WORKING PAPER

TRADE PROTECTION AND INDUSTRIAL REVITALIZATION:

American Steel in the 1980s

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Executive Summary

In the early 1980s, the U.S. steel industry found itself in an increasingly competitive market. Due to anti-inflationary monetary policy, the U.S. dollar was artificially strong, causing a sharp decline in the price of steel imports. Further, the industry was struggling to overcome the debilitating effects of the 1982 recession. The filing of petitions for antidumping, countervailing duty, and escape clause relief with the U.S. International Trade Commission (ITC) in 1982-84 alerted the government that the U.S. steel industry would not be able to recover without protection. Rather than allow the ITC cases to go through, the Reagan Administration negotiated a series of Voluntary Restraint Agreements (VRAs) with the major steel-producing nations. The VRAs limited the volume of steel imports to about 20 percent of the U.S. market.

However, even when the recession ended and the dollar returned to a more sustainable level, the steel industry was unable to recover completely, despite the fact that its cost efficiency relative to other nations had improved dramatically. The authors of this report find that U.S. steel production capacity was permanently reduced by the combination of the deep recession and the overvalued dollar after 1982. This irreversible scarring of a part of the U.S. manufacturing base was costly for workers in steel and related industries, and for the economy as a whole. This paper examines the long-term effects of the recession and the overvalued U.S. dollar on the steel industry; the impact of the VRAs and increased investment on the competitiveness of the U.S. steel industry; the cost of protecting the steel industry using VRAs and other available policies; and the implications for future policies for the steel industry, including the current round of countervailing duty and antidumping cases.

The authors conclude that trade protection for the steel industry *was* warranted in the 1980s in order to offset the damage caused by foreign unfair trade practices, the overvalued dollar, and the persistent effects of the 1982 recession. In addition, restricting imports helped the industry to become more efficient. The industry took advantage of the "breathing room" offered by the VRAs to increase investment and raise productivity. However, the specific *form* of protection (VRAs) was much more costly to the country than was necessary.

The findings of this study are especially relevant at this time because the United States is on the verge of developing a new trade policy for the steel industry, in response to a series of unfair trading complaints which domestic producers lodged against foreign steelmakers in 1992. The authors argue that if the unfair trade complaints are sustained, then import duties or auction quotas should be used to provide relief for domestic producers, rather than another set of VRAs.

Specific findings include:

- The allegedly high "consumer costs of protection" in steel (the increase in prices paid by U.S. steel consumers as a result of the VRAs) were in fact more than offset by the *fall* in the price of steel caused by the overvalued dollar and the global oversupply of steel. In other words, consumers of steel were better off in the mid-1980s than they would have been if the dollar had not risen *and* there had been no VRAs. The price of imported steel *fell* by 17 percent between 1981 and 1983, while the VRAs *increased* the prices of imported steel by less than 10 percent between 1984 and 1989.

- The great majority of the net national costs of the steel VRAs consist of benefits to foreign producers: i.e., restricting imports allows their price to rise, and those gains are reaped by foreign producers. A more efficient and cost-effective form of trade protection would allow the U.S. government to capture those benefits, as this would allow a given level of trade restriction to be implemented at the lowest possible cost to the nation as a whole. Two such options are a global auction quota, where the U.S. government sells the quota rights to foreign producers, or a tariff duty on imports. In either case, the U.S. government would collect revenues which could be used to help the industry modernize or to retrain workers. Under the 1984 agreement, the exporting countries collected the revenues from the higher steel prices which resulted from the VRAs.

- The net national cost of the steel VRAs averaged $984 million per year over the 1984-89 period. If an auction quota or tariff had been used instead of the VRAs to achieve the same level of protection, the net national cost would have been only $116 million per year, on average. Since steel workers and employees in supplier industries reaped benefits of $246 million per year in jobs and income saved by the VRAs, then it is clear that trade protection of a revenue-generating form could have had positive net national benefits in the mid-1980s.

- The increased investment in the steel industry in the late 1980s made an important contribution to productivity growth during that time. In fact, the capital-labor ratio turns out to be the most significant variable in explaining productivity growth in the steel industry in the 1980s. Therefore, policies that encourage productivity-enhancing investment, such as the 1984 requirement that steel companies reinvest their net cash flow into the industry, should be continued.

- The deep employment and capacity losses suffered by the steel industry in the 1980s reflected the long-lasting impacts of the 1982 recession and the artificially high value of the dollar from 1980 to 1985. Due to high fixed costs and the need to constantly upgrade the technology of the steel industry, temporary production cutbacks can have permanent repercussions.

- Therefore, trade policy should be triggered relatively quickly, either by an unwarranted rise in the value of the dollar or by a sudden fall in the price of imports. Current trade laws, such as Section 201, which require the industry to show that injury has already occurred, should be amended to avert this "permanent scarring" effect. This scarring caused significant loss of jobs in the U.S. steel industry in the 1980s, resulting in a net loss to the economy of $6.7 billion.

- The United States should continue to participate in multilateral steel negotiations, so that policies on steel subsidies and capacity reductions can be rationalized in an international forum. While these negotiations have recently reached an impasse, efforts to manage global steel production and trade should continue in order to distribute the burdens of adjustment more equitably among steel-producing nations.

1. Introduction and Historical Background

In the early 1980s, the U.S. steel industry suffered its worst crisis ever, when capacity utilization fell to 49.5 percent (from a high of almost 90 percent during the late 1970s) and profits were negative for five years in succession. Steel companies closed plants and permanently laid off workers (including managers and supervisors, as well as production workers) at a record pace. Total employment plummeted from almost 400,000 in 1980 to 208,000 in 1985 and fell further to 164,000 in 1990 — before the recent recession. Global excess capacity, caused by over-building in the 1970s and substantial subsidies by foreign governments, increased the pressure on domestic producers.[1]

Steel imports surged dramatically in the late 1970s and early 1980s. This resulted in a flood of antidumping, countervailing duty, and escape clause petitions from domestic steel producers and steelworkers, beginning in 1982. The Reagan Administration settled these complaints by enacting a series of voluntary restraint agreements (VRAs) with major foreign steel producers, beginning with European producers in 1982 and with other countries in 1984. Upon the urging of the United Steelworkers' union, Congress then passed a sense of Congress resolution calling upon domestic steel producers to reinvest essentially all of their cash flow in upgrading their steelmaking facilities and establishing worker retraining programs (Hufbauer et al., 1986, p. 171).

In March of 1992, the Bush Administration allowed the VRAs, which were no longer binding in many categories, to expire. They encouraged domestic producers to file antidumping and countervailing duty petitions if they felt that imports were being unfairly traded. In June 1992, U.S. steel producers filed 84 charges of unfair trading against producers from 21 countries. The Commerce Department and the U.S. International Trade Commission (which share responsibility for these cases) have both issued preliminary rulings in favor of domestic producers in these cases. Final rulings are expected in these cases in mid-1993.

This study finds that protection of the industry in the 1980s was justified on economic grounds. However, the VRAs were an unnecessarily costly form of protection which resulted in excessive net national losses for the United States. A simple tariff or an auction quota would have generated net national benefits when the gains in labor income are taken into account. These results suggest that the Clinton Administration should accept the findings of the Commerce Department in these cases (which are likely to result in the imposition of duties on the unfair imports). The new administration could negotiate an auction quota, in place of duties in the subsidy cases. However, the administration should not negotiate another VRA or any other simple quantitative barrier to imports, because such measures are much more costly to the country than revenue-generating forms of protection.

The VRAs, the reinvestment requirement, and the new trade complaints have all come under attack from mainstream economists. Free traders argue that trade protection only props up an inefficient and dying industry, while also imposing high costs on steel consumers. Few consider the potential benefits of allowing the industry some relief from imports while it attempts to improve its competitiveness. This report analyzes the effects of trade and trade restraints on the U.S. steel industry; evaluates the major economic arguments against trade protection in this industry; and considers the implications of the findings for future trade and industrial policies for the steel sector.

We challenge the view that the VRAs were merely a costly form of subsidy to steelworkers and steel firms. This view ignores the economic environment in which the steel industry was operating in the 1980s. In the early 1980s, the U.S. steel industry was beset by a confluence of both long-term structural problems and by two macroeconomic shocks: the worst recession since the 1930s, which drastically reduced domestic output, and an unprecedented appreciation of the dollar, which made imports artificially cheap. Our research indicates that this unique combination of forces permanently reduced steel output and employment in the United States. The VRAs helped to prevent these losses from being even deeper.

Many economists assume that the effects of recessions or currency distortions are reversible; we show in this report that they were not in the steel industry. When the impact of an event persists, even after the event itself is over, this effect is known as "hysteresis." One of the fundamental problems with the other studies reviewed in this report is that they fail to properly account for the economic costs of hysteresis, or to consider how public policy can be used to minimize these costs. Many studies also ignore the costs to workers who lose their jobs and are unable to find other jobs at equal wages.

The best policy response to the overvaluation of the dollar would have been an alteration in the macroeconomic policies that led to the distortion. Since that was not possible, however, we argue that trade policies to slow the hemorrhaging of jobs were appropriate. While the VRAs did raise the prices of imports somewhat — an average of less than 10 percent each year between 1984 and 1989 — this price increase only partially offset the *decrease* in the price of imported steel brought about by the overvalued dollar. The steel trade-weighted value of the dollar rose by 39 percent between 1980 and 1985 in real terms.[2] Essentially, this meant that consumers of imported goods — including steel — were receiving windfall gains from artificially low import prices. Despite the VRAs, the real price of steel for U.S. consumers fell during this period.[3]

Recent Developments in U.S. Steel Production and Competitiveness

The U.S. steel industry has made enormous strides toward greater efficiency and competitiveness since the VRAs were implemented. A recent *New York Times* article concluded that, "the American steel industry . . . has undergone a transformation in the last decade that has drastically sharpened the industry's competitive position" (Hicks, 1992, p. A1). The ITC similarly found that, "in terms of price, quality, and service, U.S. producers are better able to meet the needs of their domestic and (increasingly) foreign customers [than before 1980]. The rationalization of facilities, continued capital investment, and the implementation of new technologies have contributed to the improvement" (USITC, 1991, p. i). During this period, productivity growth has accelerated, compared with both the past history of the steel industry and with the average for all manufacturing. We argue here that the combination of competitive pressure from the low-cost electric furnace producers (the mini-

Table 1
Basic Indicators for the Steel Industry: 1960 to 1990
Average Annual Rates of Growth

	1960 - 1972	1973 - 1983	1984 - 1990
Labor productivity (production workers)	2.41%	1.20%	4.53%
Labor productivity (all workers)	2.20	0.47	4.80
Producers' price index (PPI) for steel	2.34	9.78	1.75
Aggregate PPI	1.92	8.60	2.10
Labor compensation (real total employment cost per hour worked)*	2.03	3.85	-1.32

*Wages plus fringe benefits for wage employees producing iron and steel products, deflated by the personal consumption expenditure (PCE) deflator.

Source: Productivity and PPI figures from the Bureau of Labor Statistics; labor compensation from American Iron and Steel Institute (AISI), *Annual Statistical Report*, various issues; PCE deflator from U.S. Council of Economic Advisors, *Economic Report of the President, 1991*; and authors' calculations.

mills), and some imports, along with the stability provided by the VRAs, worked to foster higher levels of investment and the resulting productivity growth.

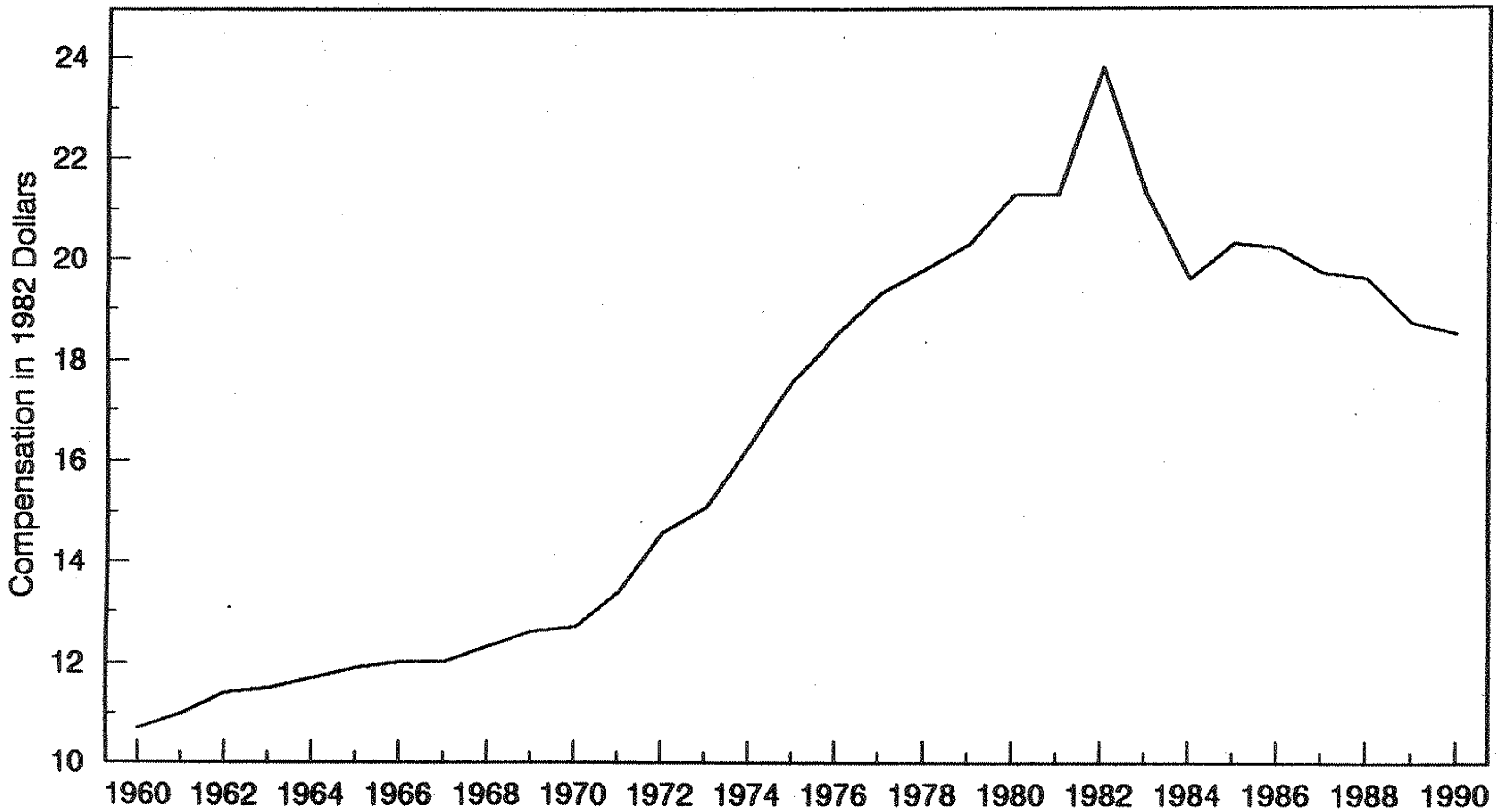
Between 1984 and 1990, output per production worker in the steel industry (Standard Industrial Classification sector 331) grew at an annual average rate of 4.5 percent a year, compared to 2.4 percent a year from 1960 to 1972 and 1.2 percent a year from 1972 to 1983 (see **Table 1**). U.S. labor productivity in steel is now the best in the world: it takes 5.3 person hours to produce a metric ton of cold-rolled steel in the United States, compared to 5.6 person hours per ton in Japan and Canada, and 11.2 person hours per ton in Brazil.[4] (In the early 1980s, it took about ten person hours to produce the same ton of steel in the United States.) The real price of steel (deflated by the aggregate producers' price index) rose in the 1960s and 1970s and then fell between 1984 and 1990. The competitiveness of U.S. steel producers, as reflected by changes in the real price of steel, thus increased during this period.

An increase in the amount of capital invested per worker and retirements of outmoded plants contributed to the rise in productivity growth and the resulting decline in the real price of steel. The reduction in real steel prices was also facilitated by wage concessions on the part of steel workers. Real wages in steel (including the value of fringe benefits) fell sharply after 1982, after rising more or less steadily in the 1960s and 1970s (see **Figure 1**[5]). World steel prices collapsed following the onset of recession in the United States and the slowdown in European and Japanese growth in the early 1990s. U.S. steel firms have alleged in the aforementioned trade complaints that foreign producers were dumping steel in this market and that production was also being subsidized in many cases. Output levels, employment and profits in the U.S. industry have all declined (dramatically in the case of profits) as a result of the combined effects of recession and unfair foreign competition.

Economic Perspectives on Trade Protection for the Steel Industry

Opposition to the VRAs has been based on the following claims: (*i*) that the industry's decline was caused mainly by domestic structural change rather than by import penetration (Grossman, 1986); (*ii*) that the industry needed to shrink and it was wrong to interfere with this process or to encourage more investment in steel facilities (Crandall, 1986 and 1987); and, (*iii*) that protecting the steel industry created unduly high costs for downstream users of steel products as well as large net welfare costs for the U.S. economy as a whole — including worsened international competitiveness in steel-using industries such as autos (Hufbauer, Berliner, and Elliott, 1986; de Melo and Tarr, 1990; Mendez and Berg, 1989). These views, which accord with economists' traditional predilection for free trade, have gone largely unchallenged in the economic literature.[6] In this paper, we address each of these claims in turn.

Figure 1
Real Steel Compensation, 1960-1990



Sources: AISI, and Economic Report of the President, 1991.

In Section 2, we review and extend Grossman's (1986) results regarding the causes of the steel industry's problems. We show that the macroeconomic shocks of the early 1980s were severe enough to cause structural change in the U.S. steel industry. Furthermore, those shocks increased the rates of decline of U.S. steel industry output and employment after 1982, which *permanently* reduced the size of the industry. When these factors are properly accounted for, Grossman's estimate of the *long-term* (pre-1982) structural trend rate of decline in steel employment is reduced. In addition, we raise questions about the use of employment, rather than output, as the best indicator of the effects of trade on this industry.

