WORKING
PAPERS

FACTORS AFFECTING STEEL EMPLOYMENT BESIDES STEEL IMPORTS

Douglas W. Webbink

WORKING PAPER NO. 128

July 1985

BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580

FACTORS AFFECTING STEEL EMPLOYMENT BESIDES STEEL IMPORTS

by

Douglas W. Webbink*

Federal Trade Commission

Bureau of Economics

July, 1985

* The views expressed here are my own and do not necessarily reflect the position of the Federal Trade Commission or any individual Commissioner. I wish to thank Keith Anderson, Richard Higgins, Robert Rogers and David Tarr for helpful comments. I also wish to thank Nancy Cole for doing much of the computer work, Cliff Huang for help with several econometric questions and Gene Grossman for supplying most of the data.

Introduction

An important current international trade issue is the extent to which the decline in production and hence employment in the U.S. steel industry has been caused by imports of foreign steel, as compared to other possible causes. In filings before the International Trade Commission and in hearings before Congressional Committees, the domestic steel producers and the steel unions have claimed that they are being substantially harmed by steel imports, that imports are a major cause of the decline in steel production and employment, and that import quotas are necessary to protect them.

However, a variety of factors other than steel imports have had a substantial negative impact on steel production and employment in recent years. Among the most important of those factors is the increase in wages and fringe benefits paid to steel workers compared to wages and fringe benefits in other manufacturing industries. Other significant factors include fluctuations in the overall level of industrial production, the substitution of materials such as aluminum and plastic in place of steel in the production of automobiles, cans and buildings, the decrease in the average size and weight and hence steel content of domestic automobiles and the decline in the total production of U.S. automobiles.

The purpose of this present paper is to study the impact of these various effects on domestic steel employment and to improve on an earlier study done by Gene Grossman.[1]

Grossman's Model

In his earlier study, using monthly data for January 1973 through October 1983, Professor Gene Grossman estimated employment in the steel industry using the following reduced form equation:

$$(1) \quad Log(L_s) = a_o + a_1 T + a_2 Log(P_e/P_a) + a_3 Log(W_s/P_a) + a_4 Log(P_i/P_a) + a_5 [EP_s^*(1+t_s)/P_a] + a_6 Log(Q)$$

Where:

L_s = Average (total) weekly hours of employment by production workers in SIC industry 3312, the blast furnace and steel mill industry

T = time in months

P_e = price index for the price of energy used in SIC 3312

---

[1] Grossman (1984). For an application of a similar type model applied to the domestic auto industry, see: Munger (1985).

P_a = aggregate producer price index for all manufacturing

W_s = average hourly wage of production workers in SIC 3312

P_i = price of iron ore

E = foreign exchange rate

P_s^* = foreign price of imported steel, net of U.S. tariffs

t_s = tariff rate on U.S. steel imports

Q = index of industrial production

Grossman's reduced form results were based upon a simple model of steel production, derived demand for steel factor inputs and final demand for steel in the domestic steel industry. Domestic steel is assumed to be produced using five inputs: labor (L_s), capital (K_s), energy (E_s), iron ore (I_s), and scrap steel (M_s). Steel production is assumed to fit a Cobb-Douglas production function:

$$(2) \quad Y_s = Ae^{ht}(K_s)^{b_1}(L_s)^{b_2}(E_s)^{b_3}(I_s)^{b_4}(M_s)^{(1-b_1-b_2-b_3-b_4)}$$

Where:

Y_s = output of steel

In this model, energy and iron ore are assumed to be internationally traded inputs, supplied competitively. Purchases of energy by the steel industry are assumed to be a small enough fraction of total energy production that the steel industry faces a perfectly elastic supply of energy. In the case of iron ore, it is assumed that purchases of iron ore by the domestic steel industry do not cause international iron ore prices to rise or fall, since the U.S. consumes less than 10 percent of the total world production of iron ore, so that within that range the supply curve of iron ore is perfectly elastic.[2] Hence the price of each of those inputs may be assumed to be determined exogenously. In that case, those inputs will be purchased by steel firms up to the point where their marginal value product equals their price.

The derived factor demands for energy and iron ore are as follows:

(3) $E_s = (b_3 P_s Y_s)/P_e$

(4) $I_s = (b_4 P_s Y_s)/P_i$

Where P_s = the price of steel.

