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IMPORTS AS A CAUSE OF INJURY: THE CASE OF THE U.S. STEEL INDUSTRY

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ABSTRACT

Recently, the United States International Trade Commission conducted a Section 201 or "escape clause" hearing to determine whether imports have been the most significant cause of injury to the US. steel industry. This paper suggests a methodology for conducting the necessary analysis for such determinations, and applies it to the case of the steel industry.

First, a reduced-form equation for steel industry employment is derived and estimated. The equation specifies industry employment as a function of the price of imported steel, the price of energy, the price of iron ore, a time trend, real income and (in one variant) the wage rate in the steel industry. The estimated coefficients are used to perform counterfactual simulations, which allow us to attribute changes in industry employment to their proximate causes. The analysis reveals that for the period from 1976 to 1983, a secular shift away from employment in the steel industry has been the most important cause of injury. For the shorter period from 1979 to 1983, secular shift and import competition are roughly equal in importance, with the latter being entirely the result of the substantial appreciation of the U.S. dollar during this period.

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Executive Summary of:

Imports as a Cause of Injury: The Case of the U.S. Steel Industry

by

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The charge of the International Trade Commission in the recent "escape clause" hearings concerning the U.S. steel industry was to determine whether imports have been the most significant cause of injury to the industry. The ITC found positively in this case, and thus opened the way for President Reagan to provide import protection for this important domestic industry. In this paper, I present empirical evidence that shows that the ITC ruling may have been in error.

The study uses an econometric model of the U.S. steel industry to attribute changes in domestic employment to a number of proximate causes. Among the potential contributors to the industry's employment decline that I considered are (i) competition from imported steel, (ii) secular decline of the steel industry (due, for example, to reduce demand for steel by the U.S. automobile manufacturers and substitution of aluminum, plastics and other mateials for steel in construction), (iii) the cyclical drop in the demand for steel caused by the recent recession, (iv) an upward trend in the wages paid to steel workers, and (v) increases in the price of energy, an important input into steel production. Looking first at the period from January 1976 through October 1983, I have estimated that if not for the secular decline in the industry there would have been approximately 209,000 more jobs in steel at period's end. By contrast, intensification of import competition, as

measured by the decrease in the real dollar price of foreign steel, accounts for only 37,000 lost jobs during this period. The simulations also show that had economic growth proceeded at a steady four percent annual rate throughout the period, thereby averting the recession of 1981 to 1983, the October 1983 employment count in the U.S. steel industry would have been some 27,000 higher than was actually observed. Finally, I have estimated that a rise in steel industry wages at a rate greater than that for the manufacturing sector at large accounts for slightly more than 5000 lost jobs, and that the increase in the real cost of energy during 1976 to 1983 is responsible for the loss of almost 4000 jobs.

In another set of estimates, I have studied the period from January 1979 to October 1983. For this shorter period secular decline again is found to be the most significant cause of injury, responsible for approximately 110,000 lost jobs. Import competition is next on the list (81,000 jobs), followed in order to significance by the recession (49,000 jobs) and the rise in real energy prices (3000 jobs). By comparing the figures for the two periods it becomes clear that competition from abroad for U.S. steel producers actually abated during January 1976 through January 1979, but intensified dramatically thereafter. In an effort to explain this finding, I decomposed the decline in employment attributable to the fall in the real dollar price of imported steel into three components representing the portion due to the recent appreciation in the value of the dollar, that due to changes in supply and competitive conditions in foreign steel sectors (including any changes in alleged unfair pricing practices) and that die to reductions in U.S. tariff rates on steel imports. My conclusion is that the occurence of increasingly severe competition from imports in this industry is entirely the result of the dollar appreciation.

I. INTRODUCTION

The allocation of resources in an open economy has many determinants. Among these are the states of technology, tastes, factor accumulation, resource prices and international competition, as well as the stage of the business cycle. A change in any of these variables usually necessitates a reallocation of factors to a new set of more profitable uses. As a result of this process of reallocation, some sectors and factors gain, others lose. While long-run aggregate economic welfare is maximized when complete adjustment to changing market conditions is allowed to take place, the trade laws of the United States, perhaps in recognition of the distributional considerations involved, provide for temporary safeguards when increased international competition is the major cause of serious injury to a U.S. industry.

On January 24, 1984, Bethlehem Steel Corporation and the United Steel Workers of America filed a petition with the International Trade Commission, seeking import relief under Section 201 of the Trade Reform Act of 1974. The provisions of this "escape clause" require the petitioners to establish that the industry has experienced "serious material injury", and that imports are "a substantial cause of that injury", where the latter phrase is defined as "a cause that is important, and not less than any other cause". Thus, the law requires that market conditions in the industry be analyzed, and that all developments be attributed to their proximate causes. The purpose of this paper is to show how such an analysis can be conducted rigorously and objectively using econometric and simulation techniques.[1] It is hoped that the method described here will be found to be useful for the conduct of escape clause investigations in the future.

In order to determine whether or not import relief is justified under the provisions of the Section 201 statute, it is necessary to account for all of the events that have occurred in the international steel marketplace. In this paper I will concentrate solely on the evolution of industry employment, adapting for this purpose the methodology that I previously developed for attributing employment developments in an industry to their various structural causes (see Grossman, 1982). The methodology involves the econometric estimation of a reduced-form employment equation for the industry, where the explanatory variables are those exogenous (from the point of view of the industry) factors that affect the allocation of resources to that industry. Once the empirical relationship between employment and its determinants has been established, counterfactual simulations can be performed in which the exogenous variables are allowed to follow paths that are different from those that were actually observed. The deviation of the actual path of employment from the simulated path reflects the effect on the number of jobs in the industry that can be ascribed to the fact that the exogenous variable took on its historical values, rather than the assumed alternatives.[2]

The remainder of the paper is organized as follows. In Section II the methodology is described, and the estimates of a reduced-form equation for employment in the U.S. steel mills products industry are reported. The counterfactual simulations are presented in Section III. A concluding section contains a discussion of the findings.

II. REDUCED-FORM ESTIMATES OF AN EMPLOYMENT EQUATION FOR THE U.S. STEEL INDUSTRY

The level of employment in the U.S. steel industry is the outgrowth of the interaction between the supply of labor to this sector and the (derived) demand for labor by firms active in the sector. These in turn depend upon such variables as the state of technology, the wage rates in the steel industry and elsewhere, the prices of the other inputs to the production of steel and the price of steel output. Some of these variables are themselves endogenous, responding to developments in the international and domestic steel markets. Indirectly then, employment is affected by all those factors that influence the supply of and the demand for steel, such as the level of industrial activity, the exchange rate, and the price of steel that is being offered to the market by the foreign competitors of the U.S. producers.