In Section 3, we analyze the contribution of increased investment in steel to rising labor productivity. Crandall (1987) argued that the growth of productivity in the steel industry in the 1980s could be explained largely by the retirement of old, inefficient plants. We examine the Crandall model and show that his results are biased because he fails to include the effects of increased investment and labor shedding (reflected in an increase in the growth of the industry's capital-labor ratio) on productivity levels. We find that the capital-labor ratio is in fact the *most* significant variable for explaining productivity in the steel industry. Reductions of capacity are of only secondary importance in explaining productivity trends.

In Section 4, we turn to an analysis of the cost of protecting the steel industry. We find that the VRAs did prove costly for consumers, over the 1984-89 period. Our estimates of the consumer costs of protection and the net national costs of protection are only about half as large as those of Hufbauer, Berliner, and Elliott (1986), one of the most widely cited reports on this subject. However, our cost estimates are somewhat larger than those of the USITC (1990). This study's estimates of the costs and benefits of protection are in the mid-range of other published estimates. There is general agreement in all recent studies that these estimates measure the costs of a particular form of trade protection, rather than trade protection in general. Voluntary restraint agreements have much higher net national costs than equivalent protection via a tariff or auction quota, because they allow foreign exporters to capture the rents or revenues resulting from the higher prices of the restricted imports. These revenues are known as "quota rents."

We find, as do Hufbauer et al. (1986), USITC (1990), and de Melo and Tarr (1990), that by far the largest part of the measured national "cost of protection" is simply the cost of using the specific policy instrument of voluntary quantitative restraints to limit imports rather than using another form of protection which would allow the U.S. government to capture the quota rents.[7] These rents, which represent the monetary value of the quota rights, are found to represent 75 to 93 percent of the welfare costs of the VRAs in all four studies. If VRAs had been replaced by a revenue-generating policy instrument, then the net national costs of steel protection (defined as the standard economic efficiency losses) would have been only about $195 million a year *at their highest*, in 1985, when the VRAs had the largest impact on steel prices.[8]

However, the VRAs also generated benefits for the economy. These benefits, taking into account both the direct and indirect jobs saved by the VRAs, amounted to about $355 million in increased labor incomes in that same year. Thus the costs of trade protection (of a type that allows the home government to capture the revenues generated by limiting imports) would have been more than offset by its benefits (including the labor incomes saved). The Hufbauer study also fails to take into account the long-term impact of the macroeconomic shocks of the early 1980s. We develop estimates of the long-term costs of these hysteretic effects. Finally, we argue that it is misleading to use the steel prices which were depressed by the overvalued dollar and global excess supply as a benchmark for measuring the costs of protection to consumers.

In Section 5 we summarize our results and consider their implications for future trade policies for this sector. The picture of steel VRAs which emerges from the analysis in this paper is different from the conventional view that they were utterly misguided and that any form of trade protection for steel was unwarranted. The VRAs did *not* inhibit the steel industry from making the structural adjustments that were necessary for it to become more efficient and competitive. On the contrary, to the extent that the VRAs encouraged investment and increased capacity utilization, they helped *reduce* costs, leading to *lower* steel prices for domestic consumers in the long run. Thus, the VRAs helped to ameliorate the short-run social costs of industry shrinkage, without preventing necessary adjustments from taking place. Furthermore, the impact of the VRAs on the domestic price of steel must be viewed in the context of the windfall gains that steel consumers were reaping during the early part of this period from the overvaluation of the dollar and global excess supply of steel. When these factors are taken into account, consumers were still *better off* during this period than they would have been under a scenario in which the dollar had not been overvalued and the VRAs had not been implemented.[9] However, less costly alternatives were available and should be used in the future if the industry is damaged by unfair foreign competition.

In addition, new policy measures relating to the steel industry should be developed which take into account the world-wide surplus of steel production capacity and address the problems caused by government subsidies abroad. Ultimately, the VRAs should be replaced with alternative policies that provide the industry with protection from sudden surges in imports or declines in import prices caused by unfair trade practices. These could include automatic measures to limit the volume of imports, through the use of auction quotas. (Auction quotas are quantitative restraints, but they are sold or allocated by the home government, rather than by the foreign government. Their advantage over VRAs is that the home government is able to capture some of the revenues generated by restricting imports.) In return U.S. steel producers should be encouraged to continue the restructuring efforts which were begun in the 1980s, which have begun to reverse the industry's pattern of long-term structural decline.

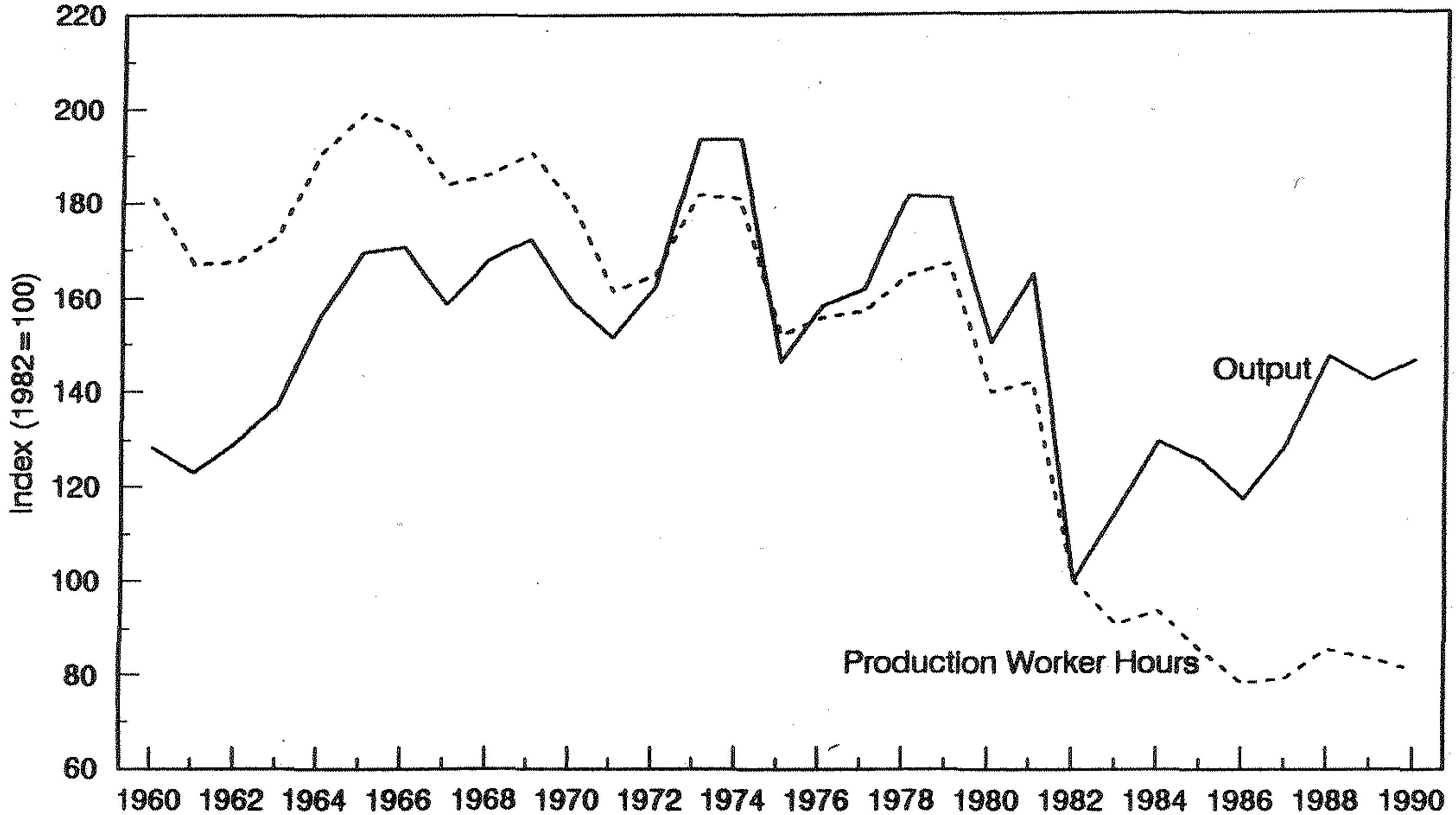
2. Explaining Changes in Steel Output and Employment: Extending the Grossman Model

This section will seek to explain the recent trends in steel output and employment, including the effects of the VRAs and of the post-1982 changes in the structure of the economy. Steel employment exhibits an overall downward trend during this period, while output trended upward until the mid-1970s. Output and employment both collapsed in the crisis year of 1982, but while steel output subsequently improved, *steel employment never recovered.* In 1990 production worker hours were still below their level in the trough of the 1982 recession. **Figure 2** shows the Bureau of Labor Statistics (BLS) indexes of output and employment (measured by total annual production worker hours) in the steel industry (Standard Industrial Classification sector 331).

Grossman (1986) argues that the decline in steel employment over the period 1976 to 1983 was caused mainly by domestic factors and not by steel imports.[10] This argument is important because requests for trade relief under the escape clause (section 201 of the U.S. trade statutes) require proof that imports were the most significant cause of injury to the domestic industry.

Grossman develops a reduced-form model of steel industry employment, which he estimates using monthly data from January 1973 to October 1983. His results are reproduced in columns (1) and (2) of **Table 2**. Grossman finds that steel employment experienced a large and statistically significant[11] negative time trend during the period under study. He argues that this time trend indicates that structural factors played an important role in determining steel employment. In this paper, we find, however, that Grossman's results are biased in two ways. First, his estimates of the long-run time trend for employment decline are biased by his choice of an end date, 1983, which followed a precipitous drop in both employment and output. We argue that the 1982-83 shift indicated a structural change in the industry, which we capture with a slope-shifting dummy variable. Second, Grossman's decision to focus on employment, rather than output, results in a larger time trend because of the normal effects of technical change and capital investment on

Figure 2
Steel Output and Employment, 1960-1990



Source: Bureau of Labor Statistics.

TABLE 2
Reproducing and Extending Grossman's Reduced-Form Model
Dependent Variable: Steel Industry Employment, Sector 3312[a]

	Grossman's Original Model		Our version		Adding the dummy	
Equation	(1)	(2)	(3)	(4)	(5)	(6)
Time Trend	-0.090[b]	-0.092[b]	-0.090	-0.104	-0.070	-0.071
	(-9.38)	(-8.56)	(-6.86)	(-9.59)	(-5.64)	(-5.94)
Industrial Production	1.400	1.511	1.784	2.075	1.422	1.422
	(4.49)	(4.86)	(5.53)	(6.94)	(4.93)	(5.04)
Import price	1.067	1.026	0.760[c]	0.895[c]	0.588[c]	0.592[c]
	(2.69)	(2.52)	(3.65)	(4.30)	(3.26)	(3.35)
Steel compensation	-0.596[d]	—	-0.385	—	-0.090	—
	(-1.41)	—	(-1.51)	—	(-.413)	—
Price of energy	-0.037	-0.060	-0.141	-0.178	-0.161	-0.175
	(-0.08)	(-0.12)	(-0.89)	(-1.15)	(-1.27)	(-1.47)
Price of iron ore	1.549	1.094	0.495	0.550	0.346	0.338
	(2.09)	(1.14)	(2.03)	(2.30)	(1.76)	(1.77)
D82T[e]	—	—	—	—	-0.010	-0.010
	—	—	—	—	(-3.70)	(-4.02)
Rho	0.821	0.806	0.744	0.604	0.611	0.599
	(16.42)	(15.50)	(4.76)	(3.54)	(3.22)	(3.18)
R^2 [f]	0.97	0.97	0.986	0.985	0.992	0.992
Durbin-Watson Statistic	1.841	1.919	1.866	1.975	1.570	1.542

Note: All variables except the time trend and D82T are measured in natural logarithms. Steel compensation, the price of energy, and the price of iron ore have been deflated by the aggregate PPI. *T*-statistics are shown in parentheses. See Appendix A for a description of Grossman's lag structure, as well as discussion of data sources and measurement issues.

[a] Annual hours of employment, for production workers. BLS figures.
[b] Grossman's monthly time trends were converted to annual rates for purposes of comparison.
[c] Sum of 0-1 lag.
[d] Wage only.
[e] D82T is the product of the time trend and a dummy variable, which is set to 1 for 1982-1990 and 0 otherwise.
[f] We report unadjusted R^2 here, for ease of comparison with Grossman's reported results.

labor productivity. In order to determine the effects of the VRAs and the 1982 recession on steel employment, we sought to replicate Grossman's results[12] using annual data for a longer time period (1960 to 1990).[13] We also used a modified version of Grossman's model to explain changes in steel output during the same period. A more detailed description of how our model compares with Grossman's is given in Appendix A.

Columns (3) and (4) of Table 2 show our effort to reproduce Grossman's results using our data set. Given the differences in the time period, the frequency of the data, and the measurement of some of the variables, the results are remarkably close. We obtain an identical time trend of -9.0 percent per year in the version with the wage (compensation) included (equations (1) and (3)). Other parameter estimates are also quite similar. (See Appendix A for a more detailed discussion.)

In our model, VRAs affect steel employment by restricting the supply of imports and thus raising real import prices. Higher import prices increase *domestic* production of steel, since buyers of steel would tend to substitute domestic steel for imported steel. When domestic steel output rises employment in the domestic steel industry also rises. Our estimates, which are explained in Appendix C, show that the VRAs raised import prices by about 9.5 percent, on average, from 1984 to 1989, with the difference reaching a maximum of about 13 percent in 1984 and 1985, and falling to only 2.5 percent by 1989. Given an import-price elasticity of just under 0.8 (from equation (3) in Table 2), this would cause employment to be a little over 10 percent higher than it would have been without the higher import prices in the peak years of 1984 and 1985. Thus, the VRAs can be said to have raised employment by about ten percent in those years.

The Effects of Structural Change on Employment

The period of the sustained dollar overvaluation in the early 1980s, in combination with the 1982 recession, may have had an irreversible effect on the level of employment in the steel industry. The term hysteresis is used to describe such a situation, where the effects of an event persist, even when the catalyst itself has been removed. Krugman and Baldwin (1987) were unable to confirm the existence of a hysteresis effect of the overvalued dollar on overall U.S. trade flows in the 1980s using a dummy variable to proxy for a one-time shift. However, in the case of steel employment, which has a strong time trend, it may be more appropriate to interact a dummy variable with the time trend in order to test for a change in that trend. The hysteresis effect is likely to be stronger and more easily detected in a capital-intensive sector such as steel than at a more aggregated level.

We test the hypothesis that hysteresis increased the trend rate of decline in steel employment, as suggested by examination of employment trends in Figure 2 above. We create a dummy variable, which is set to 1 for the period 1982-1990 and 0 otherwise. We choose 1982 as the break point because it represented the trough of the recession. In addition, by 1982, the real value of the dollar had been rising for two years, allowing sufficient time to detect the effects of dollar overvaluation on the structure of the industry. The product of the structural dummy and the time trend is the variable D82T, which is included in equations (5) and (6) to measure the effects of structural change. The coefficient may be interpreted as a *change* in the trend rate of decline in employment in this industry.

The inclusion of the time-interactive dummy has the effect of reducing the pre-1982 trend rate of employment decline by about 2 percentage points per year (from a 9 percent annual decline to a 7 percent annual decline), relative to the results of the Grossman model. This indicates that Grossman's time trend exaggerates the long-run rate of decline in employment because he fails to take into account the structural change that occurred in 1982. Our lengthening of the sample period to include the latter part of the 1980s and our inclusion of D82T allow us to correct for this omission. Our result is further confirmed by the coefficient and significance level of the D82T dummy variable. D82T is associated with a decline in the trend of steel employment of an additional 1 percent per year (for the 1982-1990 period) and is significant at the 1 percent level.

The other estimated coefficients in the model are also reduced somewhat by the inclusion of the trend-shifting dummy, which — for the period after 1981 — captures the effects of all factors other than the measured variables, including the industry's ongoing restructuring efforts as well as the persistent effects of the macroeconomic distortions (hysteresis). This reflects the fact that these events were qualitatively different from earlier variations in output and exchange rates, which are otherwise captured by the industrial production and import price variables. Thus, hysteresis has long-run consequences for the size of the workforce in the U.S. steel industry.

The Effect of Imports on Domestic Output

Equations (1) and (2) in **Table 3** estimate a reduced-form output model which is analogous to equations (3) and (4) in Table 2. For our output equations, we used the more broadly defined steel industry included in Standard Industrial Classification 331 (blast furnaces, steel works, and rolling and finishing mills), rather than SIC 3312, since BLS data on output are not available at the four-digit level in this industry. The regression results reported in Table 2 are virtually the same if 331 hours are used as the dependent variable instead of 3312 hours.

As in the employment equations described earlier, the time trend for output is negative and significant, indicating a decline in domestic steel production over time, beyond that explained by the independent variables included in the equation. (This is known as secular decline.) The time trend for output, however, is notably smaller than in the employment equation, as would be expected, since output has fallen less sharply than employment, due to productivity growth. As with employment, output is highly elastic with respect to industrial production. The prices of energy and iron ore have even less impact on output than they do on employment. Interestingly, though, output is *more* sensitive to changes in real labor compensation than is employment. This suggests that higher wages do not have a significant net effect on employment, but do have a significant negative net effect on total output.[14] The elasticity of output with respect to compensation is about twice that in the employment equation and is significant at the 1 percent level.

In order to complete our reduced-form model we then add the interactive dummy variable, D82T, to equations (3) and (4) in Table 3. In the equation including compensation, the coefficient on the dummy is negative and significant at the 1 percent level, and its presence in the equation reduces both the coefficients and the significance of the time trend and industrial

TABLE 3
Reduced-form of Steel Industry Output
Sample: 1961-1990
Dependent Variable: Steel Output, Sector 331

Equation	(1)	(2)	(3)	(4)
Time Trend	-0.064	-0.075	-0.026	-0.048
	(-7.44)	(-10.39)	(-1.71)	(-2.82)
Industrial Production	2.352	2.254	1.579	1.665
	(10.95)	(11.07)	(4.55)	(4.12)
Import price	0.643	0.702	0.274	0.450
	(3.66)	(4.13)	(1.32)	(1.94)
Steel compensation	-0.780	—	-0.918	—
	(-2.58)		(-3.41)	
Price of energy	-0.032	-0.154	0.010	-0.143
	(-0.21)	(-1.11)	(0.07)	(-0.99)
Price of iron ore	0.122	0.050	-0.107	-0.122
	(0.61)	(0.25)	(-0.52)	(-0.53)
D82T	—	—	-0.009	-0.006
			(-2.79)	(-1.73)
Rho	0.041	-0.143	0.174	-0.014
	(0.16)	(-0.66)	(0.67)	(-0.06)
R^2	0.866	0.838	0.897	0.848
Durbin-Watson Statistic	2.067	1.986	1.981	1.943

Note: All variables except the time trend and D82T are measured in natural logarithms. Steel compensation, the price of energy, and the price of iron ore have been deflated by the aggregate PPI. *T*-statistics are shown in parentheses. Variables are defined as in Table 2.

production. Note that the coefficient on the time trend in equation (3), which includes D82T, is less than half that in equation (1), which omits the dummy (-2.6 percent compared to -6.4 percent).