---

2 In 1982, total world production of iron ore was about 762.3 million tons, and U.S. consumption was about 60.9 million tons, or about 8 percent. American Iron and Steel Institute (1983, 1984).

Capital is a non-traded input, and is determined exogenously and grows at a steady rate over time, so that the supply of capital used in steel production is:

(5) $K_s = K_s e^{ct}$

Scrap steel and labor are also non-traded inputs. The derived demand for scrap steel, and for labor is:

(6) $M_s = [(1-b_1-b_2-b_3-b_4)P_sY_s]/P_m$

where P_m = the price of scrap.

(7) $L_s = (b_2P_sY_s)/W_s$

Wages are assumed to be determined exogenously by the relative bargaining power of steel labor unions with respect to steel producers, and by overall labor market conditions; rather than by the specific supply and demand conditions in the steel labor market.

The supply of scrap steel depends upon its relative price:

(8) $M_s = M(P_m/P_a)^d$

where P_a = the aggregate price level.

Finally, the demand for domestic steel is assumed to be a function of a secular shift in the demand for steel, the relative price of imported steel (taking into account the exchange rate and the tariff rate on steel), the relative price of domestic steel, and the level of aggregate industrial production. Domestic steel is an imperfect substitute for imported steel. Hence, the demand for steel is:

$$(9)\quad Y = Be^{jt}[EP_s^*(1+t_s)/P_s]^{d_1}(Pa/Ps)^{d_2}(Q)^{d_3}$$

Equations (2) through (9) make up the model from which the reduced form in equation (1) may be derived.

Using his reduced form equation, Grossman obtained the following steady state equilibrium results:[3]

---

[3] Actually these are steady state equilibrium values of the coefficients which show the total response after all lag adjustments have been made. In his study, Grossman used 18 month polynomial distributed lags for the import price, price of energy and price of iron ore; and 5 month free lags for industrial production and the wages of steel workers. He also corrected for first-order serial correlation of the residuals using an iterative maximum-likelihood procedure.

Table 1

Grossman's Reduced Form Regression Results

$$\text{Log}(L_s) = \underset{(3.160)}{16.152^*} \quad \underset{(.0008)}{-.0075T^*} \quad \underset{(.456)}{-.037\log(P_e/P_a)}$$

$$\underset{(.422)}{-.596\log(W_s/P_a)} \quad \underset{(.740)}{+1.549\log(P_i/P_e)} \quad \underset{(.397)}{+1.067\log[EP_s^*(1+t_s)/P_a]^*}$$

$$\underset{(.312)}{+1.400\log(Q)^*}$$

$R^2 = .97$

Serial Correlation Coefficient = 0.821 (0.050)

F = 1799.5

n = 130

(Note: The numbers in parentheses are the standard errors).

* Indicates that the coefficient is significant at the .01 level.

Since all variables, except time, are expressed in logs, the coefficients represent elasticities with respect to employment in the steel industry. In Grossman's study, the import price variable has the predicted sign and is statistically significant. Industrial production also has the predicted sign and is statistically significant. The coefficient for steel wages has the predicted sign, but is not statistically significant; the price of energy has the predicted sign but is also not statistically significant; and the price of iron ore has the wrong sign. The variable with the largest t-value, however, is the time trend, a variable that affects both supply and demand factors, as equations (5) and (9) indicate. The large and highly significant coefficient on time is especially striking, since is, in essence, a measure of our ignorance of the other factors such as changes in productivity in steel production and changes in the use of steel in autos, cans and buildings that have caused both supply and demand to shift over time. In addition, the coefficient on wage rates was smaller than we might have expected.

After running this regression, Grossman then used his regression results to simulate a series of counterfactual situations in which the coefficients obtained from the regression results were used, but a different value was assumed for one of the independent variables at a time. In his results, Grossman found that secular time shifts were the largest cause of declining U.S. steel employment. The next largest effect was due to changes in international currency exchange rates, followed by the low real rate of growth in the economy. Grossman also found that if international exchange rates were held constant, steel imports would have had only had a small impact on domestic steel employment. Surprisingly, Grossman also found that rising domestic steel wages only had a small impact on domestic steel employment.

