+20.7%
			97.58**	+75.5%
Domestic Steel for Export Market				
quantity (Mn tons)	0.98	4.58		+367.3%
quantity (Bn 1984 USD)	1.32		2.33*	+76.5%
			5.94**	+350.0%
Price of Domestic Steel				
BLS index	100	99.8		-0.2%
Model	100		99.6*	-0.4%
			98.5**	-1.5%

Note: * is for results of partial pass through simulations and ** is for full pass through simulations.

Sources: For quantity data and BLS price index, U.S. International Trade Commission, Steel Industry Annual Report, USITC Pub. 2316, September 1990, pp. 2 and 23. Note that BLS index above is ratio of BLS indices for steel mill products to finished goods. For data denominated in USD, see sources listed in Table 2 plus calculations from model.

pass through simulations seem more accurate for imports and exports. However, the likelihood of quality improvements in steel between 1984 and 1989 support the partial pass through simulations.

Quality improvements are expected for steel imports under the VRAs. For example, Boorstein and Feenstra (1991) found quality upgrading of steel imports for the quotas in effect during 1969 to 1974. Moreover, improvements in domestic steel quality were reported during the mid 1980s.[36] The consequence of quality improvement is that our simulations overstate the volume of both steel imports and domestic shipments, which argues in favor of partial pass through.[37]

VI. Extensions

We have discussed and applied certain issues to analyze steel imports that may also have other applications. For example, many products appear to use globalized inputs. As noted previously, virtually the default approach of economists of late is to treat partial pass through of exchange rate changes as a reliable signal

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[36] See, for example, ITC (1990), p. 36.

[37] Note that with respect to exports, the quality improvement argument does not argue for partial pass through. But U.S. steel exports are relatively small, and made primarily to just two countries, Canada and Mexico. Moreover, U.S. steel exports surged in 1988 and 1989, whereas movements in domestic shipments and imports were more moderate over the 1984 to 1989 period. These considerations suggest that our model may be less useful in explaining actual 1989 exports than in explaining imports or domestic shipments.

of imperfect competition (e.g., Dornbusch (1987), Feenstra (1989), Hooper and Mann (1989), Venables (1990)). As empirical evidence suggests that partial pass through is widespread,[38] it therefore appears to follow that imperfect competition must also be widespread. However, one of the consequences of this paper is to suggest that this inference is not warranted. It is not valid to infer imperfect competition based solely on partial pass through of the exchange rate. We have shown that partial pass through can also obtain in competitive markets with constant returns to scale, if markets for inputs are global. Casual observation suggests that the use of globally traded inputs is widespread among manufacturing as well as service industries.

One specific application of exchange rate pass through arises in antitrust policy. The effect of exchange rate changes on the volume of imports is a factor that has been considered in defining geographic markets for antitrust cases. Landes and Posner (1981) argue that when foreign firms sell to the United States, all of their output, not merely shipments to the United States, should be included in the definition of the geographic market. The Landes-Posner position is based on _a priori_ analysis of the price elasticity of import supply, which they show to be relatively elastic. This issue has sparked debate among antitrust lawyers and economists. The argument is that there are several reasons to

[38] Hooper and Mann (1989) estimate that the long run exchange rate pass through for U.S. imports of manufactured goods was between 50 and 60 percent in the 1980s. Also see "Passing the buck," _Economist_, Feb. 11, 1989, p. 63.

expect that imports may not be very responsive to domestic price changes (e.g., due to transportation constraints, difficulties in expanding distribution facilities in the United States). In any event this is an empirical question. For example, the results presented by Hay, Hilke, and Nelson (1988) suggest that imports are not very responsive to exchange rate changes. However, they assume that exchange rate changes correctly measure the magnitude of changes in domestic to foreign prices for particular products, i.e., that there is full pass through of exchange rate changes.[39] As argued above, we expect to observe partial pass through in competitive industries, if they use globalized inputs. In these cases, exchange rate movements will overstate changes in relative supply prices (domestic vs. imports): we may falsely conclude that imports are relatively unresponsive to price changes and incorrectly reject Landes-Posner.