Taken together, the results in Tables 2 and 3 suggest that there was a large, statistically significant, hysteretic shock to output and employment from the macroeconomic distortions of the 1980s. The finding of hysteresis in the steel industry is not surprising, given the characteristics of the industry. Due to its high fixed costs and use of skilled labor and capital-intensive production techniques, the steel industry cannot rebound easily or costlessly from deep reductions in capacity and employment. Once a steel plant has laid off its workers, idled machinery, and closed its doors, it cannot start up production again without incurring heavy additional costs. It may also be at a disadvantage relative to its competitors if it reduces or ceases its research and development efforts temporarily. The overvaluation of the dollar had particularly severe repercussions in steel, since it not only made steel imports cheaper, but also increased the imports of steel-using goods, such as automobiles and machine tools.

This finding of the existence of hysteresis in the steel industry underscores the need for consistent long-term trade and industrial policies in this sector. Corrective policies, such as the VRAs, may offset the effects of macroeconomic shocks on the steel industry, so as to prevent excessive capacity and employment reductions not warranted by changes in the industry's underlying competitiveness. We return to the question of the costs and benefits of the VRAs and of alternative policies in the last two sections of the paper.

3. The Determinants of Productivity Growth

A crucial policy issue affecting the steel industry is the role played by investment, both in new facilities and in modernizing old plant and equipment. Since the 1960s, economists have criticized sluggish investment patterns by the big steel companies, charging them with failing to implement new technology in a timely fashion.[15] In the 1980s, however, economists such as Robert Crandall of the Brookings Institution were more likely to argue that the integrated U.S. steel industry was so hopelessly inefficient that the most constructive step it could take would be to shut down facilities and stop investing (Crandall, 1987). In this section, we examine how investment contributed to productivity growth in the steel industry during the period from 1960 to 1990. We find, in contrast to Crandall's results, that the capital-labor ratio is the most important factor explaining productivity in the steel industry.

Crandall reasoned that the shutdown of obsolete facilities raised productivity by bringing *average* productivity closer to the *best-practice* productivity in the more modern facilities that were retained. He cites the results of a simple regression equation showing that capacity reduction was the most important explanatory variable in a productivity model. Crandall uses this result to argue that there is no need for government policy to encourage additional investment in the industry:

> It is unfortunate that much of recent steel policy has been based upon a premise that more investment is required to make the industry healthy. Tying reinvestment of earnings in steel to trade protection in the 1984 Steel Import Stabilization Act is the most recent example of this error. (Crandall, 1987, p. 286)

But this is a *non sequitur.* Shutting down old facilities can only raise average productivity for so long. Eventually, once the remaining plants are all using more or less best-practice technology, further increases in productivity can only be achieved by additional investments that improve the best-practice techniques. Moreover, marginal investments in new equipment (such as continuous casters) can upgrade and modernize some older core facilities. The percentage of raw steel that was continuously cast more than tripled in the 1980s. U.S. steel exports quadrupled between 1987 and 1990. These improvements would not have been possible without additional investment in domestic steel production.

To investigate this issue, we first attempt to replicate and then modify Crandall's (1987) model. Unlike the Grossman (1986) model discussed in the last section, which was a reduced-form model, Crandall's is a structural model with only those variables thought to influence productivity directly used as regressors.[16] While Grossman's model could be used to analyze trends in output and employment, it left changes in productivity (output per worker hour) as a residual. In spite of some deficiencies which we will note and correct, Crandall's model is more useful for explaining changes in productivity itself.

Crandall's reported results are given in the first column of **Table 4**. The dependent variable is the BLS index of labor productivity for steel.[17] The independent variables are a time trend and the Federal Reserve Board indexes of capacity and capacity utilization in steel. All variables (except the time trend) are measured in natural logarithms (logs). The sample period is 1962-1985.[18]

As expected, Crandall finds that the utilization elasticity and time trend are positive and highly significant. The utilization effect derives from the "hoarding" of labor during cyclical downturns, when layoffs are less than proportional to (or lag behind) reductions in output. The time trend is supposed to represent exogenous technical progress, although as we shall see it also captures the effects of a missing variable in Crandall's specification. In addition, the capacity variable comes in strongly negative, with an elasticity of −1.4, and a *t*-statistic of nearly 9 in absolute value. Crandall takes this as confirmation of his hypothesis that the elimination of old capacity with obsolete technology contributed positively to steel industry productivity. He concludes that the industry needs to shrink.

TABLE 4
Attempting to Replicate Crandall's Productivity Model
Sample Period: 1962-1985
Dependent Variable: BLS Productivity Indexes, Sector 331

	(1)	(2)	(3)	(4)	(5)
Productivity Measure	[a]	Production Workers	Production Workers	All Employees	All Employees
Autocorrelation Adjustment	[a]	Cochran-Orcutt	Maximum Likelihood	Cochran-Orcutt	Maximum Likelihood
Utilization Rate[b]	0.366 (8.14)	0.350 (5.63)	0.343 (5.71)	0.464 (7.76)	0.459 (7.93)
Time Trend	0.020 (20.31)	0.029 (14.11)	0.029 (15.62)	0.027 (14.39)	0.027 (15.66)
Capacity[b]	−1.37 (−8.90)	−0.921 (−4.42)	−0.935 (−4.70)	−1.03 (−5.36)	−1.04 (−5.61)
Rho	0.225 [a]	0.408 (1.85)	0.381 (1.73)	0.362 (1.60)	0.339 (1.51)
Adjusted R^2	0.951	0.952	0.953	0.944	0.944
Durbin-Watson	2.03	1.97	1.94	1.94	1.92

Notes: All variables except the time trend and D82T are measured in natural logarithms. Numbers in parentheses are *t*-statistics. A constant term was also included but is not reported here. Data are annual. See text for further explanation.

[a] Not reported
[b] Old indexes, based on 1977 output = 100.

Our efforts to replicate Crandall's results are given in columns (2) to (5) of Table 4. We tried both measures of steel productivity (all employees and production workers)[19] and two different autocorrelation procedures for correcting autocorrelated errors and estimating *rho* — the Cochran-Orcutt procedure (which drops the first observation) and the Beach-MacKinnon maximum likelihood procedure.[20] None of our results are exactly the same as Crandall's, although the overall results are similar.[21]

The utilization elasticities obtained with production workers' productivity as the dependent variable (columns 2 and 3) are very close to Crandall's. However, using this variable leads to notably greater time trends (2.9 percent per year versus 2.0) and notably smaller negative capacity elasticities (about −0.9 versus −1.4); the adjusted R^2 is about the same (0.95). When all employees' productivity is used as the dependent variable (columns (4) and (5)), the results are similar, but the utilization elasticity is higher (as would be expected, since production workers tend to be laid off faster than managers and office staff during downturns), the negative capacity effect is slightly greater (about −1.0), and the time trend is slightly smaller, compared with the estimates based on production workers' productivity.

Although this model appears to provide strong support for Crandall's view (even with capacity elasticities of −1.0 or −0.9), two major problems are evident. First, although Crandall interprets his results as showing that the steel industry does not need more investment, there is no variable in the model representing the capital stock or, more appropriately, capital per worker.[22] The effects of capital accumulation are captured in the time trend and thus confused with disembodied technological progress.

Second, Crandall's sample period is quite short, consisting of 24 annual observations. Econometric time-series results based on small samples can be highly sensitive to the choice of sample period. In this case, the cutoff in 1985 represents a possible source of bias, since this includes the early 1980s (when capacity shutdowns did contribute to higher average productivity, as we have discussed) but excludes the late 1980s (when capacity stopped falling and turned upward again). Of course, at the time of his writing, Crandall did not have later data available, but we can take advantage of more recent data to test the sensitivity of his results to the sample period.

We shall investigate the effects of both the capital-labor ratio and extending the period of study separately before presenting a complete model which corrects for both of these factors. **Table 5** shows the results of Crandall's model, for his sample period (1962-1985), with the only change being the addition of a trend capital-labor ratio estimated by the present authors.[23] For each of the four specifications shown, *adding the capital-labor trend variable reduces the explanatory power of the capacity variable*, although the latter is still significant in every case. The annual time trend coefficients are also reduced by about 1 percentage point, indicating that the time-trend variable had been picking up some of the effects of capital accumulation. The capital-labor trend ratio has a positive elasticity in every case, although it is significant at the 5 percent level only in the equations for production workers' productivity (which we take to be closer to Crandall's original specification). The estimated autocorrelation coefficients (*rho's*) are cut about in half by adding the capital-labor ratio (more so for production workers), and are not significant even at the 10 percent level. Thus the autocorrelation residuals in

TABLE 5
Adding the Capital-Labor Trend Ratio to Crandall's Productivity Model
Sample Period: 1962-1985
Dependent Variable: BLS Productivity Indexes, Sector 331

	(1)	(2)	(3)	(4)
Productivity Measure	Production Workers	Production Workers	All Employees	All Employees
AR1 Procedure	Cochran-Orcutt	Maximum Likelihood	Cochran-Orcutt	Maximum Likelihood
Utilization Rate[a]	.379 (6.28)	.378 (6.38)	.484 (8.23)	.483 (8.37)
Time Trend	.017 (3.22)	.017 (3.17)	.018 (3.43)	.018 (3.40)
Capacity[a]	-.626 (-3.01)	-.623 (-2.98)	-.783 (-3.73)	-.780 (-3.72)
Capital-Labor Trend Ratio[b]	.294 (2.24)	.298 (2.26)	.253 (1.83)	.257 (1.86)
Rho	.172 (.689)	.179 (.722)	.185 (.737)	.185 (.741)
Adjusted R^2	.959	.959	.948	.949
Durbin-Watson	1.90	1.92	1.89	1.90

Notes: All variables except the time trend are measured in natural logarithms. Numbers in parentheses are *t*-statistics. A constant term was also included but is not reported here. Data are annual. See text for further explanation.

[a] Old indexes, based on 1977 output = 100.
[b] Estimated by the authors, as explained in text and endnote 23.

Crandall's original model may have reflected a missing variable, the capital-labor ratio, rather than true autocorrelation of the least squares residuals.

Table 6 shows the results of extending the sample period to 1960-1990. For these regressions, we used the revised Federal Reserve indexes for steel capacity and utilization based on 1987=100. Otherwise, the data are measured in the same way as in Tables 4 and 5. The results are shown only for production workers' productivity as the dependent variable, and just for one autocorrelation procedure (Cochran-Orcutt) for economy of space.[24] The first two columns show Crandall's original specification, run over the longer time period with the revised data, in ordinary least squares (OLS) and Cochran-Orcutt respectively. The capacity elasticity is still negative and significant, but much smaller (only about –0.6 versus his original estimate of –1.37) merely as a result of adding 7 observations (1960-61 and 1986-1990) — even with the capital-labor trend ratio still omitted!

Columns (3) and (4) in Table 6 show the results of adding the capital-labor trend ratio into the model estimated over the longer time period, again in OLS and Cochran-Orcutt respectively. There is still a significant negative capacity elasticity, but it is reduced to about –0.4. The capital-labor trend ratio has a positive and significant elasticity of about 0.3 in both versions, with or without the autocorrelation correction. As in Table 5, the positive time trend is about 1 percent per year lower when the capital-labor trend ratio is included. Note that the estimated *rho* is only about half as big in equation (4) as in equation (2); *rho* is also insignificant in (4) while it was significant in (2). This again supports the view that the capital-labor trend ratio is a missing variable in Crandall's specification.

These results call into question Crandall's contention that additional investment would be of no benefit to the steel industry. The benefits of reducing steel capacity were exaggerated in his model both by the exclusion of the capital-labor trend ratio and by the truncation of the sample period right after the early 1980s crisis. Moreover, for every 1.0 percent increase in the capital-labor trend ratio there is a 0.3 percent increase in production workers'

TABLE 6
Extending Crandall's Productivity Model
Sample Period: 1960-1990 (Annual Data)
Dependent Variable: BLS Productivity Index for Production Workers, Sector 331

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Procedure	OLS	AR1[a]	OLS	AR1[a]	OLS	AR1[a]
Utilization Rate[b]	0.254 (5.53)	0.298 (5.37)	0.329 (6.46)	0.335 (6.16)	0.369 (6.20)	0.348 (5.18)
Time Trend	0.026 (31.95)	0.026 (17.63)	0.016 (4.23)	0.015 (3.07)	0.018 (4.44)	0.015 (3.08)
Capacity[b]	–0.608 (8.80)	–0.599 (–5.34)	–0.390 (–3.69)	–0.386 (–3.17)	–0.334 (–2.94)	–0.365 (–2.81)
Capital-Labor Trend Ratio[c]	—	—	0.279 (2.58)	0.314 (2.46)	0.197 (1.57)	0.284 (1.88)
Hysteresis Dummy (1982-1990)	—	—	—	—	0.061 (1.25)	0.021 (0.38)
Rho	—	0.408	—	0.208	—	0.161
Adjusted R^2	0.980	0.980	0.983	0.983	0.984	0.982
Durbin-Watson	1.316	1.950	1.518	1.953	1.798	1.963

Notes: All variables except the time are measured in natural logarithms. A constant term was also included but is not reported here. Data are annual. See text for further explanation.

[a] Cochran-Orcutt procedure.
[b] New indexes, based on 1987 output = 100.
[c] Estimated by the authors.

productivity, with other things remaining equal, and this elasticity of 0.3 is robust (*i.e.*, it is about the same for either sample period, 1962-85 or 1960-90, and with almost any estimation procedure). Since Crandall's model is structural, it includes as regressors some variables that reflect both the macroeconomic shocks of the early 1980s and the effects of the VRAs in bolstering output and employment. In particular, the utilization variable should reflect these factors very directly, while both capacity and the capital-labor trend ratio would be influenced by them gradually over time. Therefore, we would not necessarily expect a hysteresis dummy to be significant in the productivity equation as it was in the reduced-form Grossman employment and output models in the previous section. Indeed, the results in columns (5) and (6) of Table 6 confirm that a dummy for the years 1982-1990 is not significant in either the OLS or Cochran-Orcutt version, although it is positive in both versions. Thus we presume that the complete model should be as in equations (3) and (4). However, it should be noted that the capital-labor trend ratio grew faster after 1982, mostly as a result of the accelerated trend decrease in employment discussed earlier.

We can use the estimates from Table 6 to evaluate the importance of the different variables in our more complete productivity model for explaining steel productivity growth in the 1980s. The resulting decomposition of steel productivity growth is shown in **Table 7**. The estimates shown in Table 7 are based on equation (4) in Table 6, which includes the capital-labor trend variable and an autocorrelation correction but omits the hysteresis dummy.[25] We take the average log differences in each of the independent variables from 1979-1980 to 1989-1990 and multiply these by the respective coefficients from equation (4).[26] The product is an approximate estimate of the percentage change in productivity due to each variable. As may be seen, the sum of these changes explains almost all of the total change in productivity over this period.

By far the most important variable in explaining productivity growth in the 1980s turns out to have been the variable Crandall omitted: growth of the capital-labor trend ratio. This variable accounts for about 20 percentage points out of the total 48 percent increase in steel productivity from 1979-1980 to 1989-1990, or more than two-fifths of the total. Nearly 15 percentage points of the increase are attributed to the time trend (exogenous technical progress),

TABLE 7
Explaining Changes in Steel Productivity, 1979-1980 to 1989-1990

Variable	Percentage Change	×	Coefficient	=	Explained Change in Productivity
Utilization Rate	4.0		0.335		1.3
Time Trend	10.0[a]		0.015		14.7
Capacity	–29.3		–0.386		11.3
Capital-Labor Trend Ratio	64.6		0.314		20.3
Long-term Trend	25.9		0.314		8.1
Difference	38.7		0.314		12.2
Total					47.6
Actual					48.6

Source: Authors' calculations as explained in text.

Notes: All percentage changes in variables are measured as differences in natural logs except as noted.

[a] Difference measured in number of years (not percent).

or over three-tenths of the total. In contrast, only about 11 percentage points are attributed to the reduction in steel capacity — less than one-quarter of the total.

As discussed earlier, the growth of the capital-labor trend ratio in the steel industry accelerated in the 1980s. We therefore decompose the effect of changes in this variable into its long-term trend component (extrapolated from a log-linear OLS regression of the capital-labor ratio on time from 1960-1981) and the difference, which is the increased growth of this ratio from 1982-1990 (when it accelerated). Only about 8 percentage points of the growth in steel productivity is due to the long-term trend increase in capital per worker, while 12 percentage points of it (fully one-quarter of the total) is attributed to the difference (increased growth of capital per worker). This last figure is actually slightly greater than the effect of the capacity reductions.

The fact that all the regressors in our extended Crandall model (except the time trend) are really endogenous variables (determined by their interaction with the other variables) suggests further that OLS estimates (even with an autocorrelation correction) may be biased due to simultaneity. In other words, the regression equation is unable to estimate the coefficients precisely, because the causality works in both directions. The appropriate procedure in such a case is to use instrumental variables (two-stage least squares, or 2SLS). The instruments in this case are the exogenous regressors (the constant and time trend) and all the other exogenous variables from Grossman's reduced-form model of steel industry employment (industrial production, steelworkers' compensation, the prices of energy and iron ore, and the import price, as defined earlier, with one lag of the import price also included).[27] In addition, when we use instrumental variables with an autocorrelation correction, Fair's (1970) procedure dictates that we add the lagged values of all the included endogenous variables as additional instruments.