<u>The New Regression</u>

Using Grossman's model with a few significant modifications and additional data, we have re-estimated his results. We were especially interested in seeing whether a measure of total labor compensation would show a larger impact on steel employment than did Grossman's wage rate measure. We have used a model of the form:

$$(10)\quad \text{Log}(L_s) = a_o + a_1T + a_2\text{Log}(C_s/P_a) + a_3\log(P_m/P_a) + a_4\text{Log}(P_e/P_a) + a_5\text{Log}(EP_s^*(1+t_s)/P_a] + a_6\text{Log}(Q) + a_7\text{Log}(A_s)$$

where:

C_s = Index of total compensation to steel production workers

A_s = Average pounds of steel in U.S. produced automobiles

and all the other variables have the same definition as in equation (1).

We used an index of total compensation as an alternative measure to steel employees' wages, because it is well known that total compensation rose significantly faster than wages in the late 1970's. Demand for labor should depend upon the total cost to an employer of an employee, not just wages, so total compensation should be a better explanatory variable than wages alone.

As we mentioned earlier, the time trend in Grossman's model picks up both demand and supply shifts, and it is not possible to untangle them within the reduced form equation. In order to attempt to untangle them at least in part, we have included as a separate independent variable the number of pounds of steel per new U.S. automobile produced during the time period 1973 to 1983. That figure has declined because of increased production of smaller and lighter cars in order to increase gasoline mileage, and also because of a shift from steel to aluminum and plastic in the construction of automobiles, again principally in order to save weight, and thus increase gasoline mileage. Since the automobile industry accounted for between 14.9 and 23.9 percent of total consumption of domestically produced steel during this time period, the amount of steel per auto should have a significant and positive impact on steel production and consumption.

The Data

Most of our data were obtained from Gene Grossman.[4] The dependent variable in the regression is the log of total average weekly hours of employment by production workers in SIC 3312, the blast furnace and steel mill industry, and was taken from the Bureau of Labor Statistics (BLS) Publication, Employment and

---

[4] These were the data used in Grossman (1984).

Earnings. The net-of-tariff price of steel was calculated as the geometric weighted average of import unit values of three groups of steel products: tubes, pipes and fittings; universals, plates and sheets; and wire rods, structurals, bars and pilings, weighted by their import shares in 1977. That price was then multiplied by one plus the relevant tariff rate, and then the series was deflated by the aggregate producer price index, as reported in the BLS publication, _Producer Prices and Price Indexes_, and then expressed in logs. Real industrial output was then calculated using the log of the Federal Reserve Board index of industrial production. The price of iron ore was the log of the iron ore price series reported in the BLS publication, _Producer Price and Prices Indexes_, divided by the producer price index. The price of energy was the log of a composite index of the price of coking coal, electric power, natural gas and residual fuels (taken from _Producer Price and Price Indexes_) and divided by the aggregate producer price index. The weights used were the shares of those inputs used in the total per unit cost of energy used in steel production, as reported in an FTC Staff Report.[5] Time was expressed as a counter starting at 1 in month 1, 2 in month 2, etc.

---

5 Duke et. al. (1977).

As we mentioned above, two other variables were added. The first was the log of the annual index of total labor compensation in SIC 331, (which was unpublished data provided by BLS), divided by the aggregate producer price index. Because these data were only available on an annual basis, linear interpretations were made between the years to estimate monthly data.[6]

The other new variable uses data on the log of the average amount of steel used per new U.S. automobile produced. Data for the years 1975 to 1983 were obtained from Wards Automotive Yearbook. Data for 1973 and 1974 were estimated using unpublished data from General Motors Corp. which was then adjusted to track the 1975-1983 series.[7] Because monthly data were not available, it was assumed that the pounds of steel per auto was constant in any given year, and only changed in the new year.

---

[6] To obtain monthly estimates, we assumed that the yearly number applied to July of that year (month 7), and linearly interpolated from July of one year to July of the next year.

[7] The Wards Automotive Yearbook data were available for 1975 to 1983, whereas the General Motors Corp. data were available for 1970 to 1980. Therefore, the General Motors data were regressed against the Wards data for 1975 to 1980, and the 1973 and 1974 data were estimated using those regression coefficients.

