

ARE IMPORTS TO BLAME? ATTRIBUTION OF INJURY UNDER THE 1974 TRADE ACT*

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I. INTRODUCTION

UNDER Section 201 of the 1974 Trade Act, a domestic industry can obtain temporary protection against imports by demonstrating, first, that it has been injured and second, that increased imports have been a substantial cause of injury.¹ Protection under the act might take the form of a quota or tariff lasting for a period of five years, during which time the industry would presumably have an opportunity to make the adjustments necessary to strengthen its competitive international position. To obtain protection the industry must make its case before the International Trade Commission (ITC). The findings and recommendations of the ITC are then reviewed by the president, who makes the final decision as to whether relief is warranted and the form it will take.

Determining that an industry has been injured is relatively easy—the ITC can look to such indicators as reduced profits, plant closings, falling employment, and the like. What is much more difficult is determining whether imports, rather than one or more other factors, are the substantial cause of the injury, that is, “a cause which is important and not less than any other cause.”² Yet the ITC must make this determination regularly in the growing number of cases brought before it each year. To date,

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¹ At issue is “whether an article is being imported into the United States in such increased quantities as to be a substantial cause of serious injury, or the threat thereof, to the domestic industry producing an article like or directly competitive with the imported article.” Trade Act of 1974, Pub. L. No. 93-618, § 201, ¶ (b)(1), 88 Stat. 2012 (1978).

² *Id.* at ¶ (b)(4).

the ITC lacks a coherent framework for selecting a list of other factors that might be considered causes of injury and for weighing the effects of those other factors against those of imports.

This paper sets forth a straightforward economic and statistical framework for use in Section 201 cases and for more general analyses of the effects of imports on domestic industries. This framework is based on the fact that, if the domestic industry is competitive, injury can arise from one or more of three broad sources: adverse shifts in market demand, adverse shifts in domestic supply, and increased imports. We show how these sources of injury can be distinguished in theory and statistically evaluated in practice.

Before addressing any issues of measurement, an interpretation must be made of the economic meaning of Section 201. To an economist the view that increased imports cause injury is itself problematic. In many economic models the fundamental determinants of prices and output levels are tastes and technological possibilities, and imports are only one of the many consequences of these fundamental determinants. Changes in welfare then come about because of changes in tastes and technological possibilities, so that imports could never be a direct source of injury. This view, however, is hardly in keeping with the spirit and intent of the Trade Act.

An alternative view might focus on the distinction between domestic and foreign shifts in tastes and technological possibilities. It would attribute the deleterious effects of any such shifts of foreign origin to imports. However, it would not treat as injurious any changes in imports due to shifts of domestic origin. This might seem appealing, in that the domestic effects of foreign shifts are mediated through changes in imports. According to this view, the intent of the Trade Act is to insulate the domestic industry only from foreign developments. This view is implicitly adopted by Grossman in a recent paper that evaluates the injurious effects of steel imports.³

We do not adopt this view, however, on grounds of both implementation and interpretation. First consider implementation. The equilibrium level of imports is also affected by domestic shifts in tastes and technologies. Therefore, to calculate changes in industry welfare resulting from changes in imports in a way consistent with this view, one must be able to separate the changes in imports into two parts, namely, those due to domestic developments and those due to foreign developments. This is likely to be difficult in practice, as will become clear later. (Grossman

³ Gene M. Grossman, Imports as a Cause of Injury: The Case of the U.S. Steel Industry (Working Paper No. 1494, Nat'l Bur. Economic Research, November 1984).

avoided this separation by assuming that the supply of imports is infinitely price elastic, an assumption that is extreme and unrealistic.) As for the Trade Act, it refers only to damage from imports. It never distinguishes among the sources of increased imports.

The view that we adopt is to take any changes in imports as possible causes of injury regardless of the sources of those changes. This view is in keeping with the language of the Trade Act and has the advantage that the injury from domestic developments is computed as if the industry were not subject to import competition. Moreover, leaving the Trade Act aside, it is generally of interest to determine the causes of a domestic industry's contraction. As will be shown, this approach permits a straightforward measurement and comparison of the injuries caused by imports as well as those caused by domestic developments.

Our approach is to begin with any shifts in domestic demand, shifts in domestic supply, and changes in imports that might have occurred from a particular base period to determine their relative effects on the industry. We assign injury to increased imports by comparing actual industry performance (as measured by such indicia as profits, employment, output, and so on) with performance under a hypothetical "constant import" scenario. Under this scenario, all domestic industry variables (for example, wages, demand, and so on) have their actual values, but imports are held at their base level (for example, by imposition of a quota or tariff). With imports held constant in this way, domestic developments alone can still cause a certain amount of injury. The difference between actual industry performance and performance under the constant-import scenario is the injury that can be attributed to imports. This injury can then be compared to the injury caused by domestic developments alone.

Section II of this paper sets forth an accounting framework for the attribution of injury. Statistical issues involved in the application of this framework are discussed in Section III. As an illustrative example, Section IV applies the framework to the case of the copper industry, which petitioned the ITC for relief in 1984.⁴ Although that industry has indeed suffered injury, we show that the "substantial cause" was not imports but rather increasing costs and decreasing demand.

As explained above, our framework treats any changes in imports as possible causes of injury. Section V demonstrates how one can test for

⁴ Section IV is based on an analysis that the authors presented to the ITC at its hearings in May 1984; see Robert S. Pindyck & Julio J. Rotemberg, *Economic and Statistical Analysis of Injury Causation* (Investigation No. TA-201-52 [Unwrought Copper], presented to the International Trade Comm'n, May 1984). The authors' analysis and testimony was on behalf of Codelco, the state-owned copper company of Chile.

“substantial cause” under an alternative framework in which only changes in imports resulting from foreign shifts in tastes and technologies are included as possible causes of injury. Section VI provides a summary and some concluding remarks.

II. THEORETICAL FRAMEWORK

Injury to a domestic industry might have the following causes, occurring either individually or in combination: a drop in domestic demand, an adverse shift in supply (corresponding, say, to increases in costs), and an increase in imports. The problem is to separate these causes and measure their relative contributions. We do this as follows.