Another issue concerns economies of scope for domestic and export products and the consequent link between imports and exports in a particular product grouping. As noted, constant returns to scale for an aggregate product (comprised of domestic and export varieties) together with a constant elasticity of transformation between the domestic and export varieties implies that there are economies of scope for each variety. One interesting implication

[39] Hay, Hilke, and Nelson (1988), pp. 734-5, calculate the elasticity of net imports (value of imports minus exports) with respect to exchange rate change (multilateral trade-weighted exchange rate) for twenty-four four-digit SIC industries between 1980 and 1981. They find that the elasticity is generally small. For ten cases the elasticity is negative.

of this result is that a policy that restricts imports also increases exports. We have analyzed this situation above, in section V, and illustrated it in Figure 4. The argument that import protection is export promotion has been made previously by Krugman (1984). However, Krugman's case relies on economies to scale in domestic production (domestic product and export product are homogeneous). There is a major policy difference between these two situations. In our case, import protection unambiguously lowers national welfare. In Krugman's case, welfare effects are problematic because of second best considerations. Therefore, even if import protection promotes exports,[40] the emphasis in policy analysis should be careful examination of production conditions in the relevant industry.

VII. Conclusion

This paper constructs a computable, partial equilibrium model to test whether a depreciation of the U.S. dollar would have rendered the 1984 steel VRAs ineffective by 1989. The U.S. dollar depreciated by 36 percent between 1984 and 1989. We find that the answer is negative. Whether the exchange rate depreciation was sufficiently large to render the VRAs ineffective is an empirical

[40] We are aware of only one extensive empirical study of the import protection as export promotion argument. This is an interesting paper by Dick (1994), who examines 200 U.S. industries at the 4-digit SITC level in the mid 1970s. His econometric results largely reject the argument.

question. Indeed, we can apply our model to solve for the threshold exchange rate depreciation that just makes the VRAs nonbinding. That depreciation is found to be 41 percent.

Our principal result is for a case where material inputs into steel and "autos" are globalized and priced in U.S. dollars. Under these conditions, there is partial pass-through of the exchange rate, a case that appears to receive wide support among empirical researchers. In contrast, when we consider the less plausible case where material inputs are not globalized there is full pass-through of the exchange rate. In this case, the depreciation renders the steel VRAs nonbinding.

Three additional points are emphasized in this paper. First, when analyzing the effects of exchange rate changes on specific imported products, it is important to distinguish between final goods and intermediate goods. A depreciation of the exchange rate creates a substitution effect, which reduces imports generally, but also creates an income-output effect due to the expansion in domestic production, which increases demand for intermediate goods generally. The net impact on intermediate imports is ambiguous.

Second, the effects of exchange rate changes on imports are muted when both domestic and foreign producers use world traded inputs. Globalization of markets for standardized inputs links supply prices of user firms throughout the world. Changes in exchange rates do not alter this relationship among user firms. Accordingly, exchange rate changes will have a smaller effect on relative supply prices of domestic and foreign producers to the home market and also a smaller effect on imports.

Third, and a consequence of the second point, partial pass through of exchange rate does not necessarily signal market imperfections or monopoly power. If all producers use a world traded input, partial pass through will be observed even when industries are perfectly competitive and operate under conditions of constant costs.

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APPENDIX A

MODEL

I. Introduction

The model used to estimate the effect on steel imports of changes in the foreign exchange rate is a partial equilibrium model that assumes all markets are perfectly competitive. The principal features of the model are as follows. Steel is a modelled as a pure intermediate product that is used in the production of a final tradeable product, which is referred to as "autos." The most noteworthy aspect of the model is the treatment of inputs. Inputs into autos and steel are divided into two types: nontraded and traded. Prices of nontraded inputs are exogenous and fixed in terms of the relevant foreign currency. In contrast, traded inputs are assumed to be traded on world markets at prices that are denominated in terms of U.S. dollars, and are also assumed to be exogenous. However, changes in the foreign exchange rate will affect local currency prices of traded inputs in foreign countries. Our interest is with the effects of changes in foreign exchange rate.