Regression Results

Table 2 presents the results of running the regression using equation (10).[8] As that table indicates, the elasticity with respect to the index of real total compensation has a larger absolute value then the elasticity with respect to the real wage rate that Grossman obtained, and the coefficient is statistically significant at the .01 level. The value of the coefficient on the time variable is smaller and less significant than in Grossman's equations (it is no longer significant at the .01 level, although it would be at the .10 level). The index of industrial production is positive and significant at the .01 level, but the variable for the shipment of steel per auto is not significant, although it has the predicted sign. The import price variable is positive, as predicted, but it is not significant. Finally, neither the price of iron ore nor the price of energy is significant, and neither has the predicted sign.

Counterfactual Simulations

Employment of production workers in SIC 3312 rose to a high of 426,000 in July of 1973, whereas in 1983 it fell to a low of 198,000 in February of 1983. Thus, in a 10 year period, employment in the steel industry declined by over 50 percent. The purpose of doing

---

[8] The regressions were corrected for first order serial correlation using a single iteration and the indicated value of Rho. While Grossman used 130 monthly observations running from January, 1973 to October, 1983, we were only able to use 127 observations running from January, 1973 to July, 1983, in order to include the production worker total compensation variable.

Table 2

Regression Results For Reduced Form Estimates of Steel Industry Employment, 1973-1983

Coefficient	Regression	Lag in Months
Constant	11.937 (4.673)	----
T	-.00517 (.00237)	----
$\log(C_s/P_a)$	-1.706* (.578)	5
$\log(P_i/P_a)$	.774 (1.315)	18
$\log(P_e/P_a)$	.444 (.749)	18
$\log[EP_s^*(1+t_s)]/P_a$	.259 (.545)	18
$\log(Q)$	1.070* (.371)	5
$\log(A_s)$	.0205 (.6751)	5

$\bar{R}^2$=.801

F(31, 95) = 17.35

DW = 1.83
Rho = .75

n = 127

* Indicates that the coefficient is significant at the .01 level.

Note: the numbers in parentheses are the standard errors.

the counterfactual simulations is to try to explain the causes of that decline in steel employment, and to suggest what the level of employment might have been if certain conditions had been different.

Employee Compensation

An important issue is the question of the extent to which labor union wage demands were responsible for declining steel employment. "Voluntary" restraints on steel exports from Europe and Japan to the U.S. were first imposed from 1969 to 1974, but were apparently nonbinding on the steel industry in 1973 and 1974.[9] Therefore, if labor unions were able to exercise monopoly power over U.S. steel companies to raise wages above competitive levels, it seems likely that they might have first done so in the period 1969-1972.

As Table 3 shows, wages in the steel industry declined relative to wages in all manufacturing from 1961 to 1971. However, during the period 1973 to 1982, wages of steel production workers rose rapidly. Indeed, the wages of steel production workers' in 1983 were about 2.49 times as high as in 1973 (in nominal terms). While wages in all manufacturing also rose significantly during the same period, they did not rise as rapidly. For all manufacturing workers, wages (in nominal terms) were about 2.16 times as

---

9 Crandall (1981), pp. 103-115.

Table 3

Average Hourly Earnings and Compensation Costs by Steel Production Workers and by Production Workers in in All Manufacturing, 1960-1983