We will assume that the domestic industry is competitive.⁵ Then we can write the domestic supply schedule as $S(P, a)$, where P is price and a a shift parameter. Increases in a shift the supply schedule to the right. For example, technological progress in the United States would increase a and increase supply, while rising labor costs in the United States would have the opposite effect. Similarly, we can write the domestic demand schedule as $D(P, b)$, where increases in the parameter b (corresponding, say, to an increase in U.S. income levels) increase demand.

The United States also faces an import supply schedule, $M(P, c)$. This schedule is upward sloping; that is, a higher price creates an incentive for foreign producers to increase production and an incentive for foreign consumers to reduce consumption. In both cases this makes more imports available to the United States. The shift parameter c reflects changes in foreign supply and demand conditions, with $\partial M/\partial c > 0$. For example, a recession abroad would reduce foreign demand, thereby increasing M , so we would represent such a recession by an increase in c .

The U.S. and world markets are in equilibrium when price equates demand and total supply, that is, at a price P^* such that

$$D(P^*, b) = S(P^*, a) + M(P^*, c). \quad (1)$$

An equilibrium of this type is illustrated by Figure 1*a* and *b*. Observe from the figure that changes in a and b will affect the equilibrium price P^* and thus the level of imports, even though the import supply schedule $M(P, c)$ remains fixed. Thus the level of imports can change purely as a result of domestic developments. For example, an increase in domestic labor costs (that is, a drop in a) would shift $S(P, a)$ to the left, increasing P^* and increasing imports.

⁵ This simplifies the analysis considerably. If domestic firms had significant monopoly power (by virtue of concentration or collusion), there would be no well-defined domestic supply schedule.

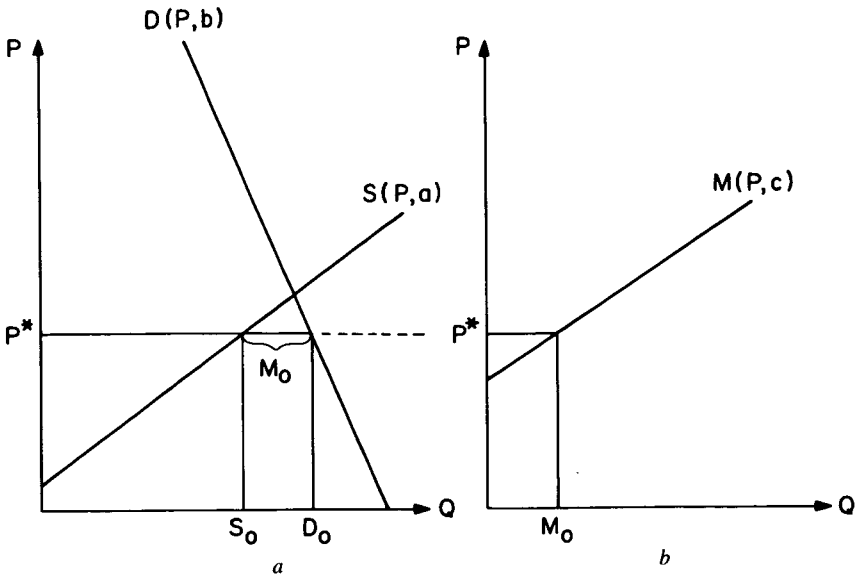


FIGURE 1.—*a*, Domestic market. *b*, Supply of imports

This raises the issue discussed in Section I of whether any changes in imports, whatever their source, should be viewed as potentially injurious. As explained earlier, we do not adopt the alternative view that the only increases in imports that should be deemed to have caused injury are those resulting from increases in c , that is, shifts to the right of the import supply schedule.⁶ The view we adopt is to include any changes in imports as possible sources of injury, no matter how those changes arise, and to compare their effects to those that result from shifts in the domestic demand or supply schedules.

Let us begin with the equilibrium given by equation (1) and consider the effect of a change in a , that is, a shift in the domestic supply schedule. This is illustrated in Figure 2*a* and *b*, which shows the effect of a decrease in a to a' , corresponding to, for example, an increase in domestic production cost. Observe that price increases from P^* to P_1 , bringing forth the higher level of imports, M_1 , with domestic supply falling to S_1 .

Now suppose that imports had been held constant at M_0 , say, through a quota. As shown in Figure 2*a*, price would rise more, to P_2 , and domestic supply would fall only to S_2 .

⁶ This was the point of view of the Federal Trade Commission in their 1984 report on copper to the ITC; see note 4 *supra*.

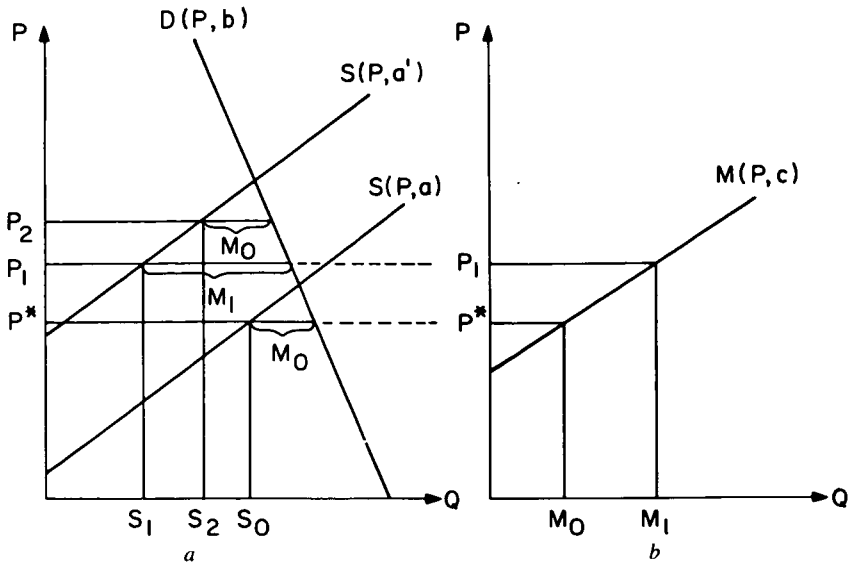


FIGURE 2.—*a*, Domestic market, shift in supply. *b*, Supply of imports, higher price