The results of instrumental variables estimation of the extended Crandall productivity model are given in **Table 8**. The most notable difference between these results and those in Table 6 is that *the use of instrumental variables makes the capacity effect insignificant when the capital-labor trend ratio is also included in the model* (equations (3) and (4)). This result holds regardless of whether or not an autocorrelation procedure is used. (Although the Durbin-Watson statistic is a bit low in equation (3), the estimated *rho* in equation (4) is not significant.) Furthermore, the effect of the capital-labor trend ratio is larger in the instrumental variable estimates (elasticity of about 0.5) compared with the OLS estimates (about 0.3 in Table 6), and clearly significant. Since the time trend also becomes insignificant in equations (3) and (4) in Table 8, we may infer that the higher elasticities of the capital-labor trend ratio in the 2SLS estimates are picking up effects which were attributed to both the time trend and the capacity variable in the OLS estimates. Thus, when we control for the endogeneity (or simultaneous interactions) of the factors that explain productivity and correct for cyclical fluctuations with the utilization rate, it turns out that the capital-labor ratio is the *most* significant variable for explaining productivity in the steel industry. Our results in this section indicate that investment in new steel equipment and facilities, far from being unnecessary, is in fact vital for the industry to become more efficient and

TABLE 8
Estimating the Extended Crandall Productivity Model
By Instrumental Variables, Sample Period 1960-1990
Dependent Variable:
BLS Productivity Index for Production Workers, Sector 331

	(1)	(2)	(3)	(4)
Utilization Rate[a]	0.270	0.338	0.369	0.417
	(5.28)	(5.15)	(5.66)	(5.93)
Time Trend	0.026	0.027	0.009	0.007
	(31.51)	(12.59)	(1.24)	(1.08)
Capacity[a]	−0.642	−0.561	−0.193	−0.181
	(−8.42)	(−3.89)	(−0.94)	(−1.11)
Capital-Labor Trend Ratio[b]	—	—	0.487	0.543
			(2.35)	(3.14)
Rho	—	0.485	—	0.280
		(2.47)		(1.19)
Adjusted R^2	0.979	0.978	0.981	0.978
Durbin-Watson	1.266	1.936	1.427	1.797

[a] New indexes, based on 1987 output = 100.
[b] Estimated by the authors.

competitive. Congress's requirement that the industry reinvest its profits in steel facilities (implicitly a quid-pro-quo concession in return for trade protection) was sensible, from the point of view of national welfare. Crandall's policy conclusion, that additional investment in steel should not have been encouraged, is not supported by the experience of the late 1980s, nor by a more completely specified model.

Of course, this leaves open the question of how large a steel industry the United States should have, and thus whether additional steel investment should be directed to expansion of existing capacity or merely to making existing capacity more efficient. But no progress even in the latter direction can be made without further increases in capital per steelworker — and that means more investment.

4. The Costs of Protection

The previous analysis has shown that the steel industry was battered by the macroeconomic and exchange-rate shocks of the early 1980s, and that this injury persisted in the form of permanently reduced output and employment even after the shocks were eliminated (hysteresis). We have also shown that, in spite of the notable shrinkage of the U.S. steel industry in the 1980s, the remaining producers made great strides in raising productivity and moderating cost and price increases. While part of this improved efficiency and competitiveness can be attributed to the shutdowns of obsolete capacity, new investment also played an important role. That new investment in turn was made possible by, and indeed required as a condition of, the trade protection which the steel industry received under the VRAs from 1984 to 1990. While on the one side the VRAs guaranteed a modicum of market stability and improved firms' financial positions, at the same time the legislation which enacted them also required the steel firms to reinvest their increased earnings in the industry.

We thus come back squarely to a critical question which was posed in the introduction: did this protection of the steel industry come at too high a cost, either for steel consumers or for the nation as a whole? In this section, we present new estimates of the costs (and benefits) of protection. Our analytical framework for measuring the costs of protection is the now standard "partial equilibrium"[28] model of supply and demand for imported and domestic products which are "imperfect substitutes" for each other,[29] supplemented with estimates of the gains in wage income for workers whose jobs were saved by the VRAs. In making our estimates, we draw upon our modified Grossman (1986) model of steel output and employment (from section 2, above) in order to estimate the effects of the VRAs on those variables. We also estimate the impact of the VRAs on the prices of imported and domestic steel products, and on import volume, using models that are discussed below (and explained in more detail in Appendices B, C, and D). Finally, we also estimate the value of the wages lost due to the hysteresis or permanent reductions in employment due to macroeconomic and exchange-rate shocks, which may be compared with the costs of protecting the industry in order to obtain a more complete picture of the costs and benefits of steel protection in the 1980s.

In analyzing the costs of protection, it is crucial to bear in mind the distinctions between several different definitions of those costs: consumer cost of protection, net national welfare cost of the VRAs, net national welfare cost of alternative forms of protection (tariff or auction quota equivalents), and adjusted net national welfare including gains in worker income. The consumer costs are by far the greatest costs, but a large part of these are merely transfers to domestic producers and are therefore not counted in any measure of net national costs. Moreover, as we have pointed out earlier, the consumer costs of protection from the VRAs — in the form of higher prices of imported steel and competing domestic steel products — merely counteracted the windfall gains which consumers would otherwise have reaped from the overvalued dollar (which made steel imports artificially cheap) and generally depressed steel market conditions of the early 1980s.

Furthermore, as we shall see, it was not trade protection *per se* which imposed the bulk of the net national costs of protection in the case of steel, but rather the particular form of protection which was implemented — the VRAs. We show below that, if an equivalent degree of protection had been achieved using a tariff or auction quotas instead of VRAs, the net national cost of protection would have been quite minimal. Moreover, using an adjusted measure of net national costs taking into account the social benefits of increased wage incomes to workers whose jobs were saved, we show that such tariff-equivalent trade protection would have yielded (adjusted) *net benefits* to the nation as a whole (because the gains in labor income exceed the net national costs of equivalent tariff protection[30]).

The rest of this section is organized as follows. The next part explains our method for estimating the costs of protection and gives our estimates of the average annual costs (and benefits) for the period 1984-89 when the VRAs were most binding. The following part then compares our estimates for particular years during this period with two important and widely cited other studies, those of Hufbauer et al. (1986) and the U.S. International Trade

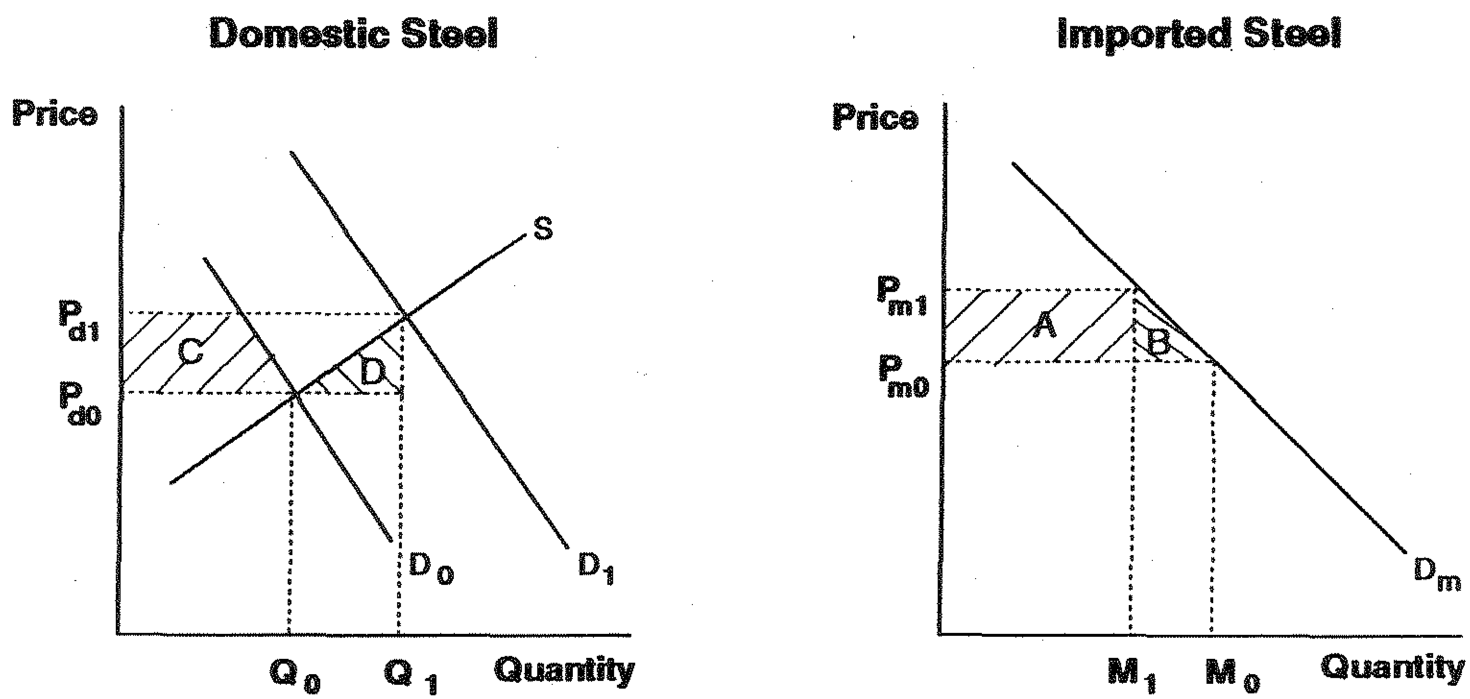
Commission (USITC, 1989). We show that Hufbauer's estimates, which are more than double ours for most measures of the costs of protection, rest on shaky foundations and are probably exaggerated. Our estimates are not the lowest, however, as the comparison with the USITC study makes clear. Although the USITC study finds lower consumer and net national costs, it also implies smaller job gains from the VRAs, and rests on a number of implausible assumptions. However, the USITC study also estimates (as we do) the gains in labor income from the jobs saved by protection. Finally, the last part of this section details our analysis of the *permanent* losses in labor income due to the hysteresis effects in the steel industry, which we find to be large relative to any measure of the net national costs of protection.

Measuring the Welfare Costs of the VRAs and Alternative Forms of Protection

The method used to estimate the costs of protection, and the distinctions between the various measures of those costs, can be understood with the aid of **Figure 3**. On the assumption that domestic and imported steel products are imperfect substitutes, we analyze the markets for these products separately. The left-hand panel in Figure 3 represents the market for domestic steel products, while the right-hand panel represents the market for imports. The two markets are linked, of course, because steel consumers can substitute domestic and imported steel products for each other. Indeed, there is reason to believe that such products are actually rather close (although not perfect) substitutes, since steel products are not highly differentiated (e.g., by brand name or styling). The differences which make them imperfect substitutes are mainly matters of technical quality, reliability of supplies, and delivery lead times, which may vary according to the national origin of the products. In addition, domestic and imported steel consist of somewhat different product mixes, and not all foreign nations can supply substitutes for particular American goods.

Both diagrams in Figure 3 have prices (P_d for domestic, P_m for imports) on the vertical axis and quantities of steel products (M for imports, Q for domestic) on the horizontal axis. For all the variables in these diagrams, the subscript 0 refers to a counterfactual scenario in the absence of the VRAs (or equivalent protection), while the subscript 1 refers to the actual situation with

Figure 3
Components of the Cost of Protection: Voluntary Restraints (VRAs) on U.S. Steel Imports



the VRAs (or equivalent protection) in place.[31] In the import diagram, P_{m1} and P_{m0} represent the prices of imports with and without the VRAs, respectively,[32] while the curve D_m represents the demand.[33] In the domestic part of the diagram, the curves D_1 and D_0 represent the demand for domestic steel with and without the VRAs in effect, respectively. S is the domestic supply curve.

Note that any area on these diagrams corresponds to the product of a price times a quantity, which equals an amount of revenue in dollars. Thus we can measure the gains and losses to steel producers and consumers and other interested parties (e.g., foreign suppliers or the U.S. government) by making appropriate calculations of the relevant areas on the diagram. Conceptually, we define the "consumer surplus" as the difference between what consumers are willing to pay for a good (represented by the height of the demand curve), and the price they actually pay. Geometrically, this corresponds to the area of the three-sided figure bounded by the demand curve, the price line, and the vertical axis. The costs of protection to consumers are then measured by the reduction in this "surplus" when consumers have to pay a higher price.

In parallel fashion, the "producer surplus" is defined as the difference between the price at which firms sell the goods and their costs of production (represented by the height of the supply curve). Geometrically, this corresponds to the area of the three-sided figure bounded by the supply curve, the price line, and the vertical axis. The gains to producers from protection are measured by the increase in this "surplus" when producers get a higher price for their product. Note, however, that this definition of producers' surplus does *not* include the benefits received by workers who keep their jobs as a result of the protection (assuming that they could not get other jobs paying equal wages immediately after losing their jobs if the industry were not protected). Since wages are included in costs, they are under the supply curve and do not form part of the "surplus." Hence, any such wage gains from protection have to be calculated separately. In making all these calculations, we take the situation without the VRAs as the benchmark, and then compare the effects of moving toward the situation with the VRAs in effect.

Using this method, then, we can see how to measure the consumer costs of protection. In the import market, the VRAs directly limit the quantities which foreign exporters can sell from, say, M_0 to M_1. This causes the equilibrium price of imports to rise from P_{m0} to P_{m1}. A quota would do the same thing, but an equivalent tariff would operate in the reverse fashion (raising the price of the imports from P_{m0} to P_{m1}, which would in turn cause the quantity demanded to shrink from M_0 to M_1). Any one of these forms of protection reduces the consumer surplus in the import market in two ways. First, since consumers must pay a higher unit price on the quantity of imports actually purchased with the VRAs (or other protection) in effect (M_1), the consumers lose the area of the rectangle labelled A in Figure 3. Second, since the higher price induces consumers to reduce their consumption of imports from M_0 to M_1, there is an additional loss of consumer surplus on the foregone imports (quantity $M_0 - M_1$). Thus the area B in Figure 3, which is the near-triangle above the old price and below the demand curve, represents an additional loss of consumer surplus.

The imposition of the VRAs (or other forms of protection) also has repercussions for consumers of domestic steel products. As imports become more expensive, consumers are induced to switch to domestic steel, and the domestic demand curve therefore rises from D_{d0} to D_{d1}. This in turn raises the equilibrium price of domestic steel products from P_{d0} to P_{d1} while the quantity of domestic steel purchased rises from Q_0 to Q_1. Although the consumers do get more domestic steel, they get it only at a higher price, which results in an additional loss of consumer surplus. Using the no-VRA domestic demand curve D_{d0} as a benchmark,[34] the consumer surplus is reduced by the area C (the four-sided figure between the two price lines P_{d0} and P_{d1}, and between the vertical axis and the demand curve D_0). Thus the total consumer cost of protection (loss of consumer welfare) is the sum of three parts, which we call $W_C = A + B + C$.

There is an important distinction between the three parts of the loss of consumer surplus in the import market. The area B is called a "deadweight" loss because it results from the fact that consumers' purchases of cheaper steel imports are reduced by the trade restriction (VRA or other). This is a pure loss of efficiency in consumption, as consumers are forced to turn to more expensive domestic products. The other two parts of the consumers' losses — by far the largest parts in practice, as we shall see — are not efficiency losses *per se*, but rather represent transfers to other economic agents.

The area C is entirely accounted for by a gain in producer surplus,[35] and thus represents a transfer from domestic consumers to domestic producers. Since it is a transfer within the country, it is not included in the net national cost of protection. The area A is what economists call the "quota rent": the excess revenue which accrues from the fact that protection (of any kind) raises the price of the imported goods inside the home country. *Who gets the area A (quota rent) depends entirely on the type of protection adopted.* Given that the United States protected its steel industry with VRAs in the 1980s, the area A was captured by foreign exporters of steel, and thus represented a net loss to the country. Had the government chosen to use a tariff instead (or to impose a quota with the quota licenses auctioned to importers), the quota rent A could have been captured as revenue by the U.S. government. In that case, A would not have been part of the net national loss.

The net national cost of protection also includes another element which is not part of the consumers' losses in this model. Since domestic steel production is more costly than foreign steel production, at the margin, the higher cost of the additional domestic steel output (the difference $Q_1 - Q_0$) represents a loss of efficiency in production. In Figure 3, this deadweight loss due to increased domestic production costs is the area D, which is the near-triangle under the domestic supply curve and above the no-VRA price line (P_0).

It is important to recognize that the static loss of efficiency in production (area D) may be offset over time if the domestic industry improves its productivity during the period when trade is restricted. As we have argued elsewhere in this paper, the U.S. steel industry did in fact take advantage of the protection offered by the VRAs to invest in an increased and improved capital stock, thus shifting the domestic supply curve downward. We have not quantified this supply-shifting effect here, but this is clearly an important area for future research.[36] Omitting this effect biases upward our estimates of the cost of protection.

While opponents of trade restrictions most often cite the high consumer costs of protection ($W_C = A + B + C$) as a rationale for removing or limiting such restrictions, we see that this can be misleading in the present case for several reasons. First, imported steel became artificially cheap in the early 1980s as a result of the appreciation of the U.S. dollar, compounded by the foreign subsidies and dumping in an environment of weak global demand (Howell et al., 1988). The cheapening of steel imports resulted in windfall gains to consumers by the exact reverse of the logic by which protection resulted in consumer losses. In terms of Figure 3, one could imagine that the variables and curves with the subscripts 1 refer to the situation before the dollar rose and steel imports became cheaper, and that the variables and curves with the subscripts 0 refer to the situation afterwards. Then the consumers would have gained the areas A + B + C as they could have bought more imports at lower prices, and they would have shifted their demand away from domestic products resulting in lower domestic prices as well. (This discussion relates to the qualitative changes involved; the areas A, B, and C resulting from cheaper imports would not be exactly the same in magnitude as the areas corresponding to the effects of imposing the VRAs.)

Second, since a large part of the consumer cost of protection (area C) is a transfer to domestic producers, and another part (area A) is the quota rent which *could* be captured by the government using a different policy tool, a more appropriate measure of *the true economic cost to the country of protecting the industry* is (if we leave aside labor gains for the moment) just the sum of the two deadweight or efficiency losses, B + D. This is what we call the "net national welfare cost of tariff-equivalent protection" ($W' = B + D$). Of course, the net national welfare cost *of the VRAs* ($W = A + B + D$) is much larger because it also includes the quota rents captured by foreign exporters. The greater costs of using VRAs result from the *choice of VRAs as the instrument of protection*, rather than from the decision to protect the industry *per se*. Both of these measures of the net national cost of protection must also be adjusted for the gains in labor income resulting from the jobs saved, which are not reflected in the diagrams in Figure 3.