If we are to attribute developments in the time path of industry employment to their proximate causes, we might in principle wish to understand all of the structural relationships that together determine the level of output of domestic steel and the method of production that is used to manufacture that output. Such a full-blown model of the steel industry would, however, be very difficult to implement empirically, especially since data on many of the requisite variables are not collected using a consistent definition of the industry. Fortunately, there is a short-cut procedure available to us. The "cause-of-injury" question is inherently a reduced-form one. That is, we are not interested per se in the mechanism by which various disturbances affect the number of jobs in the industry, but only in the ultimate quantitative effect of these exogenous shocks. All we need do then to assess the total effect that a change in any given exogenous variable is likely to have on industry employment is identify all of the structural variables that influence the allocation of labor to the steel industry, and estimate a reduced-form equation relating industry employment to these exogenous variables. Once these relationships have been estimated, it is a straightforward matter to ascertain what the effect on employment in the industry has been of some particular development in the external environment. This is done by specifying an alternative course for history, and then simulating the path of employment under the maintained counterfactual. The deviation of the simulated from the actual path of employment reveals the job loss (or gain) attributable to the particular event under consideration.

The derivation of the reduced-form employment equation begins with the specification of the production function for steel.[3] I assume that steel is produced with five inputs: labor (L_s), capital (K_s), energy (E_s), iron ore (I_s) and scrap steel (M_s). The production function is assumed to have a Cobb-Douglas form,

(1) $$Y_s = Ae^{\pi t}K_s^{a_1}L_s^{a_2}E_s^{a_3}I_s^{a_4}M_s^{(1-a_1-a_2-a_3-a_4)}$$

where π is the rate of Hicks-neutral technological progress and t denotes time.

Energy and iron ore are assumed to be traded inputs, available to the steel sector in infinitely-elastic supply at exogenous prices, p_e and p_i, respectively. The quantity of each of these inputs used by a profit-maximizing industry is found by setting its marginal value product equal to its price, or

(2) $$E_s = \frac{a_3 p_s Y_s}{p_e}$$

(3) $$I_s = \frac{a_4 p_s Y_s}{p_i}$$

where p_s is the price of domestic steel.

Capital, labor and steel scrap are non-traded factors. The supply of capital in the steel industry is taken to be exogenous in the short run, and is assumed to grow at a steady trend rate (including depreciation) of δ percent per unit time,

(4) $$K_s = \bar{K}_s\, e^{\delta t}$$

The derived demands for steel scrap and labor are

(5) $$M_s = \frac{(1-a_1-a_2-a_3-a_4)p_sY_s}{p_m}$$

(6) $$L_s = \frac{a_2p_sY_s}{w_s}$$

where w_s is the wage rate prevailing in the steel sector and p_m is the price of scrap. The domestic market for steel scrap is assumed to clear, whereby the price is a function of the total amount consumed according to a supply relationship. I specify the supply function simply as

(7) $$\bar{M}_s = \bar{M}e^{\gamma t}(p_m/p_a)^c$$

where p_a is the aggregate price level.

In this paper I consider two alternative treatments of the wage rate in the steel industry. One possibility, following Grossman (1982), is to assume that this variable is endogenous. Under this assumption, we need a structural equation describing the supply of labor to the steel sector. A simple specification, which allows for the possibility that labor is perfectly mobile between sectors in the long run, but does not impose this restriction, is

(8) $$L_s = L_a(w_s/p_a)^d$$

where L_a is the aggregate supply of labor and is assumed to grow at constant rate σ, i.e. $L_a = \bar{L}_ae^{\sigma t}$.

Alternatively, it has often been argued in the case of the U.S. steel industry that wage rates are not determined in the usual way by the interaction of the supply of and the demand for labor, but rather are a separate and relatively exogenous factor that contributes to the evolution of employment in the industry. Movements in these wages, it is claimed, are little affected by conditions in the industry labor market, but rather reflect the relative negotiating success of the steelworker's union vis-a-vis the steel producers, and the conditions in the U.S. labor market at large.[4] If this view is correct, then the industry wage rate belongs as a separate explanatory variable in the reduced-form employment equation, and it would be appropriate to inquire into the extent to which wage pressures are themselves a cause of injury. Indeed, some industry observers have further claimed that it is excessive wage pressures that deserve primary blame for the current plight of the U.S. steel industry. In order to evaluate this argument, and not rule it out a priori, I choose to remain agnostic on whether the industry wage rate should be treated as an exogenous or an endogenous variable, by estimating the employment equations that follow from either assumption.

Finally, domestic steel is assumed to be an imperfect substitute for imported steel with exogenous price in foreign currency units, p_s^*. Thus, I am assuming that the excess supply of foreign steel to the U.S. market is perfectly elastic, which may be a very reasonable approximation given the degree of excess capacity that has characterized steel production in many countries during the last decade.[5] Domestic steel also is assumed to substitute imperfectly for the aggregate basket of domestic goods, so that the demand facing the domestic steel industry (which in equilibrium is equal to its output) is given by:

(9) $$Y = Be^{\psi t}\left[\frac{Ep_s^*(1+t_s)}{p_s}\right]^{b_1}\left[\frac{p_a}{p_s}\right]^{b_2} Q^{b_3}$$

where Q is aggregate industrial production, a measure of real industrial activity that reflects the location of the demand curve for steel, E is the exchange rate, t_s is the tariff rate applicable to U.S. steel imports and ψ is the rate of secular demand shift. The latter incorporates the substitution of plastics and aluminum for steel in construction, as well as the general down-sizing of automobiles by the U.S. auto industry, two trends generally believed to be responsible for a significant and persistent decline in the demand for steel in recent years. Ideally it would have been preferable to identify these two effects individually by including as separate variables in the demand equation the prices of those materials that substitute for steel as well as a measure of the state of technical know-how in allowing such substitution, plus a measure of the size of the average U.S. automobile. However, since our time series on employment is a relatively short one, and since the secular trends in the demand for steel are manifested rather slowly, it was not possible to treat these demand shifts separately, but only to lump them with the other trend factors.

If the industry wage rate is considered to be an exogenous variable, then equations (1) through (7) and (9) are eight equations which together determine the eight endogenous variables Y_s, K_s, L_s, E_s, I_s, M_s, p_s and p_m as functions of the exogenous variables, p_e, p_i, p_a, E, p_s^*, t_s, w_s and Q. The reduced-form equation for employment is, after taking logs,

(10) $$\log L_s = \alpha_0 + \alpha_1 t + a_2 \log(p_e/p_a) + \alpha_3 \log(w_s/p_a) + \alpha_4 \log(p_i/p_a) + \alpha_5 \log[Ep_s^*(1+t_s)/p_a] + a_6 \log Q$$

Alternatively, if the wage rate is treated as an endogenous variable, then equation (8) is added to the structural system, and the reduced-form equation does not include the term $\alpha_3 \log (w_s/p_a)$.

An important thing to notice about the reduced-form equation for industry employment is that the volume of steel imports does not appear explicitly. This is because the volume of imports is itself an endogenous variable, influenced not only by developments in the steel sectors outside the United States, but also by events at home. For example, if technological advances were to raise the productivity of labor in all domestic steel firms, there would be a simultaneous increase in the number of jobs in the domestic industry and a decline in the level of imports. It would of course be wrong in this case to attribute the gain in employment to an abatement of import competition. It seems that when we seek to implement the Section 201 statute requiring an assessment of the injury caused by imports, we should identify the state of import competition not by the volume of imports or by the extent of "import penetration", but rather by the location of the foreign excess supply curve for steel. Then, if we are willing to assume that this supply curve is perfectly elastic, we find that the real price of imported steel is the appropriate measure of import competition that enters into the reduced-form equation.