Thus, the total change in domestic output (ΔS_T), resulting from changing domestic cost conditions, can be decomposed into two components, that is, a change for constant imports (ΔS_m) and a change due purely to the change in imports (ΔS_n). For small changes in a , this decomposition can be written as

$$\left(\frac{\partial S}{\partial a}\right)_T = \left(\frac{\partial S}{\partial a}\right)_m + \left(\frac{\partial S}{\partial a}\right)_n, \tag{2}$$

where

$$\left(\frac{\partial S}{\partial a}\right)_m = \left(\frac{\partial S}{\partial a}\right) + \frac{(\partial S/\partial P)(\partial S/\partial a)}{[(\partial D/\partial P) - (\partial S/\partial P)]}$$

and

$$\left(\frac{\partial S}{\partial a}\right)_n = \frac{(\partial S/\partial P)(\partial S/\partial a)(\partial M/\partial P)}{[(\partial D/\partial P) - (\partial S/\partial P)][(\partial D/\partial P) - (\partial S/\partial P) - (\partial M/\partial P)],}$$

which are both positive.

In Figure 2*a*, ΔS_m is given by $S_0 - S_2$, and ΔS_n is given by $S_2 - S_1$. Observe that, if demand is relatively inelastic ($\partial D/\partial P$ is small) and the import supply schedule is relatively elastic ($\partial M/\partial P$ is large), ΔS_n can exceed ΔS_m (which is the case in Figure 2*a*). In the extreme case of a

completely inelastic demand schedule, supply would not change at all if imports were absent. It is only the responsiveness of imports to a price increase that causes a fall in a to be detrimental to output in the industry.

Now we must deal with the meaning and measurement of injury. The Trade Act is explicit in including only domestic producers and not domestic consumers among those possibly injured. A narrow economic view might therefore limit the definition of injury to the loss of producer surplus, that is, economic profits and rents. In general, profits, output, capacity utilization, and price will be highly correlated with this measure and would represent sensible indicia of industry welfare. So too is the level of employment if workers who lose their jobs are unable to obtain alternative employment at the same wage. Indeed the Trade Act refers to all these variables as measures of industry welfare.

Let us denote these indicia of injury by I and consider those variables on which I might depend. If the parameter a is constant, it is clear that injury can result only from a fall in the equilibrium price P^* that affects supply. (For example, a drop in demand would reduce P^* .) However, a reduction in a itself will also cause injury.⁷ In general, one can therefore write the value of I as a function of S and a :

$$I = g[S(P^*, a), a]. \quad (3)$$

Observe that I rises as either a or S falls. The effect on I of a change in a can be decomposed into a "direct" effect, $\partial g/\partial a$, and an "indirect" effect, given by $\partial g/\partial S$ times the change in S induced by the change in a . The direct effect is the injury that would result even if prices somehow adjusted to keep supply constant. The indirect effect is the injury resulting from the change in the equilibrium quantity supplied. Thus the total injury is given by $\partial g/\partial a + (\partial g/\partial S)(\partial S/\partial a)_T$, while that attributable to imports is given by $(\partial g/\partial S)(\partial S/\partial a)_n$.

A similar analysis can be carried out with respect to a change in b . A recession-induced drop in domestic demand (a drop in b) will cause injury by reducing price and output. However, the fall in price will bring about a drop in imports, which will mitigate the reduction in output. In this instance, imports benefit the domestic industry; the total injury resulting from a drop in demand is less than it would be if imports had been held constant.

Finally, note that a change in c (a shift in the import supply schedule)

⁷ Some indicia of injury will be affected more than others, depending on the reason for the fall in a . A reduction in a due to an increase in wages will have a relatively more deleterious effect on employment. One that is due to the increased price of another input is likely to have a greater effect on profits.

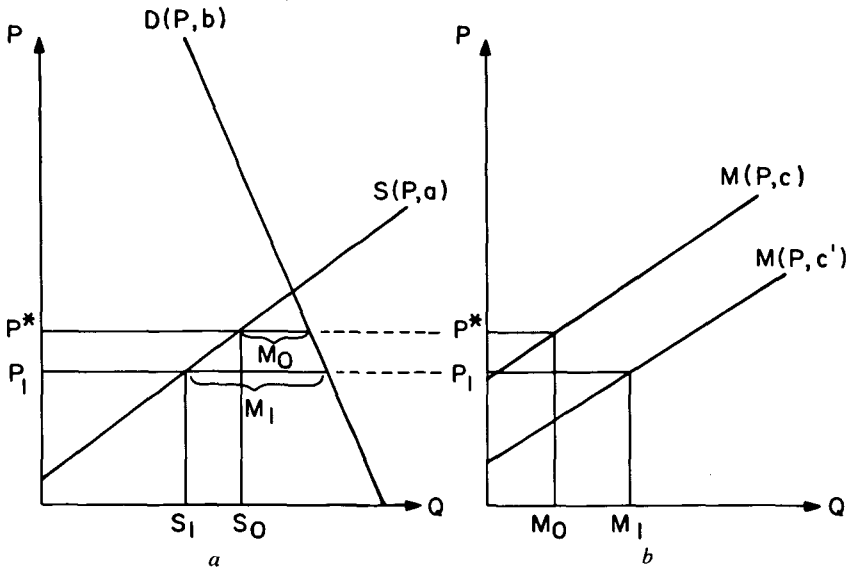


FIGURE 3.—*a*, Domestic market, lower price. *b*, Supply of imports, shift in supply

has effects on the domestic industry only via its effects on the level of imports. As shown in Figure 3*a* and *b*, an increase in c causes injury by increasing M and thereby reducing price and domestic output.

III. STATISTICAL APPROACH

In assessing injury, the ITC reviews data pertaining to some recent time period, usually the past five years. During such a period there might be shifts in all three schedules, $S(P, a)$, $D(P, b)$, and $M(P, c)$. As a result changes would occur in such observable variables as price, domestic output, and the level of imports. We now show how such data can be used to allocate injury between imports and domestic developments.