Using this analytical framework, we now proceed to quantify the costs of the VRAs and alternative forms of protection for American steel in the 1980s.[37] In order to estimate the effects of the VRAs on output and employment in the industry, we draw upon the econometric model described in Section 2. Our basic assumption is that the principal effects of the VRAs are captured through their effects on import prices. To the extent that the VRAs were binding, they restricted the supply of imports and raised import prices.[38] We estimate the costs of protection by developing a counterfactual estimate of what the price of imported steel would have been in the absence of the VRAs, but with the high dollar of the mid-1980s (see Appendix C for details). We then use that estimate of the change in the import price in our reduced-form equations from section 2 to measure the impact of the VRAs on domestic steel output and employment. In order to estimate how the quantity of imports was affected by the VRAs, we use a similar reduced form model for the volume of imports as a function of import prices and other variables (see Appendix D). Finally, in order to estimate the effect of the VRAs on domestic steel prices, we use a structural model of the domestic price of steel derived from the previous work of Blecker (1989, 1991), as explained in Appendix B.

The detailed results of these calculations of the effects of the VRAs on the U.S. steel market for the years 1984 through 1989 are shown in Appendix E. The average effects of the VRAs (over these six years) are given in **Table 9** and will be reviewed here. We estimate (in Appendix C) that the VRAs increased the price of imported steel by an average of 9.5 percent over this period. As a result, consumers paid $868 million per year more for the imported steel than they would have in the absence of the VRAs (area A in Figure 3). There was an additional loss of consumption efficiency loss on imports that would have been purchased at the unprotected price (area B) which averaged $89 million per year. Domestic steel prices were increased by about 2.3 percent as a result of the VRAs (see Appendix B), resulting in increased consumer costs of $1,046 million (area C in Figure 3). Thus the total consumer costs of the VRAs (areas A + B + C) amounted to an average of $2,004 million (or about $2 billion) per year, according to our model.

TABLE 9
Estimated Costs of Protection in Steel,
Annual Average for 1984-1989
(in millions of dollars)

Cost element		Amount
A	Higher import costs (quota rents)	868
B	Loss of consumption efficiency	89
C	Higher price of domestic steel (transfer to producers)	1046
W_c	Consumer cost of VRAs (A + B + C)	2004
D	Loss of production efficiency	27
W	Net national cost of VRAs (A + B + D)	984
W'	Net national cost of tariff-equivalent protection (B + D)	116
L	Gains in labor income	246
W'	Adjusted net national cost of tariff-equivalent protection (B + D − L)	−130

Source: Authors' calculations, as explained in text. See Appendix E for the annual estimates.

Note: A negative net cost indicates a net benefit.

While this may look like a large cost to consumers, in fact it did not even fully offset the windfall gains which steel consumers received from the fall in steel prices in the early 1980s. Our measure of the import price, which is the unit value of all imports of steel mill products (including estimated transportation costs, insurance, and duties), declined by 16.9 percent from its peak in 1981 to its trough in 1983 (before most of the VRAs were in effect). In real terms (deflating the unit value of steel imports by the overall U.S. producer price index), the decline was even greater (19.7 percent). This is about *double* the average increase in the price of imported steel which we attribute to the VRAs between 1984 and 1989 (9.5 percent), and still higher than the *maximum* one-year increase in the import price due to the VRAs (which we estimate to have been just under 13 percent in 1984-85, as shown in Table C1 in Appendix C). While we do not calculate *the annual consumer gains from this lower price of steel*, it is clear that they *must have exceeded the $2 billion average annual loss from the subsequent imposition of VRAs.*

In any case, the great bulk of the consumer costs of the VRAs were composed of transfers to domestic and foreign producers. The net welfare costs of the VRAs to the United States (W = A + B + D), which include producer efficiency losses of $27 million (area D), but exclude transfers to domestic producers of $1,046 million (area A), averaged $984 million per year, less than half of the consumer costs. If tariffs had been used to limit imports, instead of the VRA, then the increase in the cost of imports of $868 million (area A) would have been captured by the U.S. government. In that case, the national welfare cost of tariff-equivalent protection (W' = B+ D) would have averaged only $116 million per year — barely 1/20th of the consumer cost. W' includes only the losses of efficiency in consumption and production (areas B and D). These are an order of magnitude smaller than the transfers to foreign and domestic producers (areas A and C) which resulted from the VRAs.

We also calculate the labor gains which resulted from the VRAs, which reflect the additional wages earned by workers who would otherwise have been unemployed, compared with what they would have received in lower paying jobs or if they would have dropped out of the labor force altogether. Income losses are high for workers displaced from the steel industry because of the lack of high-paying job alternatives, as compared with other industries that are affected by import competition, such as the textile and apparel sectors (see Scott and Lee, 1991).

We estimate (in Appendix E) that the VRAs saved an average of about 7,500 jobs per year in the steel industry, and about 13,700 jobs in related supplier industries, each year during the period 1984-89. Retention of these positions resulted in (direct) wage gains of $129 million per year in the steel industry and $117 million per year in other related (indirect) manufacturing industries, for a total labor gain of $246 million.

When these labor gains are included, we see that a tariff equivalent to the VRAs would have resulted in a *net benefit* to the domestic economy of $130 million per year between 1984 and 1989. Thus, the adjusted net national cost of tariff-equivalent protection, which we call W^*, which is equal to B + D – L, and would have been negative (implying a net gain) in this case. This surprising result is explained by three factors. First, the efficiency losses associated with trade protection (areas B and D) are relatively small. Second, these are more than offset by the wage losses which would have resulted in the absence of protection, because wages in the steel industry in particular, and the manufacturing sector in general, are much higher than in the rest of the U.S. economy, and because many of the unemployed steelworkers would have remained either temporarily or permanently unemployed. Finally, most of the consumer costs of protection are transfers to foreign and domestic producers, which do not affect net national welfare if a tariff is used to capture the increased payments for imported steel which are required to limit imports.

Comparisons with Other Estimates of the Costs of the VRAs

Our estimates of the cost of protection in the steel industry in the 1980s are about in the middle of the range for consumer costs, and for the net national costs of the VRAs *per se*. However, we differ from a number of studies in including the labor gains and showing that these exceeded the net national cost of tariff-equivalent protection (which would have captured the quota rents for the U.S. government). In this part, we compare our results with two widely cited studies of this issue, one with higher cost of protection estimates, and one with lower estimates.

Table 10 compares our results with those of Hufbauer et al. (1986) for the year 1984, which was the only year they covered. Hufbauer et al. concluded that the consumer cost of *all* protection in the steel industry (including the basic tariffs as well as the new VRAs) were $6.8 billion in 1984. Although they do not present a precise breakdown, it appears that about five-sixths of this ($5.7 billion) is attributed to the VRAs, with the rest attributed to tariffs which were already in effect before the VRAs.[39] Even this figure is more than double our estimate of the consumer cost of protection of $2.7 billion for 1984. Our estimate of the net national welfare costs of the VRAs in

TABLE 10
Comparative Estimates of the Cost of Protection in Steel in 1984
(billions of dollars, on an annual basis)

Cost element	This Study	Hufbauer et al.
A Higher import costs (quota rents)	1.2	3.0
B Loss of consumption efficiency	0.1	---[a]
C Higher price of domestic steel	1.5	3.8
W_C Consumer cost of protection[b] (A + B + C)	2.7	6.8
D – Loss of productive efficiency	0.03	0.333
W Net national welfare cost of VRAs (A + B + D)	1.3	2.3[c]
W' National welfare cost of tariff-equivalent protection (B + D)	0.1	0.333

[a] Hufbauer et al. (1986) do not estimate a value for this category.
[b] In this study, this is the cost of the VRAs alone; in Hufbauer et al., this is the cost of the VRAs and existing tariffs. Approximately 5/6 of the cost of protection is attributed to VRAs by Hufbauer et al. (see text for discussion).
[c] This figure is the sum of Hufbauer's estimates of the quota rents captured by foreign producers and the (exaggerated) loss of production efficiency. It does not, however, equal the sum of categories A, B, and D, due to the inconsistencies discussed in the text and in endnotes 40-41.

1984, $1.2 billion, is also about half that of Hufbauer et al. ($2.3 billion).[40] However, although Hufbauer et al. do not emphasize the point, they also find that the true efficiency loss from protection (excluding the quota rents given to foreign exporters by the VRAs) is only a small fraction of the total consumer cost. And even their production efficiency loss estimate of $333 million appears to be about double what it should be due to an error in calculation pointed out by Pugel (1988): this estimate covers the entire area above the line P_{d0} and under the two demand curves (D_0 and D_1) in Figure 3, which is incorrect since the area D only includes the part of this area to the left of the Q_1 line.

There are two principal sources of difference between our estimate and Hufbauer's: first, we estimate that the VRAs increased the price of imported steel by about 13 percent in 1984 (see Appendix C), while Hufbauer et al. find that the figure is 30 percent; second, our estimated pass-through rate from import prices to domestic prices (from Appendix B) is much lower than Hufbauer's (24 versus 40 percent).

Hufbauer et al. rely on parameter estimates selected from a variety of studies to produce their estimates. In some cases, important elasticities (e.g., of domestic supply) are merely assumed. In contrast, we use direct econometric estimates developed for this report, as explained in section 2 and the various Appendices. This gives our estimates greater consistency, reliability, and transparency.

One especially important problem with Hufbauer's method is the fact that parameters chosen from different studies done by different methods with different data sets may not be consistent with each other. We solve this problem by using mainly reduced-form models to estimate directly the effects of exogenous factors on equilibrium output, employment, and imports, and by using a common data set in all our estimates (except for the import price equation, where we were constrained by data limitations as explained in Appendix C). Our reduced form model in turn is an extension of the work of Grossman (1986), a highly reputed econometric study published in a leading refereed journal (and a study intended to show that imports were *not* the main cause of the steel industry's problems in the early 1980s). This gives our estimates additional credibility.

In addition, Hufbauer's estimate can be considered to be on the high end, since it takes a single year, 1984 — when import prices diverged most sharply from the world price — as a basis for calculating the cost of the VRAs. By 1989, for example, the U.S. import price was only 2.5 percent higher than the Japanese export price (see Table C1 in Appendix C).

Both estimates show that the great bulk of the welfare costs of the VRAs are composed of quota rents lost to foreign sellers. De Melo and Tarr (1990) also estimate that about 85 percent of the welfare costs of steel VRAs could have been avoided merely by capturing the quota rents through an auction quota or equivalent tariff. We estimate the quota rents to have been 92 percent of the net national welfare costs of the VRAs in 1984, and 88 percent on average for 1984-89. Subtracting the loss to the economy of having chosen this particular form of protection thus gives a better measure of the national welfare costs of trade protection. Welfare costs could have been greatly reduced or eliminated, with a similar level of protection for the domestic industry, if a tariff or auction quota had been used to protect the industry rather than a VRA.

Hufbauer et al. do not estimate the wage gains associated with the jobs saved by the VRAs. These gains are estimated in an analysis prepared by the U.S. International Trade Commission (USITC, 1989). The USITC report estimated the effects of eliminating both VRAs and tariffs. **Table 11** compares the estimates from this study and the USITC report for the costs of protection in 1986. The USITC report assumed that the VRAs increased import prices by only about 4 percent, and that the ad valorem tariff rate was also about 4 percent. Thus, about half of the USITC cost estimate is for the VRAs, with the rest reflecting the effects of existing tariffs.

The major difference between our results and those of the USITC is explained by differences in the estimated effects of the VRAs on import prices in 1986: 12.1 percent in this study versus 4.0 to 4.3 percent in the USITC report. The USITC estimate of the effects of the VRAs on import prices seems too low for several reasons. First, they assume that the U.S. market shares of steel imports would have remained constant, at their 1984 levels, if the VRAs had not been enacted. Second, they then use an analytical model, based on published price elasticity estimates, to estimate the resulting impact of the VRAs on import and domestic steel prices. There are several problems with this approach.

With respect to the constant market share hypothesis, the market shares of steel imports would have continued to climb, at least through 1985, and would have persisted for at least one to two years after the dollar began to decline in late 1985. Thus the base for the USITC's counterfactual forecast of steel imports is too low. In addition, as acknowledged in the USITC report itself, their market-share approach underestimates the volume of imports in

TABLE 11
The Cost of Protection in Steel in 1986
(in billions of dollars)

Cost concept		This Study	USITC Pub. 2222
W_c	Consumer cost of protection	2.404	1.209 to 1.313
W	Net national welfare cost of protection	1.228	.403 to .433
W'	Net national welfare cost of tariff-equivalent protection	0.167	.109 to .110[a]
L	Gains in Labor Income	.301	.034 to .035
	direct (steel)	.158	.034 to .035
	indirect (other manufacturing)	.143	not included
W*	Adjusted net national welfare cost (W' − L)	−.133	.074 to .077[b]
Memo	Employment effects (jobs saved)	25,828	7,000 to 7,300
	direct (steel)	9,159	7,000 to 7,300
	indirect (other mfg.)	16,669	not included

Sources: Authors' calculations, and USITC (1989).

Notes: Estimates from USITC report include costs of existing tariffs as well as VRAs. This study includes only the costs of the VRAs. "Tariff-equivalent protection" means replacing the VRAs with additional tariffs giving equivalent protection. Benefits are listed in the table as negative costs.

[a] Derived from data in USITC (1989), Table 3-3, p 3-8. Line 3 minus line 4 in this Table.
[b] Derived from data in USITC (1989), Table 3-3, p 3-8. Line 5 plus line 6 in this Table.
[c] See text for derivation and source.

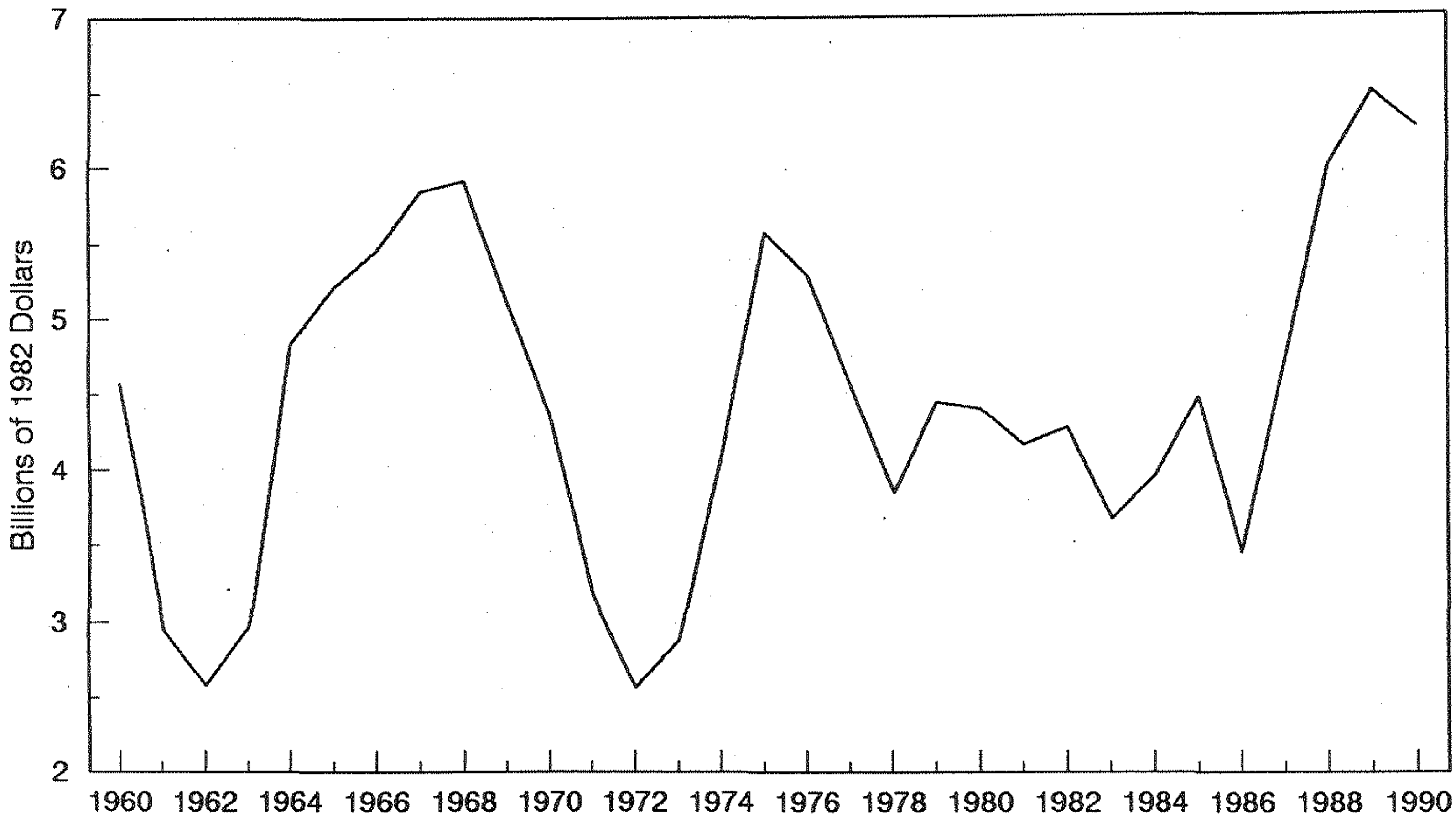
the absence of the VRAs. Total domestic consumption would have been higher without the VRAs, because both domestic and imported prices would have been lower. Finally, the procedure of selecting parameter estimates from a variety of studies is unreliable, as explained earlier in regard to Hufbauer et al.

Despite the differences in assumptions about the size of the import price effect, the USITC report provides confirmation for the general pattern of our results. Most of the national welfare costs of the VRAs (W) are the result of the use of VRAs, as opposed to tariffs or auction quotas, to protect the domestic industry, and the national welfare cost of tariff-equivalent protection (W') is quite small relative to W. In addition, the USITC report confirms the importance of labor gains created by the jobs and incomes saved by the VRAs, which further reduce that report's estimated costs of protection. The USITC only considers direct employment losses in the steel industry, and even those are less than our estimates (see Table 11). Since the USITC's estimated gains per job saved are also less than ours, its estimated gains in labor income are lower than ours. Nevertheless, the overall impression is similar: labor gains from protection are large relative to the net national welfare costs of tariff-equivalent protection.