The reduced-form employment equation, in its two alternative forms, was estimated using monthly observations from January 1973 through October 1983 (the latest data available at the time of writing). The starting date was chosen because prior to 1973 there were binding "voluntary" quotas in effect on exports of steel to the United States.[6] When such quantitative restrictions are binding, it is impossible to assume, as we have done, that the supply of foreign steel to the U.S. market is perfectly elastic.

Since monthly data were used in the estimation, it was necessary to incorporate lags on all of the exogenous variables to reflect the period of adjustment necessary to move from one long-run equilibrium to another. That is, due to the existence of various rigidities in the marketplace (e.g.,long term supply contracts, methods of production that are fixed in the short run, etc.), it is exceedingly unlikely that the total cumulative effect on employment of a change in one of the exogenous variables would be realized after one month. Instead, I began by specifying an eighteen month lag structure for each of the exogenous variables. Initial estimates showed, however, that full adjustment of employment to changes in U.S. industrial activity and to changes in the real wage rate occurred considerably sooner than eighteen months. The final specification therefore incorporated a period of adjustment of only five months for these variables.[7]

Before proceeding to a discussion of the regression results, let me briefly describe the data that were used in the estimation. The dependent variable was taken to be the (log of the) average weekly hours of employment by production workers in the blast furnaces and steel mills industry (SIC 3312).[8] Both average hours of employment per week and the total number of production workers were collected from the B.L.S. publication, Employment and Earnings. The net-of-tariff dollar price of imported steel was calculated as a geometric weighted average of the import unit values for three subcategories of steel product imports, as reported in Highlights of U.S. Exports and Imports. The categories were (i) tubes, pipes and fittings, (ii) universals, plates and sheets, and (iii) wire rods, structurals, bars and pilings, and the weights were the import shares of each of these categories for the year 1977.[9] The domestic price of imported steel was adjusted for tariff changes, incorporating both the Nixon import surcharge and the Tokyo Round tariff reductions. Average industry tariff rates were those calculated for use in the Michigan Model of World Production and Trade (see Deardorff and Stern, 1983). Finally, the entire series was deflated by the aggregate producer price index (B.L.S., Producer Price and Price Indexes), to express the prices in real terms.

The real industrial activity variable was the (log of the) Federal Reserve Boards index of industrial production. The wage variable was the (log of the) average hourly wage of production workers for SIC 3312, taken from Employment and Earnings, and deflated by the aggregate producer price index. The price of iron ore was similarly defined as a real magnitude, where the numerator was the iron ore price series from Producer Price and Price Indexes. Finally, the price of energy faced by the steel industry was constructed as a composite index of the prices of coking coal, electric power, natural gas and residual fuels (all from Producer Price and Price Indexes, and all deflated by the aggregate producer price index). The weights used in forming this index were the shares of these individual inputs in the total per unit cost of energy used in steel production, as computed by Duke et. al. (1977).

The coefficients from the reduced-form regressions are shown in Table 1. Two sets of estimates are reported: the first column is for the regression that included as an explanatory variable the real wage of steel workers; the second regression excluded this variable. As is evident, the two sets of estimates for the remaining coefficients are quite similar, so we will henceforth take as our preferred set the one that includes wage pressures as an independent cause of employment changes. All of the coefficients, with the exception of that on the time trend variable, are to be interpreted as elasticities. In addition, all of the elasticities reported are "total elasticities", that is, the full response of employment to a change in the exogenous variable after complete adjustment has taken place. (The figures in parentheses below each of the coefficients are the standard errors of the estimates.)

TABLE 1

REDUCED-FORM ESTIMATES OF STEEL INDUSTRY EMPLOYMENT

	Regression 1	Regression 2	Lag in Months
Constant	16.152 (3.160)	17.158 (3.259)	-
Time Trend	-.0075 (.0008)	-.0077 (.0009)	-
Elasticity with respect to:			
Industrial Production	1.400 (.312)	1.511 (.311)	5
Import Price	1.067 (.397)	1.026 (.407)	18
Steelworker Wages	-.596 (.422)	--	5
Price of Energy	-.037 (.456)	-.060 (.489)	18
Price of Iron Ore	1.549 (.740)	1.094 (.963)	18
Serial Correlation Coefficient	.821 (.050)	.806 (.052)	
R^2	.97	.97	
F statistic	1799.5	1978.4	
no. of observations	130	130	

The estimated reduced-form coefficients show that employment in the steel industry is relatively sensitive to both business cycle fluctuations and import prices. The elasticity of employment with respect to industrial production is estimated as 1.40, significant at the one-percent level. This suggests that fluctuations in industrial activity have a more than proportional effect on employment in the steel sector. A one percent decline in import prices will cause a 1.067 percent fall in employment in the industry (again significant at the one percent level), as import competition exerts downward pressure on domestic steel prices, and thus reduces the derived demand for labor in the domestic industry. This is a higher degree of sensitivity to import competition than was found for eight of the nine industries that I studied in Grossman (1982). This probably reflects the fact that domestic and imported steel are fairly close substitutes, so that a fall in import prices exerts strong downward pressure on the price of domestically-produced steel.

The estimates show that there has been a downward trend in employment in the U.S. steel industry. For the period from January 1973 to October 1983 we estimate that even if all of the exogenous variables included in the regression had remained constant, employment would have fallen at a monthly rate of 0.751 percent. It would be useful to know what accounts for this secular shift away from employment in the steel industry. Among the possible contributing explanations are a general economy-wide shift in employment to the services and high-technology sectors, a trend substitution of aluminum, plastics and other materials for steel, labor-saving technological progress in steel production, and a steady down-sizing of automobiles produced in the United States (automobiles being a major source of demand for the output of the U.S. steel industry). Unfortunately, the estimation of separate coefficients for each of these trend variables must await the accumulation of additional data.

Employment in the steel industry is found to be insensitive to the price of energy inputs used in steel production, although the large standard error on the parameter estimate leaves open the possibility that the elasticity is actually somewhat larger. According to the estimated coefficient, the "output effect", whereby an increase in energy prices makes domestic steel production less profitable and decreases activity in the industry, is almost offset by the "substitution effect", whereby higher energy prices induce substitution of labor for energy in the production process.

When industry wages are included as an exogenous determinant of industry employment, the estimated elasticity is -.596. Thus, the total effect of an exogenous increase of hourly wages of one percent would be a fall in hours of employment of approximately six-tenths of one percent. As indicated above, this labor demand response occurs largely within a five month period.

The final variable included in the reduced-form regressions was the real price of iron ore. The cost of iron ore makes up a significant fraction of the total unit cost of steel production, and possibilities for substitution for iron ore in the production process are limited, so one would expect that an exogenous increase in U.S. iron ore prices (everything else constant) would effect a fall in steel output as steel production becomes less profitable. This in turn should mean a decline in industry employment. However, our estimates show exactly the opposite relationship between U.S. iron ore prices and employment in the U.S. steel industry. A possible explanation for this anomoly is that iron ore prices are not, in fact, exogenous with respect to developments in the U.S. steel industry, as was assumed. If periods of great activity in the U.S. steel sector are associated both with high employment and upward pressure on world iron ore prices, then we would observe a positive correlation between these two variables, although it would not be correct to attribute the increase in either of them to the rise in the other.