We assume that time-series data are available for the indicia of injury, which we denote at time t by I_t , for the level of imports M_t , as well as for any variables that shift the supply and demand schedules, a_t and b_t . For simplicity we assume that the relations embodied in equations (1) and (3) are linear; this is always valid, at least as a local approximation.⁸ Then we

⁸ One might think that a globally valid linear formulation can be obtained when all variables are in logarithms, but this is not the case. With Cobb-Douglas production functions the log of employment is a linear function of the log of output. Similarly, the log of output is a linear function of the log of price. However, eq. (1) is not valid in logarithms, so that, in equilibrium, the log of output is generally not a function of the log of imports.

can write supply, demand, and the indicia of injury at time t as

$$S_t = s_0 + s_1 a_t + s_2 P_t + \epsilon_{st}; \quad (4a)$$

$$D_t = d_0 + d_1 b_t + d_2 P_t + \epsilon_{dt}; \quad (4b)$$

$$\begin{aligned} I_t &= i_0 + i_1 a_t + i_2 S_t + \epsilon_{it} \\ &= (i_0 + i_2 s_0) + (i_1 + i_2 s_1) a_t + i_2 s_2 P_t + \epsilon_{it} + i_2 \epsilon_{st}, \end{aligned} \quad (4c)$$

where the parameters s_1 , s_2 , and d_1 are positive, while d_2 , i_1 , and i_2 are negative. The ϵ 's are residuals (additive errors) and emerge because of a myriad of influences on supply, demand, and injury that cannot be captured by measurable variables. Next, substituting (4a) and (4b) for supply and demand into (1) yields the following for the equilibrium price:

$$P_t = \frac{d_0 - s_0 + s_1 a_t + \epsilon_{dt} - \epsilon_{st} - M_t}{s_2 - d_2}. \quad (5)$$

Equation (5) can be substituted for P_t in (4c) to yield the following equation for I_t , the index of injury:

$$I_t = \psi + \alpha a_t + \beta b_t + \delta M_t + \epsilon_t, \quad (6)$$

where

$$\begin{aligned} \psi &= i_0 + i_2 s_1 - i_2 s_2 (d_0 - s_0) / (s_2 - d_2); \\ \alpha &= i_0 + i_2 s_1 + i_2 s_1 s_2 / (s_2 - d_2); \\ \beta &= i_2 s_2 d_1 / (s_2 - d_2); \\ \delta &= -i_2 s_2 / (s_2 - d_2); \text{ and} \\ \epsilon_t &= \epsilon_{it} - i_2 d_2 \epsilon_{st} / (s_2 - d_2) + i_2 s_2 \epsilon_{dt} / (s_2 - d_2). \end{aligned}$$

Equation (6) is a reduced-form regression equation that we use to gauge the alternative sources of injury as captured by a_t , b_t , and M_t . First, however, we must determine whether consistent parameter estimates can be obtained using ordinary least squares.

The first requirement is that the included variables that shift supply and demand (a_t and b_t) not be correlated with the excluded variables embodied in the residual ϵ_t . Variables that are typically part of a_t are wage levels and other input prices; they are unlikely to have any direct effect on demand. Similarly, variables that shift demand, such as aggregate income, are unlikely to have any significant effect on supply. But even if a_t were correlated with ϵ_{dt} , equation (6) would still provide a valid gauge of the sources of injury. Although the estimate of α could not be used to recover the underlying structural parameters i_1 , i_2 , and so on, it would still be a consistent estimate of the partial correlation of a_t with the index of

injury. This represents the extent to which an increase in a , when unaccompanied by any other change, affects I .

A second requirement is that imports, M_t , not be correlated with ϵ_t . This is more problematic if imports are highly price elastic. In this case, as equation (5) shows, an increase in ϵ_{dt} or a decrease in ϵ_{st} raises price and increases imports substantially. Since increases in either ϵ_{dt} or ϵ_{st} decrease ϵ_t , with imports price elastic M_t and ϵ_t could be either positively or negatively correlated. This in turn could bias the estimated value of δ in either direction. In principle, this can be corrected by the use of instrumental variables. One needs instruments that are correlated with M_t but not with ϵ_{dt} and ϵ_{st} . Past values of imports would have this property, but only if ϵ_{st} and ϵ_{dt} are serially uncorrelated. Alternatively, current and past values of variables affecting only M_t , such as tariffs, might be used as instruments. In practice, however, such variables tend not to vary enough to account for significant movements in imports.

Once α , β , ψ , and δ have been estimated, equation (6) can be used to compute the effect on the indicia of injury of the measured changes in a , b , and M from their base levels. That provides a direct comparison of the injury due to import changes with that due to domestic developments.

The procedure described above has the advantage of using the available data to gauge alternative sources of injury as accurately as possible. A limitation, however, is that it ignores dynamic adjustments in the response of market variables to changes in imports and other variables. For example, the response of price and domestic production to a shift in the import supply schedule is likely to occur with time lags, and those lags are not captured by equation (6). In theory, one could specify and estimate a detailed structural model that captures those lags, but, given the limited amounts of data that are usually available, this is likely to be difficult or impossible in practice. We therefore suggest an alternative procedure that allows for the possibility of dynamic adjustment. Unfortunately, this procedure can be used to determine only whether imports and other variables have had any injurious effects at all, but it is of no use in measuring the sizes of those effects. Thus this procedure should be used to complement the one described earlier.

This procedure uses the test of causality introduced by Granger.⁹ It is a test of the null hypothesis that a particular variable does not help to predict some other variable. In particular, one can say that the variable x

⁹ Clive W. J. Granger, Investigating Causal Relations by Econometric Models and Cross-spectral Methods, 37 *Econometrica* 424 (1969). See also Christopher A. Sims, Money, Income, and Causality, 62 *Am. Econ. Rev.* 540 (1972); and Thomas J. Sargent, Estimation of Dynamic Labor Demand Schedules under Rational Expectations, 86 *J. Pol. Econ.* 1009 (1978).

does not help to predict the variable y if, in a regression of y against past values of y , the addition of past values of x as independent variables does not contribute significantly to the explanatory power of the regression. In such a case, the data are not inconsistent with a relatively small role for x in the prediction or explanation of y .¹⁰

To apply this notion to the problem at hand, we test the null hypothesis that changes in imports did not cause changes in an index of injury, that is, that prior changes in imports did not contribute significantly to the prediction of the index. This null hypothesis is tested by running a regression explaining the value of an index of injury at time t by past values of the index as well as by present and lagged values of imports. If imports are statistically insignificant in that regression, then one can accept the hypothesis that they did not cause injury or, more accurately, that any injury they did cause is not statistically detectable.¹¹

This is a much stronger test for lack of injury than the discovery from the estimation of equation (6) that δ is insignificantly different from zero. It allows the effects of imports to occur with a lag, and it puts no requirement on the magnitude of the coefficient on imports. As a result, there may be occasions in which the null hypothesis is rejected, even though imports may cause minimal injury.