Year	Average hourly earnings of production workers in dollars in SIC 3312	Average hourly earnings of production workers in dollars in all manufacturing	Average hourly earnings in SIC 3312 divided by average hourly earnings in all manufacturing	Hourly compensation costs for production workers in dollars in SIC 331	Hourly compensation costs for production workers in dollars, all manufacturing	Hourly compensation costs in SIC 331 divided by hourly compensation costs, all manufacturing
1960	3.08	2.26	1.363	--	2.66	--
1961	3.20	2.32	1.379	--	2.74	--
1962	3.29	2.39	1.377	--	2.85	--
1963	3.36	2.45	1.371	--	2.93	--
1964	3.41	2.53	1.348	--	3.03	--
1965	3.46	2.61	1.326	--	3.14	--
1966	3.58	2.71	1.321	--	3.29	--
1967	3.62	2.82	1.284	--	3.43	--
1968	3.82	3.01	1.269	--	3.68	--
1969	4.09	3.19	1.282	--	3.93	--
1970	4.22	3.35	1.260	5.61	4.18	1.370
1971	4.57	3.57	1.280	6.19	4.49	1.390
1972	5.17	3.82	1.353	6.93	4.84	1.463
1973	5.61	4.09	1.372	7.49	5.26	1.475
1974	6.41	4.42	1.450	8.75	5.75	1.544
1975	7.12	4.83	1.474	10.24	6.35	1.613
1976	7.79	5.22	1.492	11.23	6.93	1.620
1977	8.59	5.68	1.512	12.31	7.59	1.622
1978	9.70	6.17	1.572	13.56	8.30	1.634
1979	10.77	6.70	1.607	15.15	9.07	1.670
1980	11.84	7.27	1.629	17.46	9.89	1.765
1981	13.11	7.99	1.641	19.04	10.95	1.739
1982	13.96	8.50	1.642	22.74 p.	11.68 p.	1.947
1983	13.40 p	8.84 p	1.516	21.19 pr	12.26 pr.	1.728

-- = Not available
p = preliminary estimate
pr = provisional estimate

Source: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, various issues; and U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, unpublished statistics.

high in 1983 as in 1973. Thus wages in the steel industry rose significantly relative to wages in all manufacturing over the period 1970-1982.

Total employee compensation (including fringe benefits) data are only available since 1970. Compensation to steel production workers rose even more rapidly than wages from 1973 to 1983. Indeed, total compensation in 1983 in nominal terms for steel production workers was about 2.97 times as high as in 1973. Total compensation for all manufacturing production workers in nominal terms was about 2.50 times as high in 1983 as it was in 1973. Hence total compensation in the steel industry relative to total compensation in all manufacturing rose even more rapidly than wages in this time period.

Therefore, our first counterfactual simulation was done assuming that steel production worker compensation had risen no faster than all manufacturing labor compensation from 1973 to 1983, so that the ratio of steel compensation to all manufacturing compensation remained constant throughout the period.

The results of this simulation indicate that steel employment in July 1983 would have been about 30.9 percent higher, or there would have been about 68,666 more production employees in May-July 1983, if steel production worker compensation had not risen any more rapidly than compensation to all manufacturing workers during the past ten years.

A second counterfactual simulation was done assuming that real employee compensation in the steel industry rose no faster than all manufacturing from 1976 to 1983. In that case, there would have been about 28,024 more employees in 1983 than there actually were. Finally, a third counterfactual simulation was done, assuming that real compensation rose no faster than all manufacturing from 1979 to 1983. In that case, there would have been about 7,650 more production worker employees in May-July, 1983 than there actually were.

Import Prices

A second set of counterfactual estimates were made, assuming that real import prices (relative to the aggregate producer price index) had stayed constant, rather than changing as they actually did during the period 1973-1983. According to Grossman's estimates, real import prices were slightly higher in January 1973 than in July 1983. On the other hand, real import prices were higher in January 1976 than in 1973 or 1983, and were even higher in January 1979 than in 1976. Therefore, three counterfactual estimates were made. The first assumed that real import prices stayed at the same real level from 1973 to 1983. In that case, there would have been about 4,400 more production worker jobs in May-July, 1983.

The second estimate was made assuming that real import prices had stayed constant from January, 1976 to 1983. Because real import prices were actually higher in 1976 than in 1973, steel imports would have been lower and employment in the domestic steel industry would have been 12,377 higher in 1983, if this counterfactual situation had existed.

Finally, a third counterfactual estimate was made assuming that real import prices had stayed at their January, 1979 level. In that case, there would have been 22,282 more jobs in 1983 than there actually were.

However, as Grossman himself has argued, nearly all of the decline in the relative price of imported steel since 1976 is due to the appreciation of the dollar relative to foreign currencies, and since 1979 all of the decline in the relative price of imported steel is due to the appreciation of the dollar relative to foreign currencies (Grossman, 1984, pp. 15-18). Or putting that another way, it is changes in international exchange rates, not decreases in the price of Japanese steel in Yen at the Japanese plants that has caused the real price of Japanese steel in dollars to fall in the U.S.