In other respects our model follows the familiar approach adopted by empirical researchers of international trade policy issues.[1] In particular, our model incorporates product differentiation for both steel and autos. We assume that there are significant differences between domestic and imported products, and also between domestic and exported products. Specifically, domestic consumption of composite steel and composite autos are constant elasticity of substitution (CES) functions of domestic and imported varieties. Domestic output of aggregate steel and autos is a constant elasticity of transformation (CET) function of product varieties destined for domestic and export markets. Prices on products imported from or exported to world markets are treated as exogenous ("small" country assumption) and supply prices of aggregate products produced domestically are constant, which assumes constant returns to scale.

II. Model

Demand and Supply for Final Steel-Using Product

The demand for the final product ("autos") in which steel is consumed as an intermediate input is assumed to be a constant elasticity function of price, as shown in equation (1):

$$D_{AC} = \alpha_{AC} * P_{AC}^{-\epsilon_{AC}} \tag{1}$$

where D_{AC} is the quantity of autos demanded and P_{AC} is the price of autos. D_{AC} is a composite product and comprised of domestic (D_{AD}) and imported (D_{AF}) varieties, as indicated by the CES function:

[1] See for example, Jaime DeMelo and David Tarr (1992), A General Equilibrium Analysis of US Foreign Trade Policy, MIT Press: Cambridge, MA.

$$D_{AC} = AC[B_{AC} * D_{AD}^{\rho_{AC}} + (1-B_{AC}) * D_{AF}^{\rho_{AC}}]^{1/\rho_{AC}}$$

where $\rho_{AC} < 1$. The elasticity of substitution between domestic and imported autos (σ_{AC}) is related to ρ_{AC} by $\sigma_{AC} = 1/(1-\rho_{AC})$.

Given the quantity of composite autos, consumers demand domestic and imported varieties to minimize total expenditure on autos. Thus, the demand for each variety of autos and the average price of autos are obtained from the first order conditions of the following optimization problem. The Langrangian function L is minimized with respect to D_{AD}, D_{AF}, and λ_D:

$$MIN \quad L = P_{AD} * D_{AD} + P_{AF} * D_{AF} + \lambda_D [D_{AC} - CES(D_{AD}, D_{AF})]$$

This gives equations (2) to (4). By definition, the composite price P_{AC} equals $(P_{AD}*D_{AD} + P_{AF}*D_{AF})/D_{AC}$, but in this case it also takes the specific form indicated in equation (4).

$$D_{AD} = AC^{(\sigma_{AC}-1)} * B_{AC}^{\sigma_{AC}} * (P_{AD}/P_{AC})^{-\sigma_{AC}} * D_{AC} \tag{2}$$

$$D_{AF} = AC^{(\sigma_{AC}-1)} * (1 - B_{AC})^{\sigma_{AC}} * [(P_{AF} * ER)/P_{AC}]^{-\sigma_{AC}} * D_{AC} \tag{3}$$

$$P_{AC} = AC^{-1}[B_{AC}^{\sigma_{AC}} * P_{AD}^{1-\sigma_{AC}} + (1-B_{AC})^{\sigma_{AC}} * (P_{AF} * ER)^{1-\sigma_{AC}}]^{1/(1-\sigma_{AC})} \tag{4}$$

where P_{AD} is the domestic currency price of domestic autos, P_{AF} is the foreign currency price of foreign autos, and ER is the exchange rate (domestic currency relative to foreign currency). Since domestic demand for imports depends on the domestic currency price of imports, it is necessary to multiply the foreign price by the exchange rate. Finally, observe in equation (4) that P_{AC} is CES in P_{AD} and P_{AF}, since $1-\sigma_{AC} < 1$.

The domestic auto industry produces two varieties of autos, those supplied to the domestic market, S_{AD}, and those supplied to the export market, S_{AX}, as described by the CET function:

$$Q_{AD} = AX[B_{AX} * S_{AX}^{\rho_{AX}} + (1-B_{AX}) * S_{AD}^{\rho_{AX}}]^{1/\rho_{AX}}$$

where Q_{AD} is aggregate domestic auto output, $\rho_{AX} > 1$, and the constant elasticity of transformation between domestic and export varieties is $\sigma_{AX} = 1/(\rho_{AX}-1)$.