IV. THE U.S. COPPER INDUSTRY

As the summary data in Table 1 show, the early 1980s was a period of severe contraction for the U.S. copper industry. Copper prices fell dramatically, and many domestic mining operations became unprofitable, leading to mine closings, reduced output and employment, and a sharp decline in profitability. Domestic producers blamed this on rising imports

¹⁰ Note that failure to reject the hypothesis that imports did not cause injury is not the same as a rejection of the alternative hypothesis that imports did cause injury. This latter hypothesis can almost never be rejected even if imports did not in fact cause injury. The reason is that it is impossible to disentangle a minimal amount of injury from no injury at all.

¹¹ The test is performed by running two regressions, the first excluding current and lagged values of x , the second including them. Then one can utilize the statistic

$$F = \frac{N_1(SSR_1 - SSR_2)}{N_2(SSR_2)},$$

where SSR_1 and SSR_2 are the sums of squared residuals from the first and the second regressions, respectively; N_1 is the number of observations less the number of estimated parameters in the second regression; and N_2 is the number of parameters in the second regression minus the number of parameters in the first regression. This statistic is distributed as $F(N_1/N_2)$; see Sims, *supra* note 9; and Sargent, *supra* note 9.

TABLE 1
DATA ON INJURY AND ITS DETERMINANTS

| Year | Refinery Production* | Smelter Production* | Mine Production* | Mining Employment | Wage Ratio | Refined Imports* | Total Imports* | GNP† |
|------|-------------------------|------------------------|---------------------|----------------------|---------------|---------------------|-------------------|-------|
| 1976 | 1,715 | 1,457 | 1,457 | 36,700 | 1.349 | 346 | 364 | 1,298 |
| 1977 | 1,698 | 1,364 | 1,364 | 33,600 | 1.319 | 351 | 359 | 1,370 |
| 1978 | 1,832 | 1,343 | 1,358 | 30,000 | 1.371 | 403 | 485 | 1,439 |
| 1979 | 1,976 | 1,396 | 1,444 | 33,300 | 1.422 | 204 | 229 | 1,480 |
| 1980 | 1,686 | 1,053 | 1,181 | 30,000 | 1.459 | 427 | 471 | 1,475 |
| 1981 | 1,996 | 1,378 | 1,538 | 36,000 | 1.481 | 331 | 361 | 1,514 |
| 1982 | 1,683 | 1,021 | 1,140 | 24,500 | 1.474 | 258 | 356 | 1,485 |
| 1983 | 1,594 | 1,004 | 1,080 | 19,800 | 1.482 | 460 | 506 | 1,536 |

* Thousands of metric tons.

† Trillion 1972 dollars.

of refined and blister copper and petitioned the ITC for relief.¹² As can be seen from Table 1, imports rose sharply in 1983, but while there is little doubt that injury indeed occurred, our analysis, using the framework described above, demonstrates that imports are not a "substantial cause." Instead we find that most of the injury can be attributed to two much more important factors, namely, high and rising domestic costs and a decline in demand.

Our analysis has two parts. First, we estimate equation (6) for several indicia of injury and then, using the resulting parameters, compare the relative contributions of changes in imports, costs, and demand on each index. Second, we conduct Granger-causality tests to determine whether changes in imports "caused" changes in either copper prices or the profits of copper-mining firms. Here we briefly summarize our results.

We estimate equation (6) for the following indicia of injury: domestic copper refinery production, domestic smelter production, domestic mine production, and domestic copper-mining employment.¹³ Independent variables in these regressions include the level of real gross national product (GNP) in the United States (a variable that shifts the demand for copper); the ratio of average hourly earnings for U.S. copper-mining employees to average hourly earnings for all U.S. manufacturing employees¹⁴ (a variable that measures relative costs that shift supply); a time trend to capture the effects of productivity growth, the gradual tightening of environmental regulations, and the gradual substitution of other materials (plastics, aluminum, and fiber optics) for copper over the sample period; and the level of imports.¹⁵

These regressions are estimated by the ordinary least squares method using annual data for 1950–83; the results are shown in Table 2. Observe that all the parameter estimates have the expected signs, and, except in

¹² In a 5 to 0 decision, the ITC concluded that relief was indeed warranted. However, the commission's recommendation as to the form of that relief showed much less unanimity; two commissioners voted for a quota on imports, two voted for a \$0.05/pound tariff, and one voted for no protection. In September 1984, President Reagan decided against protection.

¹³ Time-series data on employment in other segments of the industry were available only for 1972–83. However, for this period the correlation coefficient between mining employment and smelting and refining employment is .93.

¹⁴ Adequate data on the earnings of workers in other segments of the industry were unavailable, but unpublished Department of Labor statistics from 1970 onward indicate that the earnings of smelting and refining employees have increased faster than have the earnings for mining. Also, we used the wage ratio rather than the real wage itself to capture labor costs relative to U.S. industries as a whole.

¹⁵ Imports of refined copper are used in the regression equation for refinery production, while total U.S. imports for consumption of refined and blister copper are used in the regressions for smelter production, mine production, and mining employment.

the equation for mining employment, all but the time trend are significant at the 95 percent level or above. Reestimation of these regressions by the two-stage least squares method has no material effect on the relative magnitudes of the parameter estimates.¹⁶

One might argue that net imports, that is, imports less exports, is a more appropriate independent variable than imports alone, and we reestimate the regressions accordingly. These results are also shown in Table 2 and are substantially the same as the first set of regressions. Finally, one could also argue that downstream imports is the appropriate independent variable. (For example, imports of semifabricated products will reduce the demand for domestically produced refined copper just as will imports of refined copper.) We therefore reestimate the regressions adding downstream imports to the import variables at each stage of processing. These results also appear in Table 2 and again are substantially the same.