Summary

Table 4 presents a summary of these simulation results. As that table shows, if total compensation to steel production workers had risen at the same rate rather than more rapidly than compensation in all manufacturing from 1973 to 1983, there would have been about 68,666 more steel production worker employees in May - July, 1983. Hence, the rise in compensation to steel workers since 1973 cost about 68,666 jobs. If, at the same time, real import prices had stayed constant from 1973 to 1983, rather than declining, there would have been 4,410 more steel production worker jobs in May - July, 1983. Hence, the decline in real steel import prices since 1973 cost about 4,410 domestic jobs.

Overall, the decline in employment in the steel industry is due to several different factors, but the important point to note is that rising employee compensation is responsible for the loss of far more jobs over this time period than is the decline in the price of imported steel. Thus, it is incorrect to assume that steel imports were <u>the</u> major cause of declining steel employment.

In contrast, if one chooses 1979 rather than 1973 as the base year, then it might appear that the declining real import prices since 1979 cost more jobs in 1983, (22,282 jobs), than did rising steel production worker compensation since 1979 (7,650 jobs). Note again that the cause of the decline in the price of imported steel was mostly due to changing exchange rates, and not changes in the price of imported steel expressed in foreign currencies. Moreover, the fact that steel production worker compensation appears to have less of an impact on steel employment than does steel import prices during this later period of 1979-1983 is due to two other factors. First of all, most of the increase in employee compensation (and employee wages, as well) occurred between 1973 and 1979, whereas there was a much smaller increase from 1979 to 1983. Hence, most of the negative effect on employment from rising total compensation is due to the rise in compensation <u>before</u> 1979.

In addition, the real price of imported steel in 1979 was substantially higher than in 1983 or in 1973. Hence, choosing 1979 rather than 1973 as the base year appears to made steel imports responsible for the loss of a significant number of steel jobs, since real import prices declined after 1979. As our regression results indicate, declining import prices should lead to declining domestic employment, all other things equals. However, because real steel import prices were higher in January 1979 then they were in _any_ month in the previous three years or in any month after that date until July, 1983, it seems inappropriate to choose January, 1979 as the base date. January 1973 or January, 1976 both appear to be more reasonable choices for a base year.

Overall, therefore, it appears that with regard to both real employee compensation and real import prices, it is more appropriate to choose 1973 rather than 1979 as the base year for evaluating the impact on steel employment. If one accepts that 1973 is the preferable base year as we have suggested here, then it is clear that rising employee compensation was responsible for the loss of far more jobs in 1983 than was declining steel import prices. In addition, it is important to separate out the effect of overall changes in exchange rates from the effect of the changing price of imported goods expressed in the currency of the producing country rather than expressed in U.S. dollars. If we had excluded the impact of changing exchange rates, then steel imports would have shown an even smaller impact on domestic employment in to our results.

Table 4

Counterfactual Simulations of Impact on Steel Production Worker Jobs, May-July, 1983

Number of Additional jobs if:	Number of Additional Jobs in 1983 Base Year 1973	Base Year 1976	Base Year 1979
Steel Production Worker Total Compensation Rose At the All Manufacturing Rate	68,666	28,024	7,650
Real Import Prices Stayed Constant	4,410	12,377	22,282

APPENDIX

Other Counterfactual Simulations

1. Employee Compensation

Another possible way to evaluate the impact of labor wages on steel employment would be to compare wages in union steel mills with wages in non-union steel mills. A recent BLS survey indicates that, on average, wages in unionized steel mills were $12.07 per hour, whereas wages in non union steel mills averaged $9.75, or about 80.78 percent of union wages in 1983.[10] Therefore, we did another set of counterfactual simulations, assuming that for the period 1973 to 1983, total compensation was only 80.78 percent of their actual value. The results of this simulation indicate that there would have been about 97,668 additional jobs, if it had been true.

2. Industrial Production

The second counterfactual simulation was run on the assumption that industrial production had risen at a steady 4 percent per year rate of growth from 1973 to 1983, instead of fluctuating as it actually did during that time period. If that counterfactual situation had taken place, employment would have been about 54,224 employees higher in May-July, 1983 then it actually was. As a more conservative alternative, we then simulated the impact of a 3 percent per year steady growth in industrial production

---

[10] U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, unpublished report.

from 1973. Again, even a steady 3 percent rate of growth would have increased steel employment by 25,274. Simulations were then run using January 1976 and January 1979 as the base year. Using January 1976 as the base year yields results very similar to those when January 1973 is used as the base year. Because January 1979 was a period of particularly high real industrial output, a steady 4 percent growth rate from then would have lead to 116,122 more jobs in 1983, and even a 3 percent rate of growth would have yielded 80,692 more jobs.