III. COUNTERFACTUAL SIMULATIONS

The U.S steel industry has experienced a decline in employment of more than 200,000 production workers during the period from 1973 to 1983. In order to attribute this decline in employment to its various causes, it is necessary to specify an historical counterfactual. That is, we need to compare the actual path of employment with what might have been under an assumed alternative industry development. In this section we calculate the loss of employment that can be explained by import competition, by secular shift in factor allocation, by the recent recession in the United States, by real wage pressures and by movements in the real price of energy. In each case we specify an alternative path for the exogenous variable of interest, assuming, for example, no intensification of import competition, no secular shift out of steel employment, steady four percent annual growth in real output, etc. We simulate the path of the dependent variable (hours of employment) using the actual and the assumed counterfactual values for the exogenous variables, and identify the difference between the two sets of predicted values as the relevant effect on employment. Finally, we can subtract this employment effect from the actual path of industry employment to arrive at a prediction of what employment would have been under the counterfactual assumption.

For each variable we take two alternative starting points for our simulations: January 1976 and January 1979. The shorter period coincides with the major part of the decline in employment in the U.S. steel industry since 1973, while the longer period can be justified on the grounds that it incorporates roughly one complete evolution of the business cycle. This is also the period designated by the petitioners to the ITC in the recent escape clause hearings.

A. Employment Loss Due to Import Competition

As I have argued above, it would be inappropriate to identify import competition with the volume of imports, since the latter is an endogenous variable influenced by developments in both the domestic and foreign industries, as well as by changes in domestic and foreign demand. Instead, we should attribute job losses in the domestic industry to an intensification of import competition only when there has been a shift in the foreign excess supply curve. Since we have assumed that this supply curve is perfectly elastic, we must specify our counterfactual in terms of movements in the price of imported steel.

The price of imported steel to domestic consumers is the product of three separate components. A decline in any of these components will induce a shift in demand towards imported steel, and thus exert downward pressure on the price of the domestic product. These components are (i) the foreign currency price of steel produced abroad for export to the United States, as determined by supply and demand conditions in the foreign steel sectors, (ii) the exchange rate, expressed in dollars per unit of foreign currency, and (iii) one plus the ad valorem rate of tariff protection applied to steel imports. Thus, the job loss associated with an intensification of import competition is really the sum of three separate effects: that of exchange rate movements, that of tariff reductions, and that of developments in the foreign steel sectors.

There remains the question of whether, for purposes of an escape clause determination, import competition as a cause of injury should be measured inclusive or exclusive of the effect of exchange rate movements. Unfortunately, the statutory language provides no explicit guidance concerning the treatment of exchange rate changes, nor does the legislative history of Section 201 shed any light on this matter.[10] One could argue on economic grounds that escape clause protection ought not be granted when appreciation of the domestic currency is the cause of injury to a domestic industry. The reason is that a real appreciation of a currency effects a worsening of the country's competitive position across a wide range of industries, including virtually all tradable goods sectors. Selective import protection would cause the currency to appreciate even further, and would shift the burden of adjustment to whatever macroeconomic events that caused the initial appreciation onto the other, already-injured exportable and non-protected importable industries. In other words, when exchange rate movements impart harm across the entire spectrum of tradable goods industries, the justification of escape clause protection on distributional grounds is weak, since any aid to one injured industry comes at the expense of others in a similar position. Nonetheless, the issue is essentially a legal one that is as yet unresolved, so I will proceed to quantify the job loss in the U.S. steel industry attributable to import competition under both alternative treatments of the recent appreciation of the dollar.

The total effect of import competition (including the exchange rate effects) on steel industry employment can be found by simulating hours of employment under the counterfactual assumption that the real dollar price of imported steel remained unchanged. This assumption implies a stable foreign excess supply curve when drawn in the space of (real) U.S. dollars. In one simulation we set the dollar price of imported steel (deflated by the domestic producer price index) equal to its value in January 1976 for the entire period from then until October 1983. The second simulation was conducted similarly, but under the assumption of no intensification or abatement of import competition since January 1979. The actual and predicted paths of employment (measured in manhours per week) are shown in Figures 1 and 2.[11]

Evidently, intensification of import competition has been responsible for a substantial loss of employment in the U.S. steel industry, but only when 1979 is taken as the base year. The figures show the effects of import competition on employment being concentrated during the last quarter of 1980 and the first quarter of 1981, and again during the first three quarters of 1983. We find that if the price of imported steel had risen at the rate of inflation of the domestic price index since 1979, the average level of production employment during August through October, 1983 would have been 11.64 million hours per week, rather than the actual average of 8.40 million hours. If import competition had remained at its 1976 level in the intervening years, the figure would have been 9.90 million hours per week. Dividing the figures for hours of employment by the observed average number of hours per worker per week in each month, we arrive at a figure of 80,959 for the job loss attributable to intensification of import competition since 1979. The analagous figure for the loss since 1976 is 37,403 jobs.

The timing of the import competition effect seems to coincide with the periods of rapid appreciation of the dollar. To see how much of the effect of import competition on steel industry employment can be attributed solely to movements of exchange rates, we constructed an index of the dollar value of foreign currency by weighting the bilateral dollar exchange rates for fifteen major steel exporters by the share of each of these countries in U.S. steel imports. We then simulated steel industry employment under the alternative assumptions that the dollar maintained its value as of January 1976 and as of January 1979 (i.e. we assumed that no dollar appreciation or depreciation took place in the intervening years). In these simulations, the foreign currency price of imported steel and the tariff rate applicable to steel imports were allowed to take on their historical values. The results of these simulations are shown in Figures 3 and 4.

We find that a large part of the total effect of import competition on employment since 1976 is attributable to the appreciation of the dollar. Had the dollar remained at its January 1976 level, there would have been (on average) 29,037 more jobs in the U.S. steel industry during August through October, 1983. When we take 1979 as our base, the results are even more striking. Appreciation of the dollar since then has been responsible for the loss of 82,701 jobs in the U.S. steel industry (average for August to October, 1983), which accounts for more than the full effect attributable to import competition during these years.

Our next counterfactual simulation assumed only the absence of the Tokyo Round tariff reductions. The average employment loss attributable to the decreased rate of protection of the domestic steel industry after 1979 is 1,216 job. Subtracting the exchange rate effect and the tariff reduction effect from the total import competition effect, we conclude that very little of the decline in employment in the U.S. steel industry can be explained by a change in supply and demand conditions in the steel sectors outside the United States. The shift in the foreign excess supply curve drawn in the space of real foreign currency units accounts for only 7,150 of the jobs lost since 1976. And, if we take January 1979 as our baseline date instead, and ask what would have occurred had the foreign currency price of U.S. steel imports grown at the same rate as the aggregate U.S. producer price index, we find that the industry would have had on average 2,958 <u>fewer</u> jobs during August through October, 1983 than was actually the case. In other words, leaving aside the effects of exchange rate appreciation and the reductions in tariff rates, import competition actually has abated somewhat since 1979.