Given aggregate auto output, domestic firms supply quantities to domestic and foreign markets to maximize total revenues. The supply functions and aggregate supply price are obtained from the first order conditions of the following optimization problem. The Lagrangian function is maximized with respect to S_{AD}, S_{AX}, and λ_S, which is the average price of aggregate auto output (P_{QAD}):

$$MAX \quad L = P_{AD} * S_{AD} + P_{AX} * S_{AX} + \lambda_S [Q_{AD} - CET(S_{AD}, S_{AX})]$$

This gives equations (5) to (7):

$$S_{AX} = AX^{-(\sigma_{AX}+1)} * B_{AX}^{-\sigma_{AX}} * [(P_{AX} * ER)/P_{QAD}]^{\sigma_{AX}} * Q_{AD} \tag{5}$$

$$S_{AD} = AX^{-(\sigma_{AX}+1)} * (1 - B_{AX})^{-\sigma_{AX}} * [P_{AD}/P_{QAD}]^{\sigma_{AX}} * Q_{AD} \tag{6}$$

$$P_{QAD} = AX^{-1} [B_{AX}^{-\sigma_{AX}} * (P_{AX} * ER)^{\sigma_{AX}+1} + (1 - B_{AX})^{-\sigma_{AX}} * P_{AD}^{\sigma_{AX}+1}]^{1/(\sigma_{AX}+1)} \tag{7}$$

Finally, observe in equation (7) that P_{QAD} is CET in P_{AX} and P_{AD}, since $\sigma_{AX} + 1 > 1$.

Demand and Supply for Steel

Steel is assumed to be a pure intermediate input that is used in producing tradeable goods ("autos") and nontradeable goods. Total steel demand (D_{SC}) is given in equation (8):

$$D_{SC} = D_{SAD} + D_{SND} \tag{8}$$

where D_{SAD} and D_{SND} are steel demands by the domestic auto and nontraded goods industries, respectively. The latter is treated as exogenous. The former is assumed to be a fixed proportion of domestic auto production, as shown in equation (9):

$$D_{SAD} = IO_{SAD} * Q_{AD} \tag{9}$$

where IO_{SAD} is a constant input-output coefficient.

Given total demand for steel, auto producers minimize total cost expenditures on domestic and foreign steel varieties. In an analogous procedure to the derivation of equations (2) to (4), this yields the demand equations for the domestic (D_{SD}) and foreign (D_{SF}) varieties, and the average price of composite steel (P_{SC}), as shown in equations (10) to (12):

$$D_{SD} = SC^{\sigma_{sc}-1} * B_{SC}^{\sigma_{sc}} * (P_{SD}/P_{SC})^{-\sigma_{sc}} * D_{SC} \tag{10}$$

$$D_{SF} = SC^{\sigma_{sc}-1} * (1 - B_{SC})^{\sigma_{sc}} * [(P_{SF}*ER)/P_{SC}]^{-\sigma_{sc}} * D_{SC} \tag{11}$$

$$P_{SC} = SC^{-1}[B_{SC}^{\sigma_{sc}} * P_{SD}^{1-\sigma_{sc}} + (1 - B_{SC})^{\sigma_{sc}} * (P_{SF}*ER)^{1-\sigma_{sc}}]^{1/(1-\sigma_{sc})} \tag{12}$$

The supply equations for steel are derived analogously to the derivation of equations (5) to (7). Given total steel output (Q_{SD}), domestic steel firms maximize total revenues from sales to domestic (S_{SD}) and foreign (S_{SX}) markets, and receive an average price of (P_{QSD}), which is a weighted average of domestic (P_{SD}) and export (P_{SF}) prices. This gives equations (13) to (15):

$$S_{SD} = SX^{-\sigma_{sx}-1} * (1 - B_{SX})^{-\sigma_{sx}} * (P_{SD}/P_{QSD})^{\sigma_{sx}} * Q_{SD} \tag{13}$$

$$S_{SX} = SX^{-\sigma_{sx}-1} * B_{SX}^{-\sigma_{sx}} * [(P_{SX}*ER)/P_{QSD}]^{\sigma_{sx}} * Q_{SD} \tag{14}$$

$$P_{QSD} = SX^{-1}[B_{SX}^{-\sigma_{sx}} * (P_{SX}*ER)^{\sigma_{sx}+1} + (1 - B_{SX})^{-\sigma_{sx}} * P_{SD}^{\sigma_{sx}+1}]^{1/(\sigma_{sx}+1)} \tag{15}$$

Production of Autos and Steel

Autos and steel, both domestic and foreign, are assumed to be produced under conditions of constant cost. Production functions are CES functions of value added and Leontief functions of intermediate inputs. Average total or unit cost is therefore independent of scale and equal to the sum of fixed IO coefficients times the appropriate input prices.