3. Steel Content in Automobiles

As we mentioned earlier, the average amount of steel contained in U.S. produced automobiles declined substantially during this time period, both because automobile manufacturers built smaller cars, and because materials such as aluminum and plastic were substituted for steel in automobiles, in order to reduce their weight. Therefore, we simulated the counterfactual possibility that average pounds of steel remained at the 1973 level throughout this period, rather than declining as it actually did. However, in our regression results the coefficient for steel content is very small and not statistically significant. If steel content had remained at the 1973 level, 874 more production workers would have been employed in May - July, 1983, according to the simulation. The results of using 1976 or 1979 as the base year are quite similar.

4. <u>Time Trend</u>

As we discussed above, the variable with the largest impact on the level of employment in our regression results is the time trend. Since this time trend takes into account shifts in both the demand and the supply functions, it is really a measure of our ignorance concerning the underlying structure of the steel industry. However, if there had been no time trend effect on employment from 1973 to 1983, then according to this model using 1973 as the base year, there would have been about 208,555 more jobs in the steel industry in May-July 1983. If January 1976 or January 1979 were used as the base year, there would have been 135,400 or 82,439 additional jobs respectively in 1983.

As these counterfactual simulations show, there are a large number of factors other than the price of imported steel that help to explain the decline of employment in the steel industry. Not only rising employee compensation, but also fluctuations in industrial production as well as other unmeasured variables that changed over time have had a substantial effect on steel employment.

Table 5

Additional Counterfactual Simulations of Impact on Steel Production Worker Jobs, May - July, 1983

	Number of Jobs
Base Forecast from Regression (January -March 1973)	392,458
Base Forecast from Regression (May - July 1983)	222,334

	Number of Additional Jobs in 1983		
	Base Year 1973	Base Year 1976	Base Year 1979
Number of Additional Jobs if:			
Compensation rose at All Manufacturing Rate	68,666	28,024	7,650
Compensation was only 80.78 percent of its actual value	97,668		
Industrial Production rose at Steady 4%	54,224	53,020	116,122
Industrial Production rose at Steady 3%	25,274	24,196	80,692
No Decline in Steel Content of Automobiles	874	607	767
Real import prices stayed constant	4,410	12,377	22,282
No downward time trend in employment	208,555	135,400	82,439

REFERENCES

American Iron and Steel Institute. Annual Statistical Report, 1982 and 1983. (Washington, D.C.: AISI, 1983 and 1984).

Crandall, Robert W. The U.S. Steel Industry in Recurrent Crisis: Policy Options in a Competitive World. (Washington, D.C.: The Brookings Institution, 1981).

Duke, Richard M., Richard C. Johnson, Hans Mueller, P. David Qualls, Calvin T. Roush, Jr., and David G. Tarr. Staff Report on the United States Steel Industry and Its International Rivals: Trends and Factors Determining International Competitiveness. Federal Trade Commission. Bureau of Economics, November, 1977.

Grossman, Gene M. "Imports As A Cause of Injury: The Case of the U.S. Steel Industry," working paper, Princeton University, July, 1984.

Munger, Michael C. A Time Series Investigation Into Factors Influencing U.S. Auto Assembly Employment: An Economic Policy Analysis. Federal Trade Commission, Bureau of Economics, February, 1985.

U.S. Department of Labor, Bureau of Labor Statistics. Employment and Earnings, various issues.

_______________________. Producer Prices and Price Indexes. various issues.

_______________________. Office of Productivity and Technology, "Hourly Compensation Costs and Direct Pay of Production Workers in Manufacturing, Ten Countries, 1960-1983," unpublished statistics, April 1984.

_______________________________________. "Hourly Compensation Costs for Production Workers in Iron and Steel Manufacturing, 20 Countries, 1975-1983," unpublished statistics, April, 1984.

Wards Automotive Yearbook, various years.