Our estimates of the benefits of protection can be considered conservative in the sense that we do not here take into account the impact of induced innovation on domestic steel prices and output. To the extent that the VRAs raised capacity utilization and encouraged investment, they contributed to the rapid productivity growth that took place in steel in the latter half of the 1980s. **Figure 4** illustrates the sharp increase in steel investment that took place in the late 1980s. Since, as was noted earlier, the same legislation that established the VRAs *also* forced steel firms to reinvest their net cash flow in steel upgrading and modernization, it is not at all far-fetched to argue that there was some causal link between the protection of this industry and some of the productivity growth that occurred during roughly the same period. It is more difficult to establish a precise quantitative link between the protection, productivity gains, and lower domestic prices. Nonetheless, if even some portion of the unusually rapid productivity gains in steel were caused by the VRAs, and if even some portion of those gains were passed on to consumers, the resulting reductions in the domestic price of steel could easily have outweighed the increases in domestic prices caused by higher import prices (which we estimate to have averaged about 2 to 3 percent).

Review of all three studies confirms that 75 to 93 percent of the net national cost of the VRAs resulted from the use of a non-revenue-generating form of trade restriction. Furthermore, our results show that when the costs of protection are expanded to include the wage gains which result from jobs saved then a tariff or auction quota could have provided net national benefits in this case, in the short-run. The period of U.S. dollar overvaluation in the early 1980s also had permanent effects on the U.S. steel industry, which are considered separately in the next section.

Figure 4
Real Annual Investment in Steel, 1960-1990



Source: Bureau of Economic Analysis, Census Bureau, and Authors' calculations.

Note: Deflated using non-computer investment deflator from the National Income and Product Accounts.

The Costs of Hysteresis

Trade economists often maintain that trade protection (such as escape clause relief) should not be provided in cases where imports have increased as a result of exchange rate appreciation (Grossman, 1986, p. 222). This assertion is based, in part, on the assumption that changes in output and capacity which result from exchange rate fluctuations (and other macroeconomic shocks) are reversible: that is, the industry will recover when the currency returns to its long-run equilibrium value and the macroeconomy recovers. The structural dummy variables discussed in Section 2 above show that the effects of currency overvaluation and depressed demand may not have been reversible. The dramatic capacity and workforce reductions that took place in the early 1980s altered structural relations in the steel industry, increasing the rate of decline of both output and employment beyond the immediate effects of the recession and lower import prices.

Conventional estimates of the cost of protection fail to take into account the dynamic impact of import penetration — i.e., that reducing output and employment in one year can weaken the industry in subsequent years, permanently reducing its productive capacity. We calculate the job loss (and resulting social costs) of hysteresis and then compare these results with our estimates of the cost of protection.

We measure the impact of hysteresis by establishing a counterfactual scenario, which specifies an alternative historical path and compares that to the baseline scenario (as predicted by the unconstrained model). This allows us to calculate the costs to the nation of the hysteresis which resulted from the macroeconomic distortions of the 1980s. We again refer to the BLS Displaced Worker Surveys to calculate the monetary costs of the jobs lost after 1982. The social costs of hysteresis can be seen as the costs of *not having protected* the steel industry sufficiently to avoid permanent scarring during the 1980s. Taking into account the effects of hysteresis adds a dynamic element to the otherwise static analysis of the costs of protection.

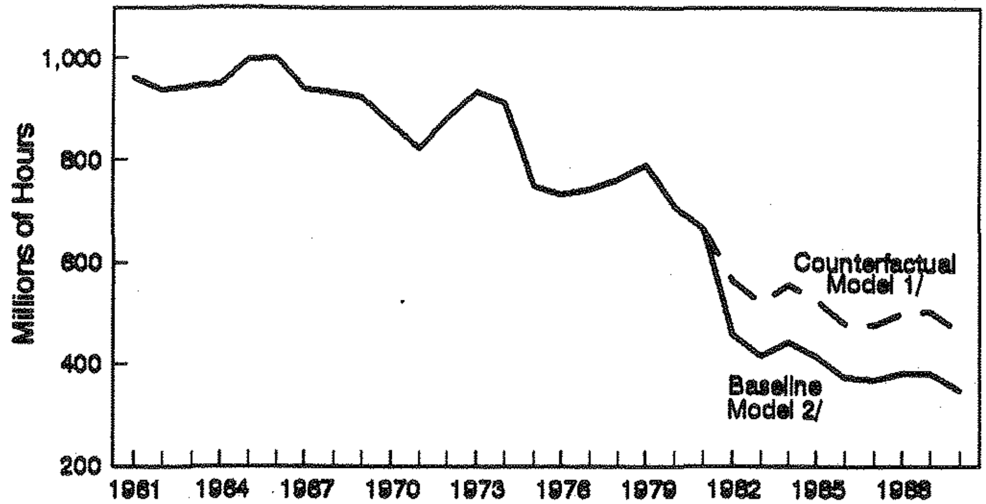
Macroeconomic distortions in the U.S. economy, which caused the steel-weighted dollar to appreciate by approximately 39 percent in real terms between 1980 and 1985, severely disrupted many traded-goods industries.

The steel industry was particularly susceptible to irreversible loss of production capacity in this period because of its high fixed costs, evolving technology, and the competitive structure of the world steel market. The structural changes in steel output and employment which occurred in the 1980s have resulted in a domestic industry which appears to be permanently smaller than it would otherwise have been. This conclusion is based on the effects of the dummy variable D82T in our output model (equation (3) in Table 3, above). A counterfactual simulation which eliminates the effects of this variable in our output and employment models is shown in **Figures 5A** and **5B**. These simulations show that output was permanently reduced by 21-30 percent by the experience of the 1980s. The rate of decline of employment (equation (5) in Table 2, above) was also increased (reflecting, in part, increased rates of productivity growth) so that by 1990 employment was 33 percent less than it otherwise would have been, and the trend rate of decline in employment was increased by almost 1 percentage point.

Hysteresis can be costly to the domestic economy in a number of ways. Such costs include the loss of productive capital stock, adjustment costs for communities and workers, and wage losses for workers in the steel or steel-supplier industries who are forced to find other, lower paying work. We consider here *only* the costs to production workers who were displaced from the steel industry because of hysteresis. This analysis builds on the "labor rents" literature (Dickens and Lang, 1987; Katz and Summers, 1989) which shows that significant and sustained pay differentials exist for workers with similar skills, because some industries pay more than others for comparable workers. In this case, a change in the distribution of employment across industries can and does lead to large economic losses.

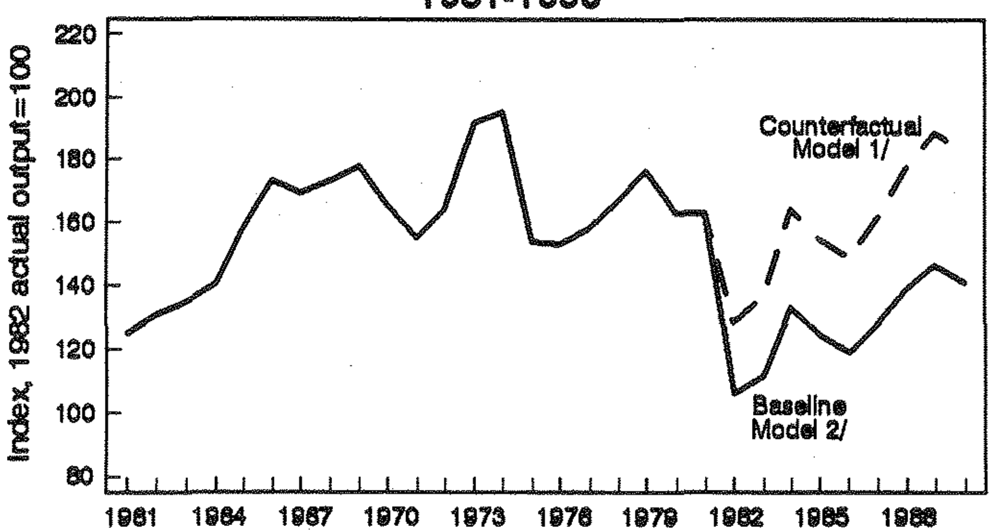
In addition to the income losses to displaced workers described above (costs of unemployment spell and reduced wages upon rehire), a large proportion of displaced workers fail to become reemployed, even after five years.[41] We assume these workers have become discouraged or were forced into early retirement, and suffer a permanent loss of their entire earning potential. Their earnings losses can be considered social losses since they are no longer contributing to national output. In order to calculate the present

Figure 5A
Effects of Structural Change on Steel Employment
1961-1990



1/ Without 1982 structural shift.
2/ With 1982 structural shift.

Figure 5B
Effects of Structural Change on Steel Output
1961-1990



1/ Without 1982 structural shift.
2/ With 1982 structural shift.

discounted value of total labor adjustment costs (assuming a discount rate of 0.1), it is necessary to multiply the permanent wage losses by 10, and add them to the one-time transitional unemployment losses.

The counterfactual estimate which is illustrated in Figure 5B shows that domestic steel output would have been 21 percent higher than it actually was in 1984 if hysteresis had not occurred. By 1990, this difference had widened to about 30 percent. **Table 12** estimates the gains to the domestic economy relative to employment levels that would have prevailed in 1985 in this industry, if the effect of the D82T dummy variable is eliminated in the output equation. This estimate is conservative for two reasons. First, it ignores the income gains of white-collar workers, who have also been displaced in the steel industry, because of an absence of data on their wages in the displaced worker surveys. Second, it omits the indirect effects of increased steel output on upstream supplier industries.

Our estimate of labor gains in Table 12, about $680 million a year, is about two-thirds of the net national cost of the VRAs, as estimated in Table 9 above. As we discussed above, however, the welfare costs of a simple tariff or an auction quota would have been much lower than those of the VRAs (only about $140 million per year). Using this basis of comparison, it is clear that trade restrictions that could have prevented the drastic losses in employment and output, while capturing the rents involved, would have yielded net benefits to the nation as a whole.

Furthermore, trade protection is a temporary measure, while the income losses associated with hysteresis are permanent. Our estimates show that the effects of the VRAs had largely dissipated by 1989.

Thus, the net present value of income losses associated with hysteresis must be contrasted with the temporary costs of protection necessary to avoid hysteresis. Assume, for purposes of illustration, that an auction quota which was three times as restrictive as the VRAs (hence three times as costly) would have been required for seven years (1982-88) in order to prevent hysteresis. The total net national cost of this form of protection would have been less than $3 billion for these seven years, as compared to a permanent income loss of

TABLE 12
Wage Losses from Hysteresis: 1985

Workers Displaced:	44,080	
	Annual Costs	Total Costs
	(millions of dollars)	
FOR THE 78.9 percent WHO ARE REEMPLOYED:		
1. Transition/Unemployment Costs	263.1	263.1
2. Permanent Wage Losses - Reemployed	383.4	3,834.0
FOR THE 21.1 percent WHO ARE NOT REEMPLOYED:		
3. Permanent Wage Loss - Dropouts	255.9	2,559.0
Grand Total Labor Adjustment Costs (Present Discounted Value with discount rate of .1)		**6,656.1**
Addendum: Loss per displaced worker:		$151,000.0

Source: Authors' calculations as described in text.

$6.7 billion from hysteresis (as shown in Table 12). Of course, simple VRAs would have been much more costly to the nation than an auction quota. However, it is clear that an efficient form of protection could have yielded positive benefits to the nation and its workers in steel and related industries.

5. Conclusions

Careful examination of the structure of the U.S. steel industry and the way in which it has responded to protection suggests that economists have been too extreme in their denunciations of trade restrictions. First, the VRAs had a much smaller impact on prices than is often claimed. Second, the argument that no additional investment was needed in the steel industry during the 1980s was exaggerated: if the steel companies had followed the advice of those advocating no new investment, they would have been in much worse shape than they are today.

Many economists, including Hufbauer and Crandall, claim that the VRAs were very expensive and fell far short of generating benefits equal to their costs. However, these economists fail to distinguish adequately between the costs of protection *per se* and the extra costs imposed by the choice of the VRAs in particular, as the instrument of trade policy.[42]

Furthermore, conventional estimates of the cost of trade protection ignore the hysteresis or permanent scarring that can occur when deep reductions in capacity and employment occur in capital-intensive industries. This paper has shown that the overvaluation of the dollar in the 1980s and the 1982 recession resulted in a persistent reduction in the levels of domestic steel output and employment. This hysteresis is extremely costly when measured in terms of lost jobs and income.

Most economists argue that better domestic macroeconomic policies could have averted the worst effects of at least some of these macroeconomic shocks to industries like steel. In particular, in its zeal to reduce inflation, the Federal Reserve seems to have overtightened monetary policy from late 1979 to mid-1982, causing unprecedented high real interest rates and two recessions. The high real interest rates in turn attracted funds into the United States, initially driving up the dollar's exchange value. The rising federal budget deficit combined with continued tight monetary policy kept real interest rates high and drove the value of the dollar still higher in 1983-84.[43] Less contractionary monetary policies, combined with a more responsible set of fiscal policies, could certainly have prevented many of these ill effects between 1980 and 1985.

But the fact remains that more sensible macroeconomic policies were *not* pursued, and internationally competitive manufacturing industries like steel suffered the consequences. The consequences included not only lost markets and jobs at the time, but permanent reductions in capacity, capital stock, and employment. Of course, some of these reductions did help to raise overall efficiency and average productivity, but they also reduced the size of the industry beyond what was indicated by its underlying fundamental competitiveness. These persistent effects of transitory macroeconomic shocks are an example of hysteresis.

Most economists believe that, if macroeconomic policy corrections cannot be made, there is nothing else that should be done to assist industries like steel in weathering the storm. We disagree. Economic theory teaches that if the "first-best" policy (which in this case would have been better macroeconomic policies to stabilize aggregate output and the value of the dollar) cannot be implemented, we must search for "second-best" policies that can accomplish the same objectives at least social cost. The objective in question was not to save all steel facilities or jobs at any cost, but to allow a more gradual modernization and rationalization of the industry consistent with its underlying competitive potential.

Economic theory further teaches that second-best policies must be precisely targeted to remedy the particular "distortions" which they are designed to offset.[44] In the present case we have two types of distortions, calling for two types of remedies. The recession, which greatly reduced the demand for steel output, can be thought of as a distortion in the level of production. In the presence of high fixed costs and rapidly evolving technology, as exist in the steel industry, a temporary reduction in the level of output can have long-term consequences for the industry's competitiveness. Constantly evolving technology means that ceasing production temporarily may handicap steel producers in future periods: in other words, a failure to pursue technological advantages constantly and aggressively will mean falling behind one's rivals, perhaps irretrievably. The appropriate countervailing policy would be a direct subsidy to steel production or, if that were not feasible, other methods of encouraging domestic steel production.

The overvaluation of the dollar, which greatly reduced the relative price of imported steel products, can be thought of as a distortion in the price signals in the international market. The appropriate countervailing policy would be a trade restriction to keep out the excessive entry of foreign steel products, either by imposing a tariff which would offset the effects of the overvalued dollar, or else by imposing an equivalent quota. In principle, then, a temporary trade policy remedy was perfectly appropriate in the 1980s given the existence of a serious distortion of the international prices facing the U.S. steel industry.

The price distortions in the U.S. steel market were exacerbated by the price dumping and subsidy practices of foreign steel producers and their governments. Penalty duties can be used to offset these unfair trade practices, but under present trade laws they can be applied only after the damage has been done to domestic producers. Proactive policies, which correct the fundamental structural problems in the global steel market are needed to prevent future disruptions of the domestic steel market.

Of course, many steel consumers are actually other industries which faced intensified international competition as a result of the global recession and overvalued dollar in the early 1980s. For these industries, such as motor vehicles and farm equipment, any trade protection for steel alone would have created a kind of scissors squeeze, as they would have had to pay more for a vital input while still facing artificially low prices of competing import products.

However, the fact that the 1980s VRAs were, in part, a response (even if not an optimal one) to macroeconomic distortions is crucial for evaluating the consumer costs of protection of the steel industry in the past decade. These costs must be set against the windfall gains that steel consumers received from the artificially low import prices resulting from the overvalued dollar and weak global demand. From this perspective, in spite of their direct costs, the VRAs still left steel consumers better off than they would have been in the absence of the macroeconomic shocks and unfairly priced steel imports, which they only partially counteracted.

Policy Implications

There are several important lessons to be learned from the experience of the steel industry in the 1980s. First, trade restriction should be of a form which allows the U.S. government — not foreign exporters — to capture the rents generated by restricting imports. While many economists prefer tariffs to any form of quantitative restraint (in the event that some form of trade restriction is called for), certain features of the global steel market may make tariffs ineffective under some circumstances. Some industry officials have argued that, due to the high-fixed-cost structure of steel production, foreign firms and governments are often willing to offset some or all of the effects of a tariff by increasing their subsidies on exports. In the presence of such behavior, quantitative restrictions offer more stability and predictability to domestic producers during periods of high demand. Global quotas which are auctioned to the highest bidders combine the desirable features of tariffs (revenue generation) and quotas (predictability). We therefore argue that if quotas are to be applied in the future, they should be of this form. A number of economists have advocated the auctioning of quota rights in recent years (see, for example, Krishna, 1991; and Bergsten et al., 1987).

Second, our findings of hysteresis in the 1980s suggest that it is also important to design policies that are proactive and not reactive. Rather than waiting until material damage has been done, trade and industrial policies should seek to identify potential problem areas early in order to avert injury which can quickly become permanent. Thus we should stand ready to implement a global auction quota rapidly, should the need arise.

Finally, the United States should continue to participate in multilateral negotiations to reduce global excess capacity. The Multilateral Steel Agreement (MSA) talks attempt to develop a multilateral approach to reducing or eliminating government subsidies and opening closed markets, thus reducing the pressure for unilateral domestic trade relief. These negotiations have recently reached an impasse, but efforts should be made to reopen the talks and encourage European producers to participate. If necessary, access to U.S. markets should be used as a bargaining chip to bring foreign producers into the negotiations.