With respect to pricing behavior there is an important distinction between traded inputs and nontraded inputs. Traded inputs are assumed to be denominated in U.S. dollars. Nontraded input prices are demonated in the currency where production takes place.

In the case of domestic autos, average unit cost (UC_{QAD}) is shown in equation (16):

$$UC_{QAD} * (1 - TX_{AD}) = IO_{VAD} * PVA_{AD} + IO_{SAD} * P_{SC} + IO_{WAD} * P_{WA} \tag{16}$$

PVA_{AD} is the price of value added in autos, as before P_{SC} is the average price of composite steel, and P_{WA} is the price of non-steel intermediate inputs. TX_{AD} is the indirect tax rate for autos.

The value added production function for domestic autos is the CES function:

$$VA_{AD} = AD[B_{AD} * L_{AD}{}^{\rho_{AD}} + (1 - B_{AD}) * K_{AD}{}^{\rho_{AD}}]^{1/\rho_{AD}}$$

where L_{AD} and K_{AD} are labor and capital in domestic autos, $\rho_{AD} < 1$, and the elasticity of substitution between labor and capital is $\sigma_{AD} = 1/(1-\rho_{AD})$. The dual for the production function, the price/unit cost of value added in autos, is given in equation (17):

$$PVA_{AD} = AD^{-1}[B_{AD}{}^{\sigma_{AD}} * W_D^{(1-\sigma_{AD})} + (1 - B_{AD})^{\sigma_{AD}} * R_A{}^{(1-\sigma_{AD})}]^{1/(1-\sigma_{AD})} \tag{17}$$

where W_D and R_A are the domestic wage rate and world rental rate for capital in autos.

For foreign autos, the equations for unit cost and price of value added are similar to the corresponding domestic equations, and are given in equations (18) and (19):

$$P_{AF} * (1 - TX_{AF}) = IO_{VAF} * PVA_{AF} + IO_{SAF} * P_{SF} + IO_{WAF} * (P_{WA}/ER) \tag{18}$$

$$PVA_{AF} = AF^{-1}[B_{AF}{}^{\sigma_{AF}} * W_F^{(1-\sigma_{AF})} + (1 - B_{AF})^{\sigma_{AF}} * (R_A/ER)^{(1-\sigma_{AF})}]^{1/(1-\sigma_{AF})} \tag{19}$$

where W_F is the foreign wage rate.

Note that prices of intermediate inputs and capital are assumed to be determined on world markets and expressed in U.S. dollars. Therefore in equations (18) and (19) these prices are divided by the exchange rate to convert them to foreign currency units.

In the case of domestic steel, unit cost is given in equation (20):

$$UC_{QSD} * (1 - TX_{SD}) = IO_{VSD} * PVA_{SD} + IO_{WSD} * P_{WS} \tag{20}$$

where, since value added in steel is a CES function of labor and capital, the price of steel value added (PVA_{SD}) is as shown in equation (21):

$$PVA_{SD} = SD^{-1}[B_{SD}{}^{\sigma_{SD}} * W_D{}^{1-\sigma_{SD}} + (1 - B_{SD})^{\sigma_{SD}} * R_S{}^{1-\sigma_{SD}}]^{1/(1-\sigma_{SD})} \tag{21}$$

where R_S is the world rental price of capital for the steel industry.