B. Employment Loss Due to Secular Shift

The reduced-form regression coefficient indicates that employment in the U.S. steel industry has been declining by more than 0.75 percent per month for reasons that, for the purposes of this study, can only be described as long-term secular shift. As discussed above, the time trend variable picks up the effect of changes in technology, shifts of the demand for steel, and structural reallocation of resources into growth sectors such as services and high-technology products.

Had the time trend in industry employment been zero since January 1976, weekly hours of employment by production workers would have averaged 16.76 million during August through October 1983. Similarly, we estimate that employment during this period would have averaged 12.79 million production hours per week had the secular shift been absent only since January 1979. These figures translate into an employment loss of 208,734 jobs and 109,600 jobs, respectively.

C. Employment Loss Due to Sluggish Real Income Growth

Steel is an important intermediate input to many industrial activities in the U.S. economy. It is not surprising, therefore, that employment in the industry is sensitive to the stage of the business cycle. When industrial activity is depressed, demand for steel will be so as well, and workers in the U.S. industry will be laid off as a result.

We conducted several simulations to ascertain the implications for steel employment of the recent U.S. recession. In one pair of simulations we assumed a steady rate of growth of real industrial production of four percent per annum. Had such growth occurred from January 1979 through October 1983, the average level of employment in the last three months of our time period would have been 10.37 million hours per week. Thus, the recession during this period is responsible for a decline in employment of 49,251 workers. Replacing the actual path of real income growth since January 1976 by a path exhibiting a steady four percent growth per year yields an estimate for the average level of employment during August through October 1983 of 9.48 million hours per week. This employment level would have meant 27,031 more jobs. The difference between these two counterfactuals arises because the former assumes away the most recent recession while still allowing for the boom that immediately preceded it, while the latter considers a steady path of growth between roughly comparable points in the business cycle.

A second pair of simulations was conducted under the more conservative assumption of three percent annual growth in real icome. If such had been the case since January 1979, the average August-October 1983 number of jobs would have been 33,577 greater than was actually observed. Three percent growth of industrial production for the entire period since January 1976 would have meant 3,777 more jobs on average during the period from August through October, 1983.

D. Employment Loss Due to Wage Pressures

Some observers have attributed much of the loss of employment in the U.S. steel industry in recent years to the movement of wages in that industry. The claim is that the steelworker's union has been unusually successful at the bargaining table, and that the resulting wage hikes have caused steel manufacturers to substitute for labor in the production process. We investigated the validity of these claims by simulating a path for industry employment under the counterfactual assumption that wage growth in the industry was exactly equal to the average wage growth for all private, non-agricultural workers. If this had been the case during the period from January 1976 thorugh October 1983, there would have been only 5,047 more jobs in the U.S. steel industry during the last three months of the period. Industry wage growth equal to average since Janaury 1979 would actually have meant 4,101 fewer jobs in the U.S. steel industry. Evidently, the rate of wage increase in recent years in the steel industry has been fairly close to the average for private, non-agricultural workers, so that not much of the industry's recent employment decline can be explained in this way.

It should be pointed out that our wage figures are for direct compensation, and do not include fringe benefits. To the extent that benefits have increased at a faster rate in the steel industry than elsewhere in the economy, it is possible that this has been responsible for some of the loss in industry employment.[12]

E. Employment Loss Due to Increase in the Price of Energy

Our final pair of simulations was intended to measure injury caused by increases in the price of energy faced by producers of steel. As for the other variables, we conducted our analysis with starting dates of January 1976 and January 1979. In each case we assumed in our counterfactual comparisons that the composite price of energy inputs grew at a rate equal to the rate of inflation of the aggregate producer price index. We found that an increase in relative energy prices since 1976 can explain the loss of 3,582 jobs in the U.S. steel industry. Had the relative price of energy remained at its January 1979 level throughout the period since then, there would have been an estimated 2,966 more jobs in the industry (on average) during August through October, 1983.

IV. DISCUSSION AND CONCLUSIONS

The findings from the counterfactual analysis are summarized in Table 2. The table shows the total loss of employment, measured in numbers of production workers, that can be attributed to each of the proximate causes discussed above. I report in the table only the cumulative effect as of August-October 1983, for the two alternative choices of starting dates.

The analysis shows that for the period from 1976 to 1983 the most important cause of injury to the U.S. steel industry has been a general secular shift away from employment in this sector.[13] This trend incorporates several factors, including possibly a labor-saving change in the production technology, faster than average growth of employment and productivity in the high-technology and service sectors (which has meant that resources have been drawn away from more traditional manufacturing industries), and a slow decline in the demand for domestic steel not explained by either relative price or real income movements.[14]

For the period since 1979 the evidence is mixed. Our estimates show that secular factors have been quantitatively most significant even during this shorter time period. Intensification of import competition has had nearly as large an impact during this period, with the difference falling well within the confidence interval for our analysis.[15]

TABLE 2

CAUSES OF INJURY TO THE U.S. STEEL INDUSTRY

ESTIMATED JOB LOSS (Average for Aug-Oct 1983)	BASE PERIOD	
	January 1976	January 1979
Import Competition, of which:	37,403	80,959
Exchange Rate Appreciation	29,037	82,701
U.S. Tariff Reductions	1,216	1,216
Shift in Foreign Supply	7,150	- 2,958
Secular Shift	208,734	109,600
Sluggish Real Income Growth		
Assuming "Normal" Growth of 4% p.a.	27,031	49,251
Assuming "Normal" Growth of 3% p.a.	3,777	33,577
Wage Pressures	5,047	- 4,101
Increase in Relative Price of Energy	3,582	2,966