If the MSA talks fail, our study suggests that further changes in industrial and trade policies for the steel industry should be considered. When the VRAs expired in March, the steel industry filed a number of unfair trade petitions, as discussed above, which could ultimately lead to pressures for a new VRA regime. This process is cumbersome and reactive. What the industry needs is a set of measures designed to limit the risks of unfair foreign competition in the future. Aggressive use of modified escape clause measures may be the solution.

However, Congress may wish to consider substantial changes in the escape clause implementation procedure, which is currently subject to substantial executive discretion and is limited by the requirement that imports be the "most significant cause of injury." Congress could redefine injury to the steel industry more precisely. It could direct an administrative agency to implement relief whenever certain trigger thresholds are crossed in the future, thus limiting executive discretion in the execution of these measures. These triggers could, for example, include a decline of more than 5 percent in steel import prices or an increase of more than 5 percent in steel import volumes. The remedy should also be specified clearly, in advance, with preference given to tariff duties or global auction quotas, measures which increase government revenues.

Unfortunately, it is possible that the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), if it is successfully concluded, will further restrict the application of U.S. trade remedy laws, as well as VRA-type measures. In this case, other measures which are consistent with the proposed GATT restrictions should be considered. The resulting revenues should be channeled into retooling of the domestic industry and retraining of steel workers, in order to improve the competitiveness of domestic producers. Domestic producers should continue to be required to reinvest profits from domestic steel operations in domestic capacity improvements.

Thus, we feel that additional trade protection may be justified in the future if: 1) the value of the dollar rises rapidly and unjustifiably again, as it did in the early 1980s; or 2) foreign governments or producers distort steel export prices by subsidizing production or selling below cost. We have shown that such price distortions can permanently eliminate jobs and capacity in the U.S. steel industry, resulting in substantial losses to the domestic economy. Future policies should be designed to limit their net costs to the nation and provide more direct improvements in the competitiveness of the domestic industry.

Appendix A: The Grossman Model and Data Sources

Grossman's dependent variable is the BLS measure of production worker hours (average weekly hours times the number of workers) in the blast furnaces and steel mill products industry (SIC 3312). The independent variables are a time trend, the Federal Reserve index of industrial production, the import price (measured by a unit value index), the hourly wage, an energy price index (weighted by steel industry expenditure shares), and the price of iron ore, with the last four variables all deflated by the overall BLS producer price index (PPI). All the variables (except time) are measured in natural logarithms (logs) so that the coefficients may be interpreted as elasticities.

In our model, we follow Grossman's definition of variables and data sources with the following exceptions. For the price of imported steel, we use a data series constructed by Blecker (1986) for the period 1947-83. This is a unit value index of customs values for five major types of carbon steel products (bars, hot- and cold-rolled sheet, plate, and structurals) accounting for over 60 percent of total steel imports, including estimated costs of transportation, insurance, and duties. These were the same five import products whose prices were estimated by Crandall (1981) for the period 1956-76 only. We extrapolated Blecker's series to the period 1984-1990 using the new BLS import price index for SITC 67 (after verifying that the BLS index is closely correlated with Blecker's unit value measure for the years in which they overlap). The import price was measured in dollars per net ton.

For industrial production, we use the revised Federal Reserve series, with 1987 = 100. Instead of using the hourly wage to measure the cost of labor, as Grossman does, we use the American Iron and Steel Institute's measure of total hourly compensation costs, which includes fringe benefits. This measure was not available to Grossman, who used monthly data, but is available on an annual basis.

For the energy price index, we construct a linear expenditure-weighted average of the prices of residual fuel oil, natural gas, electricity, and coking coal.[45] The price of residual fuel oil for 1960-1977 came from Blecker's (1986) data series, which was taken from oil industry sources. We update the residual fuel oil price series from 1978 to 1990 using the sale price to end user series from the U.S. Department of Energy's 1990 *Annual Energy Review*, Table 71.[46] We also use the 1990 *Annual Energy Review* for the retail price of electricity, which includes a series for our entire time period. The price of coal is taken from the U.S. Department of Energy's *Quarterly Coal Report*. The price of gas came from the *Natural Gas Annual*, also published by the U.S. Department of Energy. We used the price to industrial consumers in the East North Central region. Expenditure shares were based on the price times quantity of each input, which varied with the year.

For the price of iron ore, Grossman used the BLS producer price index (PPI), while we used a method developed in Blecker (1986) and extended by the present authors. We took a weighted average of domestic and imported iron ore prices and included estimated transportation costs. The calculation of transportation costs follows a method developed by Deily (1985).

Grossman used two versions of his model, (1) with all the variables included, and (2) with the wage rate treated as endogenous (and therefore excluded from the reduced-form model).[47] He used a five-month, free-form lag for industrial production and the wage rate, and an eighteen-month, polynomial distributed lag for the prices of imports, energy, and iron ore; the reported coefficients are "total elasticities" reflecting all the lagged effects.

In addition to large and significant negative time trends, Grossman found that steel employment was highly elastic with respect to overall industrial production. He found close to a unitary elasticity of employment with respect to the real import price. When the (real) wage is included, it has an elasticity which has the correct (negative) sign but is insignificant at the 5 percent level. The small and insignificant negative elasticity for the energy price is not surprising, since the total effect of an energy price increase on steel employment is theoretically ambiguous (it is the sum of a negative output effect and a positive substitution effect; apparently, the former slightly dominates).

The large positive elasticity for iron ore (which is significant at the 5 percent level in equation (1) in Table 2) is surprising, since it is also theoretically ambiguous, and one would not necessarily expect a large elasticity of substitution between iron ore and workers.[48] Grossman interprets this result as implying the possible endogeneity of iron ore prices, but this seems unlikely if one looks at the small correlation between the real price of iron ore and other industry variables. Some collinearity with energy prices or mismeasurement of the iron ore price are a more plausible explanations.

In comparing our estimates of the employment function (columns 3-4 in Table 2) with Grossman's (columns 1-2), the following differences may be noted. Our industrial production elasticities are slightly higher (about 1.8 versus 1.4 in the versions with the wage included), while our import price elasticities are slightly lower (about 0.8 versus 1.1 in the same version). Our estimated compensation elasticity is close to Grossman's wage elasticity in both magnitude and statistical significance level (*t*-statistic). We find a slightly greater negative energy-price elasticity, which remains insignificant at the 5 percent level. And our measures of the elasticity of steel employment with respect to the price of iron ore are much lower than Grossman's, perhaps because of better measurement of the iron ore price.

Appendix B: Domestic Price Effects

In order to estimate the relationship between the price of imported steel and the domestic price, we develop a structural model based on the earlier work of Mancke (1968), Crandall (1981), and Blecker (1989, 1991). The nominal price of steel is modelled as a function of nominal costs, including production workers' hourly compensation, and a unit materials cost index; the import price; a time trend; and the Federal Reserve Board measure of capacity utilization in manufacturing, which is used to represent demand conditions.

For the nominal price of steel, we used the average realized price (unit value) of all steel products from the Census Bureau's *Current Industrial Report* series for total value and total quantity of shipment of steel mill products (SIC 3312). We used this instead of the BLS PPI for steel mill products, which is based on list prices and does not accurately reflect variations in actual transactions prices (see U.S. Federal Trade Commission, 1977, and Blecker, 1986). The unit materials cost index is a linear expenditure-weighted index of the iron ore and energy price series described in Appendix A. A version including scrap prices was also tried, but with less satisfactory results, possibly because of the endogeneity of scrap prices.

We chose to use capacity utilization in manufacturing, rather than in the steel industry, because the industry utilization rate is endogenous. The time trend is included in order to pick up the effects of growth in labor productivity on the price of steel. All variables (except the time trend) are expressed in natural logarithms, so that their coefficients can be interpreted as elasticities.

It is also necessary to control for the effects of the 1973 oil price shock on steel prices, which affected the industry in an unprecedented manner, for a short period of time. This is reflected in the variable DSHOCK which is set equal to one in 1973 only, and 0 otherwise. Including this variable eliminates an otherwise large negative residual in 1973, which would bias our hypothesis tests.

$$PRICE_t = \underset{(0.29)}{0.179} - \underset{(-0.81)}{0.005}\, TIME_t + \underset{(2.22)}{0.283}\, COMP_t + \underset{(4.97)}{0.394}\, MATCOSTS_t$$

$$+ \underset{(3.70)}{0.481}\, CAPUTILMFG_t + \underset{(4.29)}{0.240}\, IMPPRICE_t - \underset{(-2.14)}{0.058}\, DSHOCK_t$$

Rho = 0.281 (1.20)

Adjusted R^2 = 0.997; Durbin-Watson = 1.852

(*t*-statistics are shown in parentheses.)

The import price is a significant determinant of domestic steel prices in our model. However, the implied rate of pass-through of 24 percent is only a little over half that estimated by Hufbauer et al. (1986). This suggests that domestic prices are less responsive to changes in the import price than is commonly believed.

Wages and unit materials costs show the expected positive elasticities, and are both significant at the 1 percent level. Capacity utilization in manufacturing has a positive and significant effect on price, confirming once again the hypothesis of Blecker (1989, p. 75) that the price of steel (or the markup of price over cost) was sensitive to demand conditions during this period.

Equations including dummy variables (both shift and intercept types) for the 1982-1990 period were tried, but found unsatisfactory. None of the dummy variables were significant at the 10 percent level, although they did have the expected (negative) sign. This indicates that slower steel price increases after 1982 are well explained by the included variables — especially slower growth in compensation and falling energy prices. Also, the overvalued dollar reduced the price of imported steel during the early 1980s.

Appendix C: The Effects of the VRAs on Import Prices

The VRAs caused the price of steel imported into the United States to rise above world levels for at least several years in the mid-1980s. It should be noted, however, that world prices were depressed during this period by the overvalued dollar and by global excess capacity. We use the Japanese export price as reported in PaineWebber's *World Steel Dynamics* as a benchmark, attributing the difference between the price of U.S. steel imports and the Japanese export price to the VRAs. When U.S. steel imports were largely unconstrained by quantity restrictions, the Japanese price was almost perfectly correlated with the U.S. import price.[49]

We estimated the effect of the VRAs by first regressing our measure of the price of imported steel on the Japanese export price (in dollars) and a constant term for the period from 1972 to 1983 (from the beginning of our data on Japanese export prices, to the year before most of the VRAs went into effect).

$$\text{IMPORT PRICE}_t = \underset{(6.86)}{1.205} + \underset{(25.64)}{0.792}\ \text{JAPANESE EXPORT PRICE}_t$$

Adjusted R^2 = 0.984

We used this estimated model to forecast what U.S. import prices would have been (counterfactually) in the absence of the VRAs for the period 1984-89.[50] We then used the percentage differences between these counterfactual import prices and the actual import prices as our measure of the effects of the VRAs. The results are shown in **Table C1**.

We estimate that import prices were 9.5 percent higher, on average, over the period 1984-89 than they would have been in the absence of the VRAs, with the difference peaking in 1984 at 13 percent and falling to 2.5 percent by 1989. This estimate lies between those of Hufbauer et al., 1986 (30 percent) and Mendez and Berg of the U.S. International Trade Commission (0.5 percent to 4.3 percent) (Mendez and Berg, 1989, table 1, p. 83).

We also tested a number of more sophisticated models of import pricing. We tried several versions of a pass-through model (with a test for a structural break in the pass-through relationship in the period of the VRAs) based on Hooper and Mann (1989). We also tried a reduced form model of import prices (similar to our employment and output models based on Grossman, 1986) which incorporated a dummy variables for the period of the VRAs. These efforts generated a range of estimates of how the VRAs affected import prices, both higher and lower than those shown in Table C1. The simple import price model specified above was utilized in our analyses because its out-of-sample forecast structure seemed most appropriate to the question in this case, and because its estimated effects of the VRAs on import prices were in the mid-range of all the models we tried.

TABLE C1
Estimated Percent Difference Between Price of Imported Steel and Predicted Value Based on Japanese Export Price

1984	12.96%
1985	12.72
1986	12.11
1987	10.62
1988	5.95
1989	2.47
Average, 1984-89	9.47

Source: Authors' calculations. See text for explanation.

Appendix D: The Effects of the VRAs on Import Volumes

The volume of steel imports is an endogenous variable in a reduced-form model of the steel industry. Our import volume model, shown in **Table D1**, is

TABLE D1
Reduced-form Estimates of Steel Imports
Sample 1961-1990
Dependent Variable: Steel Imports

Equation	(1)	(2)	(3)	(4)
Time Trend	-0.091 (-3.74)	-0.080 (-3.60)	-0.054 (-1.13)	-0.043 (-0.96)
Industrial Production	3.360 (5.50)	3.375 (5.42)	2.557 (2.40)	2.555 (2.42)
Import Price	-1.375 (-2.76)	-1.396 (-2.77)	-1.736 (-2.75)	-1.800 (-2.91)
Steel Compensation	0.654 (0.79)	— —	0.580 (0.69)	— —
Price of Energy	0.592 (1.37)	0.666 (1.66)	0.602 (1.44)	0.696 (1.77)
Price of Iron ore	-0.290 (-0.51)	-0.211 (-0.37)	-0.525 (-0.84)	-0.487 (-0.79)
D82T	—	—	-0.0009 (-0.92)	-0.009 (-1.00)
Rho	0.103 (0.37)	0.153 (0.63)	0.100 (0.35)	0.112 (0.42)
Adjusted R^2	0.901	0.902	0.900	0.902
Durbin-Watson Statistic	1.926	1.912	1.924	1.921

Note: All variables except the time trend and D82T are measured in natural logarithms. Steel compensation, the price of energy, and the price of iron ore have been deflated by the aggregate PPI. *T*-statistics are shown in parentheses. Variables are defined as in Table 2.

based on the reduced-form model used for output and employment described in Section 2. We use AISI statistics for our steel import variable.

The results of our basic steel import equation are shown in equations (1) and (2) in Table D1. Equation (1) is the basic model, and equation (2) is the model without steel compensation as an independent variable. As with our earlier reduced-form equations, it was estimated in double-log form, using annual data for the 1960-1990 period. Estimates are reported for the Cochran-Orcutt autocorrelation correction.

It is interesting to note that the time trend for import volume is large, *negative*, and significant at the 1 percent level. However, imports are *highly* sensitive to the level of industrial production, which more than compensates for the negative time trend over the long term, resulting in a generally rising level of total imports. It is likely that these results reflect multicollinearity between the time trend and industrial production, in which case these particular coefficients should be interpreted with caution. The coefficient on import prices has the expected (negative) sign and is significant at the 5 percent level. The demand for imports is price elastic. This reflects the high degree of substitutability between foreign and domestic steel.

For consistency with our output and employment models, we added the structural dummy variable used in our earlier reduced-form equations, D82T, to equations (3) and (4). The dummy was not statistically significant in either equation. The reason for this is that hysteresis following the 1982 crisis did not affect the volume of imported steel, as it did domestic output and employment, due in part to the effects of the VRAs. In our welfare calculations in Section 4, we used the import-price elasticity from equation (4), in order to maintain a consistent structure in the reduced-form model.

Appendix E: Estimates of the Cost of Steel Protection, 1984-89

We estimated the costs of protection using the analytical framework described in Section 4, above. To estimate what domestic output would have been without the VRAs, we made a counterfactual estimate using the output model in equation (4) from Table 3. This was the model with a time trend to capture hysteresis and structural change, and with the compensation variable omitted.[51] We estimated the import prices which would have prevailed in the absence of the VRAs as explained in Appendix C (this gives us the series for P_{m0}). Then we simulated the output model using those estimated no-VRA import prices in place of the actual import prices. This exercise generated estimates of Q_0, the predicted level of output in the absence of the VRAs. The model baseline (fitted value of output with actual import prices) was used to generate Q_1, the level of output with the VRAs.

M_i and P_{di} (with $i = 0$ without the VRAs and 1 with the VRAs) were then estimated in a similar fashion using, respectively, equation (4) from Table D1 (import volume equation) and the domestic price equation from Appendix B. The resulting estimates were used to calculate the costs of protection, as described in Section 4 above. Our cost of protection estimates for each year between 1984 and 1989 are reported in **Table E1** (below), along with the estimates of Q_i, M_i, P_{di} and P_{mi} ($i = 0, 1$) used in developing these estimates. The average cost estimates for 1984 to 1989 reported in text Table 9 are based on these annual figures.

Benefits of Protection

The VRAs provided temporary relief from the effects of lower import prices in the mid-1980s. Our analysis shows that without the VRAs more steel workers would have been displaced and forced to locate other employment. We calculate the benefits of the VRAs from estimates of the wage losses of workers displaced from the steel industry. The effects of the VRAs on domestic output (through higher import prices) are used to estimate the number of jobs

Table E1

Estimates of the Cost of Protection, 1984-1989

Welfare costs of the VRAs in:		1984	1985	1986	1987	1988	1989
Predicted values of (1 in label refers to level with VRAs, 0 is without VRAs):							
P_{m1}--Dollars per ton		396	388	387	420	493	515
P_{m0} "		345	339	340	376	464	503
P_{d1} "		504	489	470	479	498	514
P_{d0} "		488	473	456	466	491	511
M_1--millions of tons		24	22	23	23	21	18
M_0 "		26	28	28	28	25	19
Q_1 "		93	91	90	97	107	107
Q_0 "		89	86	85	92	104	106
Cost Element:	(Formula)	(Millions of Dollars)					
A--Quota Rents	(Pm1-Pm0)*M1	1,214	1,086	1,061	1,005	616	226
B--Consumer Efficiency Loss	.5*(Pm1-Pm0)*(M0-M1)	63	153	130	124	56	10
C--Producer Surplus	(Pd1-Pd0)*Q0	1,464	1,349	1,212	1,175	753	325
D--Producer Efficiency Loss	.5*(Pd1-Pd0)*(Q1-Q0)	34	43	37	32	13	3
W_c--Consumer Welfare Loss (A + B + C)		2,741	2,587	2,404	2,304	1,425	561
W--National Welfare Loss from VRAs (A + B + D)		1,311	1,282	1,228	1,161	684	239
W'--Net National Cost of Tariff-Equivalent Protection (B + D)		98	196	167	156	68	13
L--Gains in labor income		302	356	301	259	178	83
W*--Adjusted Net National Cost of Tariff-Equivalent Protection (B + D - L)		–205	–160	–133	–103	–109	–71

Note: Negative net costs indicate net benefits.

saved (temporarily) by trade restraints. Our estimates of the labor costs of eliminating the VRAs are shown in **Table E2.**

Displaced steel workers experienced reduced incomes for three reasons. First, they earned no wages while unemployed. Second, they tended to suffer a decline in weekly earnings once they were reemployed. Third, some workers were unable to find new jobs, for as long as five years after losing their jobs. We treat the lost incomes of these workers as a *social* loss, as well as a personal loss. Analysis of data from the January 1988 and January 1990 BLS Displaced Worker Surveys has shown that displaced steel workers are unemployed for an average of 28.6 weeks (Podgursky, 1991). Since pre-displacement weekly earnings were about $529, their wage losses while unemployed equaled $15,132. Once they were reemployed their average weekly compensation (including estimated benefits) fell by $163 — about 31 percent.

