FACTORS AFFECTING STEEL EMPLOYMENT BESIDES

STEEL IMPORTS

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. l

Grossman's Model

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

Where:

+alT

+a3Log (Ws/Pa)

+a2 Log (Pe/Pa)
+a4Log (Pi/Pa)

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

Pe = 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}.

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Pa = aggregate producer price index for all manufacturing Ws = average hourly wage of production workers in SIC 3312
Pi = price of iron ore
E = foreign exchange rate
P: = foreign price of imported steel, net of u.S. tariffs
ts = 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 (Ls)' capital (K s)' energy (E s)' iron ore (Is)' and scrap steel (M s). Steel production is assumed to fit a Cobb-Douglas production function:

Where:

Ys = output of steel

In this model, energy and iron ore are assumed to be interna-tionally 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

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world production of iron ore, so that within that range the supply curve of iron ore is perfectly e1astic. 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:

Where Ps = 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.

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:

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

(6) =

where = the price of scrap.

(7) =

Wages are assumed to be determined exogenously by the relative bargaining power of steel labor

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:

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

Log(LS) =

(Note:

Table 1

Grossman's Reduced Form Regression Results

16.152*

(3.160)

-.596log(Ws/Pa) (.422)
+1.400log(Q) *
(.312)

R2 = .97

F = 1799.5

n = 130

-.0075T*

(.0008)

+ 1.549log (Pi/Pe) (.740)

-.037log(Pe/Pa) (.456)

+1.067log[EP~(1+ts)/PaJ* (.397)

Serial Correlation
Coefficient = 0.821
(0.050)

The numbers in parentheses are the standard errors).

the time trend, a variable that affects both supply and demand factors, as equations (5) and (9) indicate. The large and highly significant

especially interested in seeing whether a

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 signifi-cant 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

! These were the data used in Grossman (1984).

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Earnings. The net-of-tariff price

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.

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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 abso-lute value then the elasticity with respect to the real wage rate that Grossman obtained, and the coefficient is statistically signi-ficant at the .01 level. The value of the coefficient on the time variable is smaller and less significant than in Grossman's equa-tions (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

Table 2

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

Coefficient

Constant

T

log (Cs/Pa)

log (Pi/Pa)

log (Pe/Pa)

Regression

11.937

(4.673)

-.00517

(.00237)

- 1.706*

(.578)

. 774

(1.315)

.444

(.749)

* 10g[EP .259 s (1+ts)]/Pa (.545)
log (Q) 1.070* (.371)

log (As) .0205
(.6751)

R2=.801

F(31, 95) = 17.35

DW = 1.83
Rho = .75

n = 127

Lag in Months

5

18

18

18

5

5

- -

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

Note: the numbers in parentheses are the standard errors.

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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

Year

1960
1961
1962
1963
1964

1965
1966
1967
1968
1969

1970
1971
1972
1973
1974

1975
1976
1977
1978
1979

1980
1981
1982
1983

Table 3

Average Hourly Earnings and Can:t;:ensation Costs by steel Production Workers and by Production Workers in
in All l-bnufacturing, 1960-1983

Avera~ hourly Hourly Hourly
Average Average hourly earnings in com:t;:ensa- Hourly can:t;:ensation
hourly earnings of SIC 3312 tion rosts canp:!nsa tion costs in SIC
earnings of production divided by for rosts for 331 divided
production workers in average hourly production production by hourly
workers in dollars in earnings in workers in workers in can:t;:ensation
Cbllars in all all Cbllars in Cbl1ars, all costs, all
SIC 3312 manufacturing manufacturing SIC 331 manufacturing manufacturing

3.08 2.26 1.363 2.66
3.20 2.32 1.379 2.74
3.29 2.39 1.377 2.85
3.36 2.45 1.371 2.93
3.41 2.53 1.348 3.03

3.46 2.61 1.326 3.14
3.58 2.71 1.321 3.29
3.62 2.82 1.284 3.43
3.82 3.01 1.269 3.68
4.09 3.19 1.282 3.93

4.22 3.35 1.260 5.61 4.18 1.370 4.57 3.57 1.280 6.19 4.49 1.390 5.17 3.82 1.353 6.93 4.84 1.463 5.61 4.09 1.372 7.49 5.26 1.475 6.41 4.42 1.450 8.75 5.75 1.544

7.12 4.83 1.474 10.24 6.35 1.613 7.79 5.22 1.492 11.23 6.93 1.620 8.59 5.68 1.512 12.31 7.59 1.622 9.70 6.17 1.572 13.56 8.30 1.634 10.77 6.70 1.607 15.15 9.07 1.670

11.84 7.27 1.629 17.46 9.89 1.765 13.11 7.99 1.641 19.04 10.95 1.739
13.96 8.50 1.642 22.74 p. 11.68 p. 1.947
13 .40 P 8.84 P 1.516 21.19 pr 12.26 pro 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.

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would have been about 28,024 more employees in 1983 than

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 u.s.

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

Table 4

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

Number of Additional jobs if:

Steel Production Worker Total Compensation Rose At the
All Manufacturing Rate

Real Import Prices Stayed Constant

22

Number
Base
Year
llll

68,666

4,410

of Additional
Base
Year
l.2li

28,024

12,377

Jobs in 12!D
Base
Year
llli

7,650

22,282

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

4. Time Trend
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
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Table 5

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

Base Forecast from Regression
(January -March 1973)

Base Forecast from Regression
(May - July 1983)

Number of Additional Jobsl4m15so

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