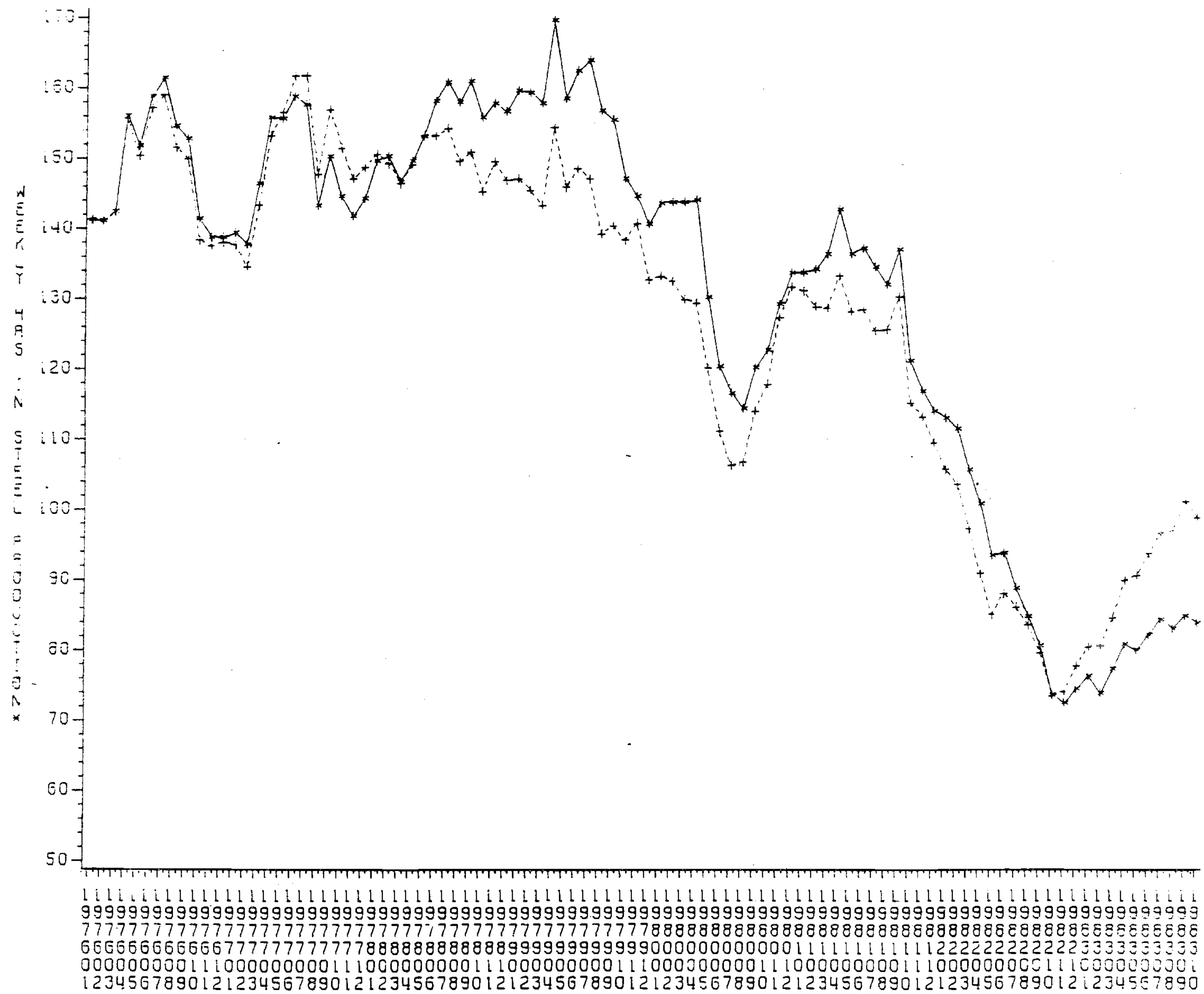
I have argued further that the import competition effect is actually the sum of three separate components: the effect of shifts in the foreign excess supply curve for steel (in foreign currency units), the effect of exchange rate changes and the effect of U.S. tariff reductions. Of these, only the sharp appreciation of the dollar in the last four years can be held responsible for the loss of a significant number of jobs in the U.S. steel industry. Movements in the foreign excess supply curve account for the loss of only 7,150 steel industry jobs since 1976, and in the period since January 1979, import competition measured in this way has actually abated somewhat.

What does the analysis imply about the merits of the Section 201 escape clause case heard recently by the U.S. International Trade Commission? Clearly, the period of analysis is important. The petitioners cited the period since 1976 as the relevant one. During this time, import competition cannot be considered to be the most important cause of injury to the U.S. steel industry; the secular decline that the industry has been undergoing for more than a decade has been responsible for the loss of more than five times as many jobs as has the intensification of import competition. In the most recent four years, however, import competition and secular decline have been roughly equal as causes of injury to the industry. But the injury due to import competition during this period is entirely the result of the more-than- thirty-percent real appreciation of the U.S. dollar. Thus, escape clause protection could only be justified under the Section 201 statute if it were determined on legal grounds that exchange rate effects do qualify as "injury caused by imports", despite sound economic arguments that suggest that protection should not be provided in such instances.