The parameter estimates in Table 2 can be used to quantify the effects of changes in a given independent variable on each index of injury. To do this, however, one must compare the actual value of the independent variable in a given year to some meaningful reference value. Obviously, the choice of these reference values is critical for assessing injury. One possibility is to use as reference values the value of the independent variable in the very recent past. For example, one might use the value of imports in 1982 to assess the injury caused by 1983 imports, thereby taking into account that Section 201 cases usually follow surges in imports. (Indeed copper imports went from 356,000 metric tons in 1982 to 506,000 metric tons in 1983.) However, this approach would be heavily influenced by year-to-year fluctuations. As can be seen in Table 1, the level of imports in 1983 is not much larger than that in 1978 or in 1980. We therefore prefer to use as reference values "normal," or "long-run," levels of the independent variables. We do this as follows.

For real GNP we take the average annual growth rate for 1959–79 and use this to generate a series of projected (or "full capacity") values for subsequent years.¹⁷ Our proxy measure for the shift in demand is then the difference between projected and actual GNP for each year. To obtain the wage ratio, we take 1969 as a reference, the last year of a period of relatively uninterrupted prosperity and the year that preceded a decade of wage-price controls, recessions, and energy shocks that should have pro-

¹⁶ We used two sets of instruments. The first included lagged values of imports and GNP, while the second included lagged values of real copper prices as well.

¹⁷ The values of this "full capacity" GNP are \$1.59, \$1.65, and \$1.71 trillion (1972 dollars) for 1981, 1982, and 1983, respectively.

duced a relative decline in the real wages of copper-mining employees.¹⁸ We then use the difference between the actual wage ratio and its 1969 value as a measure of increased cost. Finally, our reference value for imports of refined copper is 300,000 short tons, or 272,160 metric tons (the quota recommended by the ITC in 1978), and for imports of blister it is zero, so that any blister imports are treated as “increased imports” in our calculations.

To calculate the relative effects of the recession-induced decline in demand, the increase in the wage ratio, and the increase in refined and blister imports, we multiply the difference between the reference and actual values of each variable by the parameter estimates in parts A and B of Table 2. The results are shown in Table 3, where the effect of each variable in each year is measured relative to the effect of the wage ratio.

As Table 3 shows, for each index of injury and in each year, low GNP and high real wages each had a greater industry effect than did increases in imports. In 1981, for example, real-wage increases had by far the greatest effect on the industry. In fact, the parameter estimates in Table 2 imply that, had real wages in copper mining remained stable relative to the wages in all manufacturing, domestic production at each stage of the industry would have been 350,000–675,000 tons higher. Had there been no increases in imports on the other hand, domestic production would have been only 55,000–100,000 tons higher. In 1982, refined imports were below the ITC’s proposed quota of 272,160 metric tons, and blister imports clearly had a miniscule effect relative to the other variables. The parameter estimates of Table 2 imply that the combined effects of the recession and increased real wages caused production to decline by 650,000–1,000,000 tons at every stage of processing and caused employment to decline by roughly 20,000 workers. Even in 1983, when imports rose, demand and wages contributed significantly more to the changes that occurred in each index of injury.¹⁹ On the basis of these results, imports hardly seem a “substantial cause” of injury to the domestic copper industry.

Table 3 concentrates on the relative injury caused by imports, wages, and GNP. This is consistent with the Trade Act. However, it might be

¹⁸ This value equals 1.144.

¹⁹ These results do not change dramatically if we use 1982 as the base year for imports instead of using the quota recommended by the ITC in 1978. Since imports of refined copper were lower in 1982 than in this quota, the injury to the production of refined copper rises from .87 of that due to wages to .94 when the estimates in part A of Table 2 are used. On the other hand, because total imports exceeded the quota in 1982, the injury to mining production, mining employment, and smelter production is lower if one uses 1982 as the base year for imports.

TABLE 2
ESTIMATION OF EQUATION (10)

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES | | | | | | | R ² | D-W |
|--------------------|-----------------------|---------------------|-----------------------|--------------------|---------------------|-------|--------------------|----------------|------|
| | CONST | GNP | WAGERAT | RIMP | RBIMP | TREND | TREND | | |
| A. Imports: | | | | | | | | | |
| RP | 1,817,316 (3.39) | 1,983,483 (2.63) | -1,046,669 (2.27) | -1.6497 (-4.64) | ... | ... | -27,088 (-1.14) | .76 | 2.41 |
| SP | 2,400,498 (4.89) | 2,019,087 (2.58) | -2,013,854 (4.26) | ... | -7141 (2.99) | ... | -30,299 (-1.25) | .62 | 2.04 |
| MP | 2,022,446 (4.69) | 1,956,602 (2.85) | -1,780,360 (-4.29) | ... | -6404 (-3.05) | ... | -24,547 (1.15) | .76 | 1.93 |
| ME | 55,967 (3.85) | 41,741 (1.80) | -41,583 (-2.97) | ... | -0104 (-1.47) | ... | -715.0 (-1.00) | .35 | .95 |
| B. Net imports: | | | | | | | | | |
| RP | 547,141 (.99) | 3,642,210 (4.72) | -910,578 (-2.34) | -1.3555 (-6.50) | ... | ... | -76,480 (-3.19) | .83 | 2.31 |
| SP | 1,555,741 (3.05) | 3,146,011 (3.72) | -1,857,710 (-4.34) | ... | -7326 (4.06) | ... | -64,771 (-2.48) | .69 | 1.84 |
| MP | 1,345,475 (2.87) | 2,767,790 (3.57) | -1,637,460 (-4.17) | ... | -5986 (-3.62) | ... | -49,381 (-2.06) | .78 | 1.77 |
| ME | 45,867 (2.79) | 52,673 (1.93) | -39,225 (-2.84) | ... | (.00908) (-1.56) | ... | -1,050 (-1.25) | .36 | .88 |