The corresponding equations for the foreign steel industry are (22) and (23):

$$P_{SF} * (1 - TX_{SF}) = IO_{VSF} * PVA_{SF} + IO_{WSF} * (P_{WS}/ER) \tag{22}$$

$$PVA_{SF} = SF^{-1}[B_{SF}{}^{\sigma_{SF}} * W_F{}^{1-\sigma_{SF}} + (1 - B_{SF})^{\sigma_{SF}} * (R_S/ER)^{1-\sigma_{SF}}]^{1/(1-\sigma_{SF})} \tag{23}$$

The equilibrium conditions for the model state that the demands for domestic varieties of autos and steel equal their respective supplies, equations (24) and 25), and that the average prices of domestic autos and steel equal their respective unit costs, equations (26) and 27):

$$D_{AD} = S_{AD} \tag{24}$$

$$D_{SD} = S_{SD} \tag{25}$$

$$P_{QAD} = UC_{QAD} \tag{26}$$

$$P_{QSD} = UC_{QSD} \tag{27}$$

We also assume that when domestic firms sell exported varieties of autos and steel they receive the average prices of foreign produced autos and steel. This is expressed in equations (28) and (29):

$$P_{AX} = P_{AF} \tag{28}$$

$$P_{SX} = P_{SF} \tag{29}$$

Finally, we close the model by fixing the exchange rate, ER, the domestic demand for steel used by producers of nontraded products, D_{SND}, the prices of the world traded inputs, P_{WS}, P_{WA}, R_A, R_S, and the domestic and foreign wage rates, W_D and W_F. The remaining 29 variables in the model are endogenous, and listed in Table A1.

TABLE A1
ENDOGENOUS VARIABLES IN MODEL

1. D_{AC}	Demand for composite autos consumed domestically
2. D_{AD}	Demand for domestic variety of autos
3. D_{AF}	Demand for imported variety of autos
4. S_{AD}	Supply of domestic variety of autos
5. S_{AX}	Supply of export variety of autos
6. Q_{AD}	Total output of domestic autos
7. P_{AC}	Price of composite autos (USD)
8. P_{AD}	Price of domestic variety of autos (USD)
9. P_{AF}	Price of imported variety of autos (for cur)
10. P_{AX}	Price of export variety of domes autos (for cur)
11. P_{QAD}	Average price of total domestic auto output (USD)
12. UC_{QAD}	Unit cost of domestic autos (USD)
13. D_{SAD}	Demand for steel in domestic tradeables
14. D_{SC}	Demand for composite steel
15. D_{SF}	Demand for imported variety of steel
16. D_{SD}	Demand for domestic variety of steel
17. S_{SD}	Supply of domestic variety of steel to domes mkt
18. S_{SX}	Supply of export variety of steel
19. Q_{SD}	Total production of domestic steel
20. P_{SC}	Price of composite steel (USD)
21. P_{SD}	Price of domestic variety of steel (USD)
22. P_{SF}	Price of imported variety of steel (for cur)
23. P_{SX}	Price of export variety of domes steel (for cur)
24. P_{QSD}	Average price of domestic steel output (USD)
25. UC_{QSD}	Unit cost of domestic steel (USD)
26. PVA_{AF}	Value added price of foreign autos (for cur)
27. PVA_{AD}	Value added price of domestic autos (USD)
28. PVA_{SD}	Value added price of domestic steel (USD)
29. PVA_{SF}	Value added price of foreign steel (for cur)

APPENDIX B

DATA USED IN MODEL

The model presented in Appendix A is benchmarked to annual data for year 1984. The steel industry is represented by Bureau of Economic Analysis (BEA) industry 37 (Primary iron and steel manufacturing), and steel-using tradeables industries ("autos") are represented by a group of 26 BEA industries (see Table B3). Most data were obtained from the 1984 U.S. input-output table.[1] Other data were estimated using methods and sources described in Table B2.

Steel Industry

All values described below are annual data for 1984 for Primary Iron and Steel Manufacturing, BEA industry 37. All values are in millions of U.S. dollars.

Steel exports are $1,318 (XSD0) and steel imports are $12,670 (DSF0). The net value of domestic steel production is gross industry output ($67,964) minus intermediate consumption of steel ($11,044), or $56,920 (QSD0).

The value of tradeable inputs into domestic steel is total intermediate inputs ($41,356) minus the primary iron and steel intermediates ($11,044) plus the estimated "other" value added[2] ($4,264, derived in table B2), or $34,576 (WSD0).

The value of nontradeable inputs into domestic steel (i.e., labor compensation and indirect taxes) is total value added ($26,608) minus the estimated "other" value added ($4,264), or equal to $22,344 (ZSD0).

U.S. produced steel consumed in the U.S. is net value of domestic steel output ($56,920) minus steel exports ($1,318), or $55,602 (DSD0). This amount ($55,602) plus steel imports ($12,670) is apparent steel consumption in the U.S., $68,272 (DSC0).