FIGURE 1

ACTUAL AND SIMULATED PATHS OF EMPLOYMENT

SIMULATION WITH RELATIVE IMPORT PRICES CONSTANT AFTER 1976



TIME IN YEAR AND MONTH

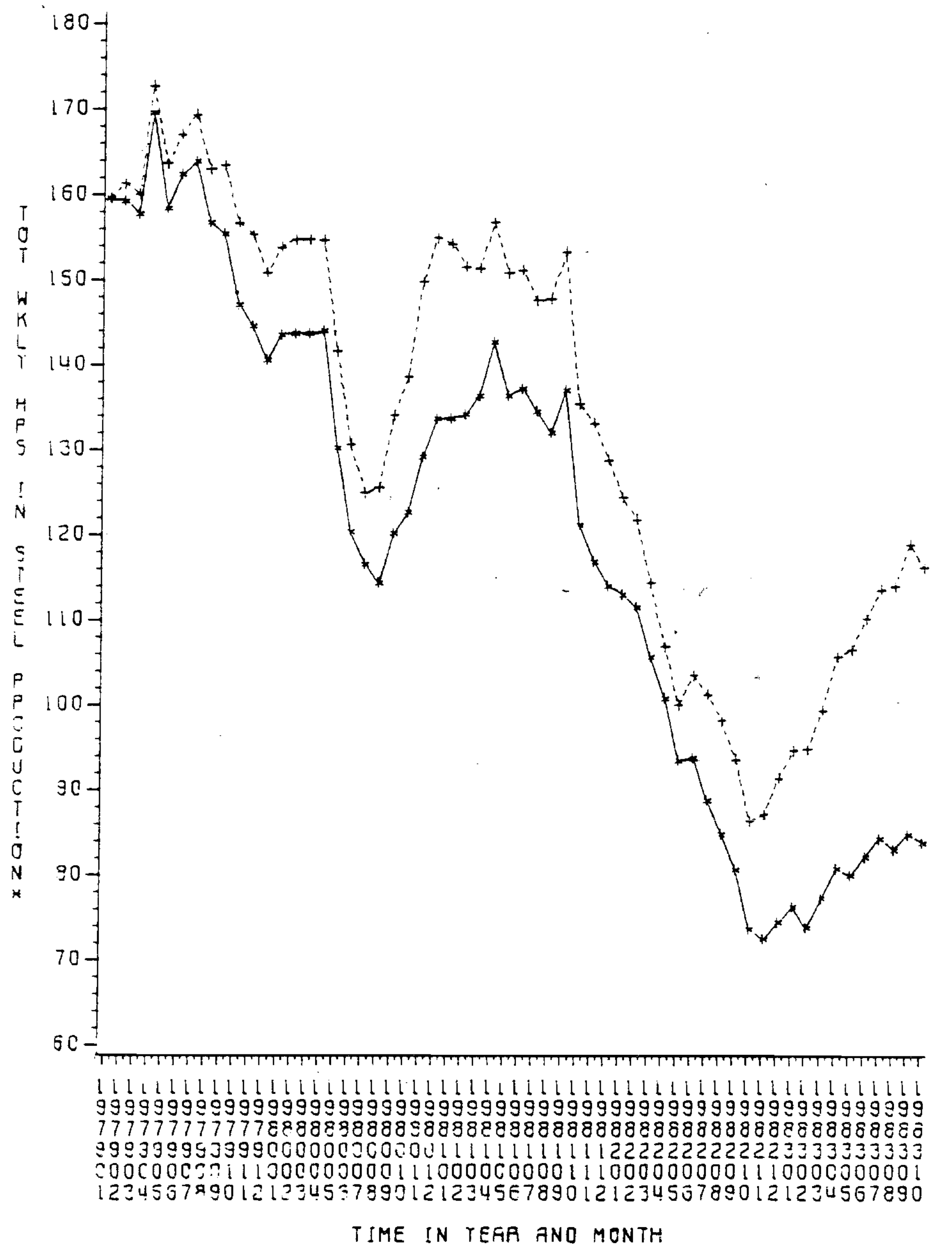
*- = ACTUAL HOURS + = SIMULATED HOURS

* TOTAL WEEKLY HOURS IN HUNDRED THOUSANDS

FIGURE 2

ACTUAL AND SIMULATED PATHS OF EMPLOYMENT

SIMULATION WITH RELATIVE IMPORT PRICES CONSTANT AFTER 1979



* = *ACTUAL HOURS* + = *SIMULATED HOURS*

* *TOTAL HOURS IN HUNDRED THOUSANDS*

FIGURE 3

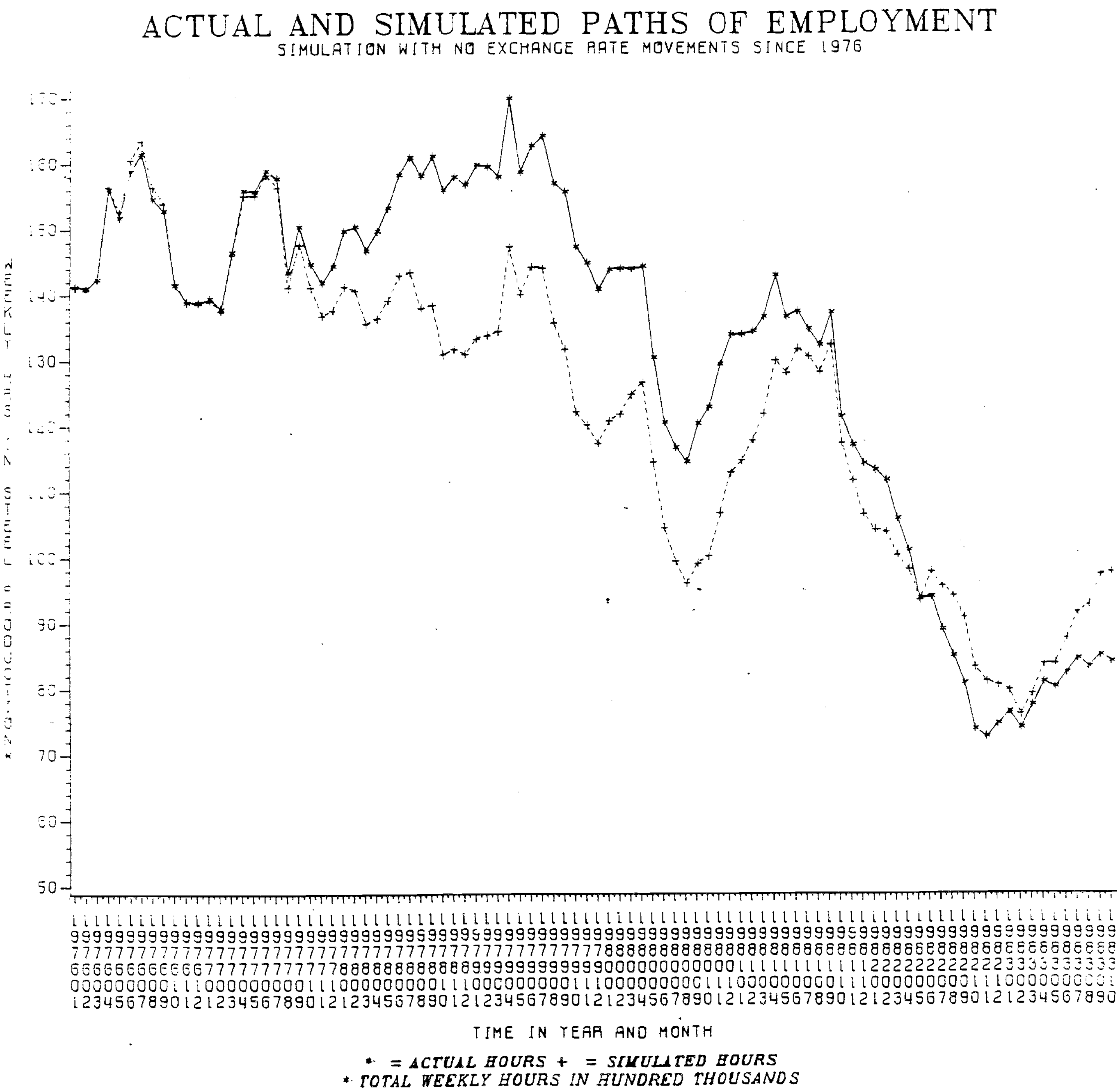
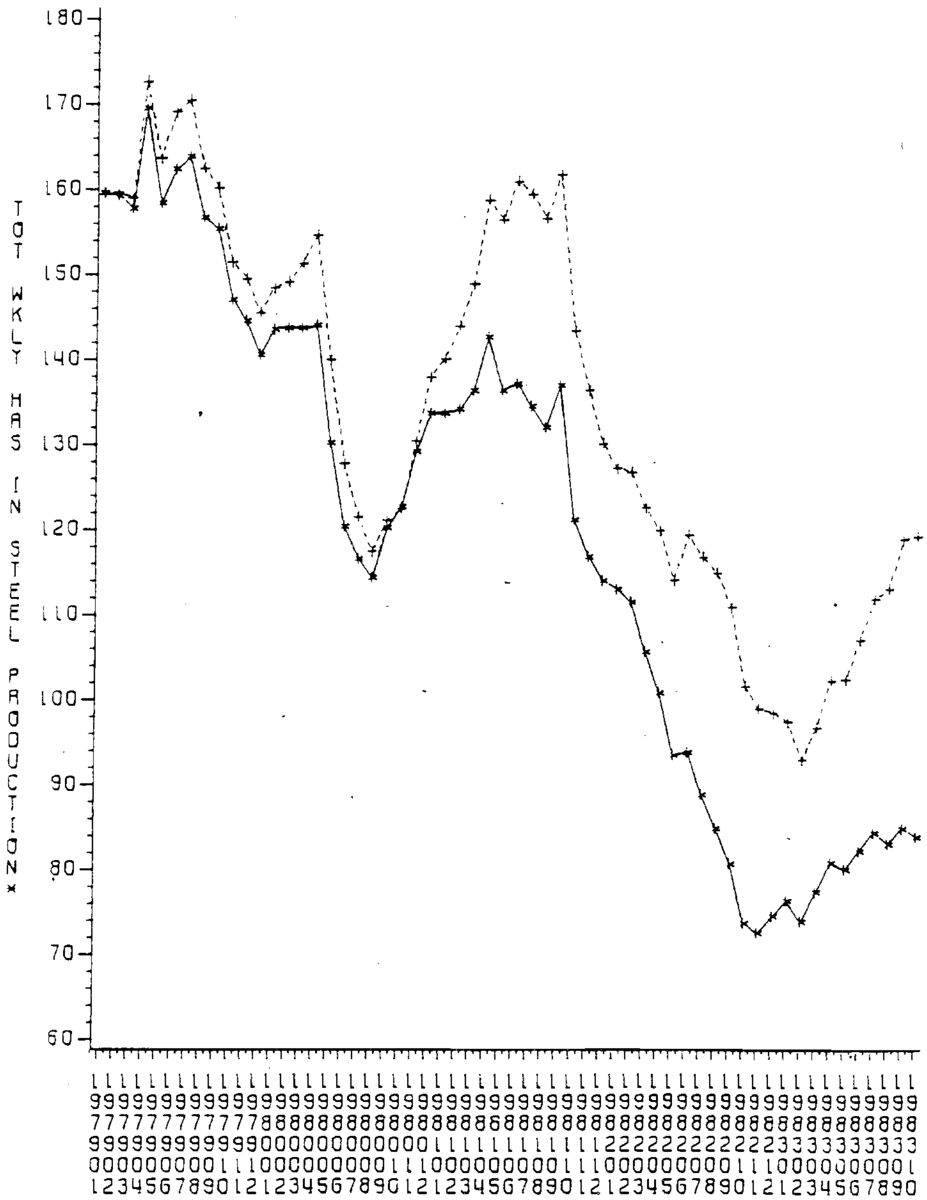