C. Downstream imports:

| | CONST | GNP | WAGERAT | IMPI | IMP2 | IMP3 | TREND |
|----|---------------------|---------------------|-----------------------|--------------------|------------------|--------------------|--------------------|
| RP | 1,845,535 (2.90) | 2,148,157 (2.18) | -1,189,418 (-2.29) | -1.3515 (-3.39) | ... | ... | -27,121 (-.90) |
| SP | 2,089,519 (3.82) | 2,646,124 (2.65) | -2,013,806 (-3.91) | ... | -7299 (-2.56) | ... | -48,879 (-1.58) |
| MP | 1,627,442 (3.39) | 2,123,178 (2.50) | -1,489,734 (-3.45) | ... | ... | -.5432 (-2.56) | -31,693 (-1.18) |
| ME | 42,854 (2.84) | 44,009 (1.65) | 31,563 (-2.33) | ... | ... | -.00690 (-1.03) | -869.0 (-1.03) |

NOTE.—Data are for 1950-83; r-statistics are in parentheses. Variable definitions (data sources in parentheses): RP, SP, and MP = U.S. refined production, smelter output, and mine output, respectively, all in metric tons of copper content (Bur. Mines); ME = U.S. mining employment, in number of workers (Dep't Labor); GNP = U.S. real GNP, in trillions of 1972 dollars (Commerce Dep't); WAGERAT = U.S. ratio of average hourly earnings of copper-mining employees to average hourly earnings of all manufacturing (Commerce Dep't); RIMP and RBIMP = U.S. imports for consumption of refined copper and of refined and blister copper, respectively, in metric tons (Bur. Mines); NRIMP and NRBIMP = U.S. imports for consumption of refined copper - U.S. exports of refined copper and of refined and blister copper, respectively, in metric tons (Bur. Mines); IMPI = RIMP + SEMIIMP + SCRAPIMP, where SEMIIMP = U.S. imports of refined copper and copper alloy semifabricated products, in metric tons of copper content (World Bur. Metal Statistics), and where SCRAPIMP = U.S. imports of copper and copper alloy scrap, in metric tons of copper content (World Bur. Metal Statistics); IMP2 = IMPI + U.S. imports for consumption of blister copper; and IMP3 = IMP2 + OREIMP, where OREIMP = U.S. imports of ores and concentrates, in metric tons of copper content (World Bur. Metal Statistics).

TABLE 3
RELATIVE EFFECT OF ALTERNATIVE SOURCES OF INJURY

| YEAR: INDEPENDENT VARIABLE | INDEX OF INJURY | | | | | | | | |
|----------------------------------|------------------------|-------|-----------------------|-------|--------------------|-------|----------------------|-------|--|
| | Refinery Production | | Smelter Production | | Mine Production | | Mining Employment | | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | |
| 1981: | | | | | | | | | |
| Real GNP | -.43 | -.92 | -.23 | -.39 | -.25 | -.39 | -.23 | -.31 | |
| Wage ratio | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | |
| Refined imports | -.27 | -.26 | -.06 | -.07 | -.06 | -.06 | -.04 | -.04 | |
| Blister imports | ... | ... | -.03 | -.04 | -.03 | -.03 | -.02 | -.02 | |
| Refined and blister imports | ... | ... | -.09 | -.11 | -.09 | -.09 | -.06 | -.06 | |
| 1982: | | | | | | | | | |
| Real GNP | -.95 | -2.00 | -.50 | -.85 | -.55 | -.85 | -.50 | -.67 | |
| Wage ratio | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | |
| Refined imports | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | |
| Blister imports | ... | ... | -.10 | -.12 | -.11 | -.11 | -.07 | -.07 | |
| Refined and blister imports | ... | ... | -.10 | -.12 | -.11 | -.11 | -.07 | -.07 | |
| 1983: | | | | | | | | | |
| Real GNP | -.98 | -2.08 | -.52 | -.88 | -.57 | -.88 | -.52 | -.70 | |
| Wage ratio | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | |
| Refined imports | -.87 | -.83 | -.20 | -.22 | -.20 | -.20 | -.14 | -.13 | |
| Blister imports | ... | ... | -.05 | -.05 | -.05 | -.05 | -.03 | -.03 | |
| Refined and blister imports | ... | ... | -.25 | -.27 | -.25 | -.25 | -.17 | -.16 | |

NOTE.—Column 1 based on parameter estimates for total imports and col. 2 for net imports.

argued that, to merit protection, injury caused by imports should not be large relative to other causes of injury but, rather, large in an absolute sense or large relative to the industry as a whole. These approaches have difficulties as well. Absolute standards are not invariant to industry agglomeration, while comparing injury to the size of the industry penalizes large domestic industries relative to industries in which most consumption is imported. In any event, it is worth pointing out that injury caused by imports in 1983 is not insignificant relative to the size of the industry. Suppose that imports of refined copper had been 272,160 metric tons instead of 460,000 tons while there had been no imports of blister. Then, in thousands of metric tons, refined production would have been 1,904, smelter production 1,171, and mine production 1,230, while mining employment would have been essentially identical to what it was with actual imports. In sum, the increased imports reduced the various measures of production by between 12 and 16 percent.

Conceivably, the effects of imports occur with lags not captured by the model of equation (6). We therefore examine the relation over time between imports and an additional index of industry welfare, namely, price. Using the notion of Granger causality, we test the null hypothesis that changes in imports have not caused changes in prices.²⁰

To perform this test, we use data for the U.S. producer price of refined copper (deflated by the producer price index for all commodities) and for U.S. imports for consumption of refined copper. Using annual data for 1950-83, we run the two regressions

$$P_t = a_0 + a_1P_{t-1} + a_2P_{t-2}$$

and

$$P_t = a_0 + a_1P_{t-1} + a_2P_{t-2} + b_0RIMP + b_1RIMP_{t-1} + b_2RIMP_{t-2}$$

and calculate the test statistic $F = N_1(SSR_1 - SSR_2)/N_2(SSR_2)$ (see note 12 above). We obtain $SSR_1 = .071433$ and $SSR_2 = .066791$, so, with $N_1 = 26$ and $N_2 = 3$, $F = 0.60$. At the 95 percent significance level the critical value of $F(3/26)$ is 2.95, so we can accept the hypothesis that imports have had no causative effect on U.S. producer prices.