Major Steel-Using Tradeables Sectors

All values described below are for the 26 BEA industries that represent steel-using tradeables industries. These industries are listed in Table B#. All values are in millions of U.S. dollars.

Exports by steel-using tradeables sectors are $93,147 (XAD0) and imports of steel-using tradeables are $137,945 (DAF0). The amount of steel used in the production of tradeables is

[1] U.S. Department of Commerce, Bureau of Economic Analysis, "Annual Input-Output Accounts of the U.S. Economy, 1984," Survey of Current Business, Nov. 1989, pp. 25-40, Table 1.

[2]Note that the total value added is the sum of compensation to employees, indirect taxes, and "other" value added (i.e., returns to owners of capital). Only compensation to employees and indirect taxes are nontradeable.

$55,022 (SADO). The amount of steel used in nontradeable sectors is apparent steel consumption in the U.S. ($68,272, DSCO) minus steel used in tradeables ($55,022), or $13,250 (SNDO).

The amount of domestic nontraded inputs in U.S. steel-using tradeables is the sum of estimated compensation to employees ($268,881, derived in Table B2) and indirect taxes ($8,956, derived in Table B2), or $277,837 (ZADO). The amount of tradeable inputs (excluding steel) in the U.S. steel-using tradeables sectors is the sum of all intermediates consumed (excluding steel and BEA steel-using tradeables)[3] ($312,492) plus the estimated "other" value added ($60,636, derived in Table B2), or $373,128 (WADO).

The amount of domestic production of steel-using tradeables is found by adding steel used in tradeables ($55,022), tradeable inputs (excluding steel) used in tradeables ($373,128), and nontraded inputs used in tradeables ($277,837), which equals $705,987 (QADO).

For U.S. apparent consumption of U.S. produced steel-using tradeables, subtract exports of steel-using tradeables ($93,147) from domestic production of U.S. steel-using tradeables ($705,987), or $612,840 (DADO). Total U.S. apparent consumption of steel-using tradeables is sum of U.S. apparent consumption of U.S. produced steel-using tradeables ($612,840) and imports of steel-using tradeables ($137,945), or $750,785 (DACO).

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[3]This value represents consumption of intermediate inputs by steel-using tradeables sectors net of intra-industry consumption.

TABLE B1

Data (1984) Used in Model

VARIABLE NAME	VALUE (Mn)	DESCRIPTION
XSD0	$1,318	Value of U.S. steel exports
DSF0	$12,670	Value of U.S. steel imports
QSD0	$56,920	Value of U.S. steel production QSD0 = WSD0 + ZSD0
WSD0*	$34,576	Value of tradeable inputs used in U.S. steel production
ZSD0*	$22,344	Value of nontraded inputs used in U.S. steel production
DSD0	$55,602	Value of U.S. steel production consumed in U.S. DSD0 = QSD0-XSD0
DSC0	$68,272	Value of apparent steel consumption in U.S. DSC0 = DSD0 + DSF0 = SAD0 + SND0
XAD0	$93,147	Value of exports of U.S. produced steel-using tradeables
DAF0	$137,945	Value of U.S. imports of steel-using products
SAD0	$55,022	Value of steel used in U.S. to produce steel-using tradeable products
SND0	$13,250	Value of steel used in U.S. to produce nontradeable products
ZAD0	$277,837	Value of domestic nontraded inputs used in U.S. to produce steel-using tradeable products
WAD0*	$373,128	Value of tradeable inputs (excluding steel) used in U.S. to produce steel-using tradeable products
QAD0*	$705,987	Value of U.S. production of steel-using tradeables QAD0 = SAD0 + ZAD0 + WAD0
DAD0	$612,840	Value of U.S. apparent consumption of U.S. produced steel-using tradeables DAD0 = QAD0-XAD0
DAC0	$750,785	Value of U.S. apparent consumption of steel-using products traded in world markets (tradeables) DAC0 = DAD0 + DAF0

*Variables contain estimated values (see Table B2).