ACTUAL AND SIMULATED PATHS OF EMPLOYMENT
SIMULATION WITH NO EXCHANGE RATE MOVEMENTS SINCE 1976
170
160
150
140
130
120
110
100
90
80
70
60
50
TIME IN YEAR AND MONTH
* = ACTUAL HOURS + = SIMULATED HOURS
* TOTAL WEEKLY HOURS IN HUNDRED THOUSANDS

FIGURE 4

ACTUAL AND SIMULATED PATHS OF EMPLOYMENT

SIMULATION WITH NO EXCHANGE RATE MOVEMENTS SINCE 1979



* = ACTUAL HOURS + = SIMULATED HOURS
* TOTAL HOURS IN HUNDRED THOUSANDS

Footnotes

1. Historically, the International Trade Commmission, in making its Section 201 determinations, has relied heavily on the subjective testimony of industry experts, and on other more casual forms of industry analysis. Incidentally, on June 12, 1984 the I.T.C. found in favor of the petitioners in the case that is the subject of this paper. As of the time of this writing, the Commission is deliberating on the form of protection to recommend to the President.
2. Note that, in principle, this same methodology could be used to analyze other industry developments besides employment, such as the evolution of industry production, sales, profits, etc. An initial attempt was made to estimate a reduced-form equation for steel sector sales, using tons of carbon steel shipments (as reported by the American Iron and Steel Institute) as the endogenous variable. However, the equation left much of the variance in shipments unexplained, and most of the estimated reduced-form coefficients had large standard errors (in several cases, larger than the absolute value of the estimated coefficient). For this reason, we did not proceed with the simulations of steel shipments, concentrating instead on the employment equations for which the estimation yielded a better fit and more precise estimates of the parameters.
3. The derivation of the reduced-form equation and the justifications for some of the assumptions are kept intentionally brief. The interested reader is referred to Grossman (1982) for a more detailed discussion.
4. It would also be appropriate to treat wages in the steel industry as exogenous if labor is highly mobile and if the steel industry is small in relation to the U.S. economy. A high degree of intersectoral labor mobility

is consistent with the findings of Grossman (1982). Nine U.S. industries were studied there, and it was found that the price of imports had a non-negligible effect on the industry wage rate in only one of these.

5. The trigger price mechanism, in force since the mid-1970's, also contributes to a high elasticity of supply of imported steel into the United States. The trigger prices essentially serve as a price floor for European of Japanese steel in the U.S. market, so that even if the import supply curves from these sources would be upward sloping in its absence, they would be perfectly elastic in the neighborhood of equilibrium whenever the policy is binding.

6. In fact, VER's continued to place an upper bound on imports from some foreign suppliers until the end of 1974. However, Crandall (1981, p.103) has shown in his careful study of the U.S. steel industry that the quantitative restrictions were binding before 1972, but ceased to be so after that date.

7. The lag structures for import prices, for the price of energy and for the price of iron ore were specified as fourth-degree polynomial-distributed lags. Those for wages and real industrial activity were estimated as five-month free lags. In addition, the equations included a constant term, and were corrected for first-order serial correlation of the residuals using an iterative, maximum-likelihood procedure.

8. SIC 3312 was selected over SIC 331 (blast furnaces and steel products) because 3312, by excluding some fabricators, is closer to the industry at issue in the recent escape clause proceedings.

9. It would have been preferable to use actual import prices, rather than an index of unit values. However, the B.L.S. series for U.S. import prices by industry are too short to allow us to estimate the reduced-form regressions. Another possibility would be to use export prices of steel for our trade partner countries. Export prices for continental European steel are

available in the Metals Bulletin. However, the data series are not complete. Another problem with using these data would be that the existence of the U.S. trigger prices mechanism during our sample period suggests that European steel prices averaged across all export markets are a poor proxy for the price of European steel delivered to the U.S. market. In defense of the use of unit values in this case, it can be argued that foreign steel is a relatively homogenous product, so that changes in the value of shipments for a given quantity sold are unlikely to reflect changes in the quality of the product. Duke et. al. (1977) found that unit values tracked the prices reported in the Metals Bulletin fairly closely after a lag of three months.

10. Note that Congressional debate on the Trade Reform Act of 1974 took place during a period of fixed exchange rates.

11. Recall that the predicted path of employment under the counterfactual assumption of no intensification of import competition is found by subtracting from the actual employment values the difference between the simulated values using assumed and historical values for the exogenous variables. In effect, we add back in the residual from the reduced-form regressions in forming our prediction of "what would have been" under the assumed counterfactual.

12. Unpublished data from the Office of Productivity and Technology of the Bureau of Labor Statistics shows that total compensation for production workers in the steel industry has increased by 94.5 percent from 1976 to 1983. The same source reports an increase of 81.1 percent in total compensation to all employees in manufacturing industries in the United States during this period. If total compensation in the steel sector had grown at this slower (average for all sectors) rate, and if the estimated wage elasticity of -.596 can be assumed to apply to total compensation, then an additional 4.1 percent

of the employment in 1976 would have been preserved in 1983. This amounts to approximately 15,000 jobs, as compared to the figure of 5046 for wage pressure alone.

13. A one-tailed t-test of the hypothesis that the estimated job loss attributable to import competition is greater than or equal to that attributable to secular shift for the period 1976 to 1983 can be rejected at the 99% significance level.

14. A rough calculation using data from Ward's Automotive Yearbook on pounds of steel in the "typical" U.S. car and on total car and truck production by the U.S. automobile industry, and assuming (arbitrarily) that the employment elasticity with respect to steel output is one, would suggest that the reduction in demand for steel by the U.S. automobile industry (due to both the down-sizing of cars and the retrenchment in the industry) could account for as much as one-quarter of the job loss attributed to secular decline.

15. It is impossible to reject the hypothesis at even the eighty precent level of significance that the employment effect of secular shift and that of import competition are equal for the period 1979 to 1983.

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