This causality test complements the regression results shown in Tables 2 and 3. Together these results provide strong evidence that imports have not been a substantial cause of injury to the U.S. copper industry.

²⁰ In the regressions of the form of eq. (5), imports had no statistically significant negative effect on prices. On the other hand, the statistically significant coefficients reported in Table 2 imply that Granger tests of lack of causality from imports to the other indicia we have considered would have been rejected.

V. STATISTICAL IMPLICATIONS OF AN ALTERNATIVE
INTERPRETATION OF SECTION 201

As explained in Section I, an alternative interpretation of Section 201 is that changes in imports are considered to cause injury only when they are due to shifts in the import supply schedule (that is, changes in parameter c). We reject this interpretation because it requires that changes in the observed level of imports be divided into changes due to domestic developments and changes due to foreign developments (where only the latter are injurious). This is difficult to do in practice and seems in conflict with the wording of the Trade Act. Nonetheless, it is an interesting approach to the analysis of industry performance and is potentially valid as a means for assessing injury.²¹ Thus we discuss the statistical issues involved in its implementation.

The simplest approach is to estimate directly the effects of changes in a , b , and c on the indicia of injury. This can be done by estimating the reduced-form regression equation:

$$I_t = \phi' + \alpha'a_t + \beta'b_t + \delta'c_t + \gamma_t. \quad (7)$$

The coefficients in this regression directly measure the effects of a , b , and c on I . Note, however, that α' and β' differ from α and β , in that the former also account for the indirect injury caused by the endogenous response of imports to changes in a and b .

Even when data on c_t are available, the use of equation (7) has two related disadvantages. First, "imports," the key variable in Section 201, does not appear explicitly. Second, the equation does not make use of the fact that all the injury resulting from changes in c is mediated through changes in imports; that is, it does not make full use of all available information.²² Thus a better approach is to estimate (6) together with an equation explaining the level of imports:

$$M_t = m_0 + m_1a_t + m_2b_t + m_3c_t + \eta_{mt}, \quad (8)$$

where m_0 , m_1 , and so on are parameters and the η_m 's residuals. Then the effects of changes in a , b , and c are given by $(\alpha + \delta m_1)$, $(\beta + \delta m_2)$, and δm_3 , respectively.

²¹ This is the basis of Grossman's analysis of steel imports (see note 5 *supra*). Grossman, however, makes the extreme assumption that the import supply schedule is infinitely elastic.

²² This information is particularly useful when there is a large number of measurable variables affecting the supply of imports. Then the fact that their injurious effects are all mediated through imports imposes constraints on the coefficient δ' in eq. (7).

If c_t is uncorrelated with excluded domestic variables that affect I , there is an additional advantage to estimating (6) and (8) simultaneously. Suppose that M_t and ϵ_t in equation (8) are correlated so that an estimate of δ from that equation is biased. The bias can be reduced by treating M as an endogenous variable in the system of equations (6) and (8). This amounts to treating the variables represented by c as instruments for M .

There are two difficulties with this procedure. First, any changes in imports not explained by (8), that is, the η_m 's, are attributed to neither domestic nor foreign developments, and there are no a priori grounds for attributing them in toto to either. This of course brings us back to the fundamental problem with this interpretation of Section 201; that is, in practice it is impossible to make a complete division of changes in imports into those due to domestic and those due to foreign developments.

Perhaps the biggest practical difficulty with estimating (7) is that doing so requires data on c . As we mentioned when discussing instruments for imports, this data will likely be much more difficult to obtain than will data on a and b . An alternative procedure is to estimate only the effects of a and b on imports and attribute the remainder of the changes in imports to changes in c . This involves estimation of the parameters n_0 , n_1 , and n_2 :

$$M_t = n_0 + n_1 a_t + n_2 b_t + \eta_{mt}. \quad (9)$$

With this procedure, the effects of changes in a and b are given by $\alpha + \delta\eta_1$ and $\beta + \delta\eta_2$, respectively. Any change in M not explained by a and b in (9) can be attributed to c . It can then be multiplied by the estimate of δ obtained from equation (6) to yield an estimate of the extent of injury due to changes in "imports."

This procedure, however, aggravates the difficulties in dividing imports. If a and b are positively correlated with c , equation (9) will attribute too much of the variation in M to a and b . On the other hand, because the entire residual in (9) is attributed to changes in c , the procedure overstates the importance of c by attributing to it all the changes in M that are in fact due to excluded domestic variables.

This discussion should help to clarify why the implementation of this interpretation of Section 201 would be difficult in practice. Consider the case of copper imports discussed earlier. Since there are no meaningful data available for c , one cannot estimate (7) and must instead use the alternative procedure, that is, estimate (6) together with (9) as a simultaneous system. But, as we have seen, the result will be a highly imperfect division of import changes into domestic and foreign sources and thus a possibly biased estimate of injury.

VI. CONCLUSIONS

This paper has presented an economic and statistical framework for the attribution of injury under Section 201 of the 1974 Trade Act. Using this framework, one can evaluate the relative effects on an industry of imports versus shifts in domestic demand and supply and thereby determine whether imports are a "substantial cause" of injury as required by the act. We have also shown how one can test whether imports have had any deleterious effect at all.

As this paper has shown, the attribution of injury in Section 201 cases is in principle a straightforward task. In practice, however, problems arise. The main one is that statistical analyses that use different data and different specifications can lead to different results in borderline cases. But it is in just such cases that the methods presented here are particularly useful. The reason is that they focus attention on precisely those issues that ought to be resolved when deciding such cases.

For example, if the petitioner in a Section 201 case presents a dynamic version of equation (6) and the respondent does not, then the industry's dynamics may well be important in understanding the causation of injury. Although assessing the role of dynamics may be difficult to do, it is probably just the issue that the ITC should ponder in such a case. The economic and statistical framework presented here may help to focus such pondering and to make it more productive.