TABLE B2

Estimates of Certain Variables
(Values in millions of U.S. dollars)

I. BEA industry 37, Primary iron and steel manufacturing

A. 1984 Compensation of Employees

Compensation of employees, primary metal industries[4]
(Survey of Current Business Table 6.4B)

1982	1984	Percent Change
30,198	30,401	+0.067222

1982 compensation of employees, BEA #37 = 21,285

1984 estimated compensation of employees, BEA #37
21,285 x 1.0067222 = 21,427

B. 1984 Indirect Business Taxes

Total industry output, BEA #37

1982	1984
59,033	67,964

1982 indirect business taxes, BEA #37 = 797

Ratio of indirect business taxes to total industry output
797 ÷ 59,033 = 0.0135

1984 estimated indirect business taxes, BEA #37
0.0135 x 67,964 = 918

C. 1984 "Other" Value Added

1984 total value added, BEA #37 = 26,608

Estimated 1984 compensation of employees + indirect business taxes
21,427 + 918 = 22,344

1984 estimated "Other" value added, BEA #37

[4]The category "primary metal industries" corresponds closely to BEA industry number 37, primary iron and steel industries. See notes for source information.

26,608 - 22,344 = **4,264**

1984 estimated "other" value added was used to calculate the variables WSDO and ZSDO.

II. Major Steel-Using Tradeable Sectors "major sectors" (see Table B3)

A. 1984 Compensation of Employees

Compensation of employees, major sectors[5] (Survey of Current Business Table 6.4B)

1982	1984	Percent Change
215,515	253,501	+17.6257

1982 compensation of employees, BEA major sectors = 228,590

1984 estimated compensation of employees, major sectors
228,590 x 1.176257 = **268,881**

B. 1984 Indirect Business Taxes

The ratio of 1982 indirect business taxes to 1982 total industry output for each of the major sectors (BEA industry) was multiplied by the corresponding value for 1984 total industry output for each of the major sectors. These values represented 1984 estimated indirect business taxes for each of the major sectors. The addition of the 1984 estimated indirect business taxes for each major sector gives

1984 estimated indirect business taxes for all major steel-using tradeables = **8,956**

C. 1984 "Other" Value Added

1984 Total value added, BEA major sectors = 338,473

Estimated 1984 compensation of employees + indirect business taxes
268,881 + 8,956 = 277,837

1984 Estimated "Other" value added, BEA major sectors
338,473 - 277,837 = **60,636**

Estimated values for compensation of employees and indirect business taxes were used to calculate the variables WADO and QADO.

[5]The group of "major sectors" here corresponds closely to the group of 26 BEA industries and is defined in the notes at the end of this appendix.

TABLE B3 (Part I)

Major Steel-Using Tradeable Sectors in BEA Classification

BEA INDUSTRY	DESCRIPTION
13	Ordnance and Accessories
22	Household furniture
23	Other furniture and fixtures
39	Metal containers
40	Heating, plumbing, and fabricated structural metal products
41	Screw machine products and stampings
42	Other fabricated metal products
43	Engines and turbines
44	Farm and garden machinery
45	Construction and mining machinery
46	Materials handling machinery
47	Metal-working machinery and equipment
48	Special industry machinery and equipment
49	General industrial machinery and equipment
50	Miscellaneous machinery, except electrical
51	Office, computing, and accounting machines
52	Service industry machines
53	Electric industrial equipment and apparatus
54	Household appliances
55	Electric lighting and wiring equipment
56	Radio, TV, and communication equipment
57	Electronic components and accessories
58	Miscellaneous electrical machinery and supplies
59	Motor vehicles and equipment
60	Aircraft and parts
61	Other transportation equipment

TABLE B3 (Part II)

Major Steel Using Tradeable Sectors in
Survey of Current Business Classification

1. Furniture and fixtures
2. Fabricated metal products
3. Machinery, except electrical
4. Electric and electronic equipment
5. Motor vehicles and equipment
6. Other transportation equipment

SOURCES

U.S. Dept. of Commerce, Bureau of Economic Analysis, "Annual Input-Output Accounts of the U.S. Economy, 1984," Survey of Current Business, November 1989, pp. 25-40.

______________, "Benchmark Input-Output Accounts for the Economy, 1982," Survey of Current Business, July 1991, pp. 30-71.

______________, Survey of Current Business, July 1986, p. 65 (Table 6.4B).