We assume that the immediate benefits each worker gains from *not being displaced* include half of his/her unemployment costs (assuming workers receive unemployment compensation which would equal approximately half of their normal income) during the 28.6 weeks of unemployment, plus the difference between their pre- and post-displacement pay for the remainder of the year. We also include the total wage of those workers who were unable to find new employment after being laid off — 21.2 percent of displaced steel workers were not reemployed as of the survey date.[52]

In order to calculate the total income losses averted by the VRAs, we sum the losses for each of the three categories discussed above. We include both the jobs saved in the steel industry itself and jobs saved indirectly in supplier industries. In 1984, for example, 9,213 steel workers would have been displaced if the VRAs had not been enacted. Gains per workers (from the VRAs) totaled $17,212 (for all three factors listed above). Total labor gains to workers in the steel industry in 1984 equaled $158.6 million.

According to BLS employment tables, each job in the steel industry is associated with 1.82 jobs in other sectors. Thus, an additional 16,767 workers in other industries were also affected by the VRAs. Valuing these jobs at the manufacturing average, we find that the indirect jobs saved by the VRAs produced gains of an additional $143.7 million.[53] The total labor gains from the VRAs for 1984 were thus $302 million. The labor gains for the other years are calculated in a similar fashion.

Table E2

Components of L, the Labor Costs of Eliminating the VRAs

Year:			1984	1985	1986	1987	1988	1989	Average: 1984-89
Total workers in SIC 3312:			205,000	181,700	160,100	154,200	163,700	163,900	
Workers displaced									
Steel:	(Q1-Q0)/Q1)*wrks3312		9,213	10,840	9,159	7,890	5,412	2,538	7,509
All manufacturing (multiplier = 1.82):			16,767	19,729	16,669	14,361	9,850	4,619	13,666
	total jobs saved:		25,979	30,569	25,828	22,251	15,261	7,157	21,174
Temp Wage Losses--Steel Industry	(Millions of	Dollars)	159	187	158	136	93	44	129
Temp Wage losses other industries	(Millions of	Dollars)	144	169	143	123	84	40	117
Memo:									
Labor Losses									
Costs Per Worker (1988-1990 averages)			All mfg	steel					
Unemployment cost (.5*lost wages)			4,502	7,566					
Change in Annual Earnings									
for those Reemployed									
(52-mean wks jobless duration)*wage change			1,336	3,814					
Losses for those not reemployed			2,735	5,832					
total labor losses per worker displaced			8,572	17,212					

Endnotes

1. See Howell et al. (1988) for a comprehensive discussion of international government intervention in the steel industry.

2. This calculation measures the change in the exchange value of the dollar against the currencies of our major steel trading partners, correcting for differential rates of inflation (measured by the producer price index). We excluded Brazil from the calculation, since Brazil's inflation rate is so high that its measurement may not be reliable. When Brazil is included, the real steel-weighted dollar appreciated by 35 percent. Sources: exchange rates from the U.S. Board of Governors of the Federal Reserve System and the International Monetary Fund, *International Financial Statistics*, 1991 Yearbook; imports from AISI, *Annual Statistical Report: 1980;* producer price indexes from the International Monetary Fund, *International Financial Statistics*, 1991 Yearbook, and, for Taiwan, the Central Bank of China (Taiwan District, Republic of China), *Financial Statistics*, September 1991.

3. It is worth noting that at the time Reagan authorized the 1984 VRAs, most analysts believed that the price of imported steel would rise significantly as a result. Hufbauer et al. (1986, p. 179) write that Robert Crandall estimated that the VRAs would cause the price of imported steel to rise an *additional* 20 percent (beyond the 25 percent premium attributed to the EC VRAs). This additional price rise never materialized.

4. Figures are as of November 1990. Marcus and Kirsis, *World Steel Dynamics*, June 18, 1991, p. 55.

5. We show the indexes for 331 hours and output in Figure 1 because the BLS does not have an output index for 3312. Grossman argued that the four-digit 3312 sector more accurately captures the parts of the steel industry which sought trade relief in the early 1980s than the three-digit 331 sector (blast furnaces and steel products). Sector 3312 accounts for the lion's share of 331 employment (76 percent as of June 1991), and the trends in production worker hours in both sectors are very similar.

6. But see the business literature such as Howell et al. (1988) for a different view.

7. Despite their economic inefficiency, VRAs or other quantitative restraints administered by foreign exporters present a politically convenient option for domestic policymakers. They are preferred above tariffs both by domestic producers and foreign governments. Domestic producers like the predictability and stability of trade protection via quantitative restrictions. Foreign governments, on the other hand, prefer VRAs because of the quota rents foreign producers are able to capture. Since foreign producers capture the quota rents, foreign governments are less likely to retaliate or launch a trade war than they are in response to a tariff. Also, and perhaps most relevant,

"voluntary" export restraints do not violate GATT, nor do they require explicit proof of injury under U.S. trade laws.

8. Tariffs, in the form of a tax on imports, generate revenues collected by the domestic government. Export restraints, on the other hand, like the VRAs, are quotas or quantitative restrictions negotiated bilaterally between governments. Since they are administered and allocated by the foreign government, they do not allow the domestic government to capture the quota rents. An alternative form of quota, such as the auction quotas we discuss in the Conclusion, would allow the domestic government to capture these rents.

9. It should be noted that, if the dollar had not been overvalued, there would have been little political pressure to implement the VRAs.

10. Similar points have been made by Crandall (1981), Barnett and Schorsch (1983), and Blecker (1991) with regard to earlier periods.

11. All significance levels reported in this paper are for two-tail tests.

12. See Mirowski and Sklivas (1991) for insightful discussion of the hazards and rewards of attempting to replicate econometric results.

13. There are several advantages to using annual rather than monthly data. Some variables can be measured more accurately on an annual basis, particularly total labor compensation (as opposed to just wages) and iron ore prices. Use of annual data also reduces somewhat the problems with serial correlation that tend to arise with monthly data. The most important motivation in lengthening the series, however, was to obtain a longer historical perspective on the changes in employment in the 1980s.

14. One explanation for this somewhat surprising result is that compensation affects output mainly through the price-elasticity of demand, due to mark-up pricing behavior. Labor demand, on the other hand, is relatively inelastic with respect to compensation.

15. The first and most prominent example of this literature is Adams and Dirlam (1966).

16. Some of these variables might be internally explained or endogenous variables in a more complete model of the industry, whereas all the regressors in Grossman's model are independent or exogenous.

17. We assume that Crandall has used SIC sector 331 (since the BLS does not produce a more disaggregated productivity index).

18. The frequency of the data is not reported, but would seem to be annual from the magnitude of the coefficient on time. A *rho* coefficient is given, but without a *t*-statistic or standard error; the AR1 procedure used to correct for autocorrelated errors is also not reported. Crandall's model also includes a constant term, which we do not report here. In a regression in log-levels, the

constant reflects the natural units in which the logged variables are measured, and thus is not of any intrinsic interest. The other coefficients are all elasticities, except the time trend, which captures the exponential annual growth rate of the part of productivity growth not explained by the other included variables.

19. Crandall does not report whether he used the index for all employees or for production workers only.

20. These are the two non-iterative AR1 procedures available in our software package, IBM-PC version 3.02 of RATS (© VAR Econometrics, Inc.).

21. It is possible that the BLS productivity indexes have been revised since Crandall used them, although we deliberately used the unrevised Fed utilization and capacity indexes (based on 1977=100) which were available when he wrote his paper. Differences in the software packages, AR1 procedures, and computer hardware probably account for the remaining discrepancies.

22. In fact, in an earlier paper, Crandall (1986, p. 198) did attempt to measure "the contribution of changes in the capital-labour ratio to the growth in labour productivity." In a model that included only three variables--a time trend, capacity utilization, and the capital-labor ratio--Crandall found virtually no influence of the capital-labor ratio on productivity. Since Crandall does not give sufficient information about how he calculated his capital-stock variable, we cannot easily compare those results to ours.

23. The capital stock was estimated by accumulating real expenditures on new plant and equipment in blast furnaces and steel works in constant 1982 dollars and assuming a 20-year service life for all plant and equipment with straight-line depreciation. New plant and equipment expenditure data are from the Department of Commerce, Bureau of Economic Analysis (before 1978) and Bureau of the Census (from 1978 to 1990). The current dollar expenditures were deflated by the implicit deflator for nonresidential, non-computer, fixed investment (1982=100) from the BEA's national income and product accounts. Computers (information processing equipment) were excluded because the BEA's hedonic measure of "real" computer output overstates the growth of computer investment and thus understates the implicit deflator in the late 1980s when the hedonic attributes of personal computers are measured in 1982 dollars. In any case, computers are much less important in the steel industry than elsewhere in the economy, and the series for real expenditures thus calculated almost exactly matches the real expenditure series in 1972 dollars (converted to 1982 dollars) formerly reported by the BEA for the overlapping years.

The trend of labor employed in the steel industry was measured by a five-year moving average of the BLS index of labor hours in SIC sector 331. This was done in order to purge the labor hours measure of its correlation with the utilization variable. The indexes for either all employees or production workers' hours were used for consistency with the different productivity measures. Finally, the logs of the ratios of the capital stock to the appropriate labor hours trend variables were used in the regressions reported in Tables 5 and 6.

24. The results are similar for all employees except that the capital-labor trend variable is less significant. The results are not affected substantially if the Beach-MacKinnon maximum-likelihood procedure is used instead of Cochran-Orcutt.

25. The results from using equation (3) in Table 6, which is the same but in OLS (no AR1 correction), are very similar to those reported here. The AR1 version was preferred because it explained slightly more of the change in productivity (47.6 versus 47.1 percent out of the actual change of 48.6 percent).

26. Using two-year averages lessens the impact of unusual one-year fluctuations in any one variable. These particular pairs of years are similar in their business cycle characteristics (both periods include a business cycle peak and downturn).

27. A "lag" is the value of the same variable from a previous time period. Including a lag of the import price, for example, makes it possible to determine whether the dependent variable is affected by past values of import prices, as well as by present values.

28. Partial-equilibrium analysis examines a single market in isolation, as opposed to general-equilibrium analysis, which attempts to measure the economy-wide repercussions of trade restrictions.

29. The assumption of imperfect substitutes implies that the domestic and imported goods can have different prices, which is likely to occur when the products are either differentiated or are aggregates with different mixes of individual products. Our implementation of this model most closely follows William Cline's (1990) study of textiles and apparel. For an application of essentially the same type of model to the steel industry see U.S. International Trade Commission (USITC, 1989). Hufbauer et al. (1986) use a similar model, but make some mistakes in implementing it as discussed below.

30. Henceforth, whenever the phrase "tariff equivalent protection" is used it is meant to include also an equivalent auction quota, unless otherwise indicated.

31. Note that the counterfactual scenario 0 is not pure free trade, since it includes the effects of the basic American tariffs on steel. We do not estimate the effects of removing all trade protection from steel in this report, as Hufbauer et al. (1986) and USITC (1989) do. We focus only on the effects of the VRAs.

32. Note that this model assumes infinitely elastic supplies of steel imports at a given world price (including any baseline tariff) P_{m0}, i.e., that U.S. demand does not influence the world price of steel. While this is not literally true, it is

a common simplifying assumption in studies that measure the cost of protection (including the sources cited in note 29, above).

33. Technically, there should be two demand curves for imports, since demand for imports is higher when the VRAs are in effect and thus domestic steel is more expensive. However, this difference is likely to be small in practice, and in any case is usually ignored in empirical studies applying this method of estimating the costs of protection (see the citations in note 29, above).

34. We do not count the area between the two domestic demand curves as an increase in consumers' surplus, since consumers would not have been willing to buy the larger quantities of the domestic goods indicated by the curve D_{d1} in the absence of the import restraints.

35. In fact, the gain in producer surplus is *larger* than the area C, since it also includes the near-triangle *between* C and D in Figure 3 (bounded by the demand curve D_0), the supply curve S, and the higher price P_{d1}. In our measurement of the costs and benefits of protection, we measure the gain in producer surplus conservatively by the area A only (following the procedure of Cline, 1990).

36. See Scott (1990) and Blecker (1991) for examples of such quantification.

37. Cline (1990) is quite careful to distinguish shifts in demand curves for domestic and imported goods from movements along those curves. Our empirical techniques do not allow for such precision because of their reduced-form structure. However, the price changes we estimate for the effects of the VRAs are so small that we need not be concerned with these second-order effects here.

38. Note that this comparison is between import prices with and without the VRAs, but does not take into account what import prices would have been without the VRAs *and* without the overvalued dollar.

39. Hufbauer et al. present their results rather confusingly in a table in their statistical Appendix (pp. 178-80). Footnote h to that table (p. 180) says that the increased price of steel imports due to all protection caused a loss of \$3.0 billion, of which \$0.5 billion (1/6) is attributed to tariff revenue, and \$2.5 billion (5/6) to the quota rents from the VRAs. Presumably, this is their estimate of the area A in our Figure 3 (they do not give an estimate of area B). We apply the 5/6 ratio to their total consumer cost (which also includes a transfer of \$3.8 billion to producers) in order to obtain the consumer cost of the VRAs. However, it should be noted that the numbers in the table itself (on p. 179) do not add up correctly. The table lists the quota rents ("gains from restraints to foreigners") as \$2.0 billion, and the tariff revenue as \$560 million. These figures, added to the \$3.8 billion gain to producers, would yield a total consumer cost of protection of only \$6.3 billion.

40. As explained in the previous note, Hufbauer's figures do not add up correctly, so it is difficult to know exactly what their measure of W is. We calculated the $2.3 billion by adding the "gain from restraints to foreigners" (quota rents, area A) listed as $2.0 billion to the $0.333 billion of "efficiency loss from larger domestic production in the United States" (the loss of production efficiency, area D; they did not calculate an efficiency loss from lower consumption of imports, area B). Even if only 5/6 of the efficiency loss is attributed to the VRAs, the net loss is still about $2.3 billion.

41. About 21 percent of steel workers who had been displaced from full-time jobs due to plant shutdowns or permanent layoffs at least one year prior to the survey date had not been reemployed by the survey date (Podgursky, 1991).

42. De Melo and Tarr (1990) do make this point quite clearly in their analysis of the costs of the VRAs.

43. See Blecker (1992) for a survey of arguments on the macro causes of the dollar's rise in value. The final ascent of the dollar in 1984-85 seems to have been due to a "speculative bubble" in the foreign exchange market, with currency traders betting on continued appreciation of the dollar in spite of the fact that U.S. interest rates were already falling relative to foreign interest rates.

44. See Bhagwati and Srinivasan (1983).

45. For earlier estimates of these energy prices see Duke et al. (1977) and Blecker (1986).

46. This required adjusting Blecker's earlier series up by a factor of 1.176 for consistency.

47. Grossman tests for exogeneity of the wage and is unable to reject it. In any case, the evidence in Lawrence and Lawrence (1985) suggests that steel compensation is not affected by current industry performance in any simple way, but rather is determined by a bargaining process over oligopoly rents in which the current profitability of the industry would be just one determining factor.

48. However, if one regards iron ore as a complementary input with capital (since iron ore must be reduced to pig iron in capital-intensive blast furnaces), then there may in fact be some aggregate substitutability between iron ore *cum* blast furnaces, which are used intensively in integrated steelmaking, and labor, which is used more intensively in nonintegrated steelmaking (using electric furnaces charged with scrap). Note that this does not really imply substitutability between labor and iron ore in a single steelmaking process, but rather a switch in technique between two different processes which utilize these inputs in different proportions. It is more like a shift from one fixed-coefficient technique to another, rather than a move along a smoothly curved isoquant.

49. Apparently, the price effects of the Trigger Price Mechanisms of the late 1970s and the EC VRAs of the early 1980s were not pervasive or consistent enough to cause the U.S. import price to deviate significantly from the world price before the VRA period. Or else, the effects of Trigger Prices were incorporated in the Japanese export prices.

50. Since the 1990 figure for the Japanese export price was not available at the time when this work was done, our analysis goes only through 1989. In any case, the VRAs are generally believed not to have been binding by 1990, and our results shown in Table C1 indicate that they had little effect on import prices by 1989.

51. Equation (3) with the D82T interactive dummy and with compensation included has a low and statistically insignificant estimated import-price elasticity of steel output. Therefore, equation (4) was preferred.

52. This figure counts only those workers who were displaced at least one year before the survey date. Thus, we do not count some short-term unemployment here (Podgursky, 1991).

53. Using the same assumptions noted in the text, we estimate that the average displaced manufacturing worker experienced the following losses: one-half of the pre-displacement earnings for the mean duration of unemployment (0.5 x $446 x 20.2 weeks) plus the change in weekly compensation for the duration of the year ($42 x 31.8 weeks). This amounts to $5,837 for each of the 16,767 workers who would have been displaced in 1984 and who experienced temporary spells of unemployment, which comes to $98 million. In addition, 11.8 percent of manufacturing workers were unable to find new jobs at the survey date, so their incomes were also lost: $446 x 52 x 1,979 = $46 million. Thus total gains in the rest of the manufacturing sector equaled $144 billion in 1984, as shown in Table E2. The data on earnings losses and duration of unemployment spells were supplied by Michael Podgursky for the Economic Policy Institute using the 1988 and 1990 Displaced Worker Surveys.

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