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

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ABSTRACT

Under Section 201 of the 1974 Trade Act, a domestic industry can obtain temporary protection against imports by demonstrating before the International Trade Commission that it has been injured, and that imports have been the "substantial cause" of injury -- i.e., "a cause which is important and not less than any other cause." To date, the ITC lacks a coherent framework for selecting a menu of other factors which might be considered as causes of injury, and for weighing the effects of these other factors against those of imports.

This paper sets forth a straightforward economic and statistical framework for use in Section 201 cases. 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, or increased imports. We show how these sources of injury can be distinguished in theory, and statistically evaluated in practice. As an illustrative example, we apply the framework to the case of the copper industry, which petitioned the ITC for relief in 1984. Although that industry has indeed suffered injury, we show that the "substantial cause" was not imports, but instead increasing costs and decreasing demand.

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1. 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, is the substantial cause of the injury, -- i.e., "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, the ITC lack a coherent framework for selecting a menu of other factors which might be considered as causes of injury, and for weighing the effects of these other factors against those of imports.

This paper sets forth a straightforward economic and statistical framework for use in Section 201 cases. 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, or 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 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 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 adopted by Grossman in a recent paper evaluating the injurious effects of steel imports.[3]

We reject 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, in order 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 -- those due to domestic and those due to foreign developments. This is likely to be difficult in practice, as will become clear later. (Grossman avoided this separation by assuming the supply of imports is infinitely price elastic, an assumption that is extreme and unrealistic.) As for the interpretation of the Trade Act, it only refers to damage from imports. It never distinguishes between 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. An advantage of this approach is that the injury from domestic developments is computed as if the industry were not subject to import competition. Moreover, this view is in keeping with the language of the Trade Act, and as we will see, it permits a straightforward measurement and comparison of the injuries caused by imports, and 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 since some base period, and determine their relative impacts on the industry. We assign injury to increased imports by comparing actual industry performance (as measured by such indicia as profits, employment, output, etc.) with performance under a hypothetical "constant import" scenario. Under this scenario, all domestic industry variables (e.g. wages, demand, etc.) have their actual values, but imports are held at their base level (e.g., 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 with the injury caused by domestic developments alone.

The next section 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 3. As an illustrative example, Section 4 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 instead increasing costs and decreasing demand.

As explained above, our framework treats any changes in imports as possible causes of injury. Section 5 shows how one can test for "substantial cause" under the alternative framework in which only changes in imports resulting from foreign shifts in tastes and technologies are included as possible causes of injury. Section 6 provides a summary, and some concluding remarks.

2. Theoretical Framework

Injury to a domestic industry might have the following causes, which could occur individually or in combination: a drop in domestic demand, an adverse shift in supply (corresponding, say, to increases in costs), or 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 is a shift parameter. Increases in a shift the supply schedule to the right. For example, technological progress in the U.S. would increase a, and increase supply, while rising labor costs in the U.S. 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 U.S. also faces an import supply schedule $M(P,c)$. This schedule is upward sloping; a higher price creates an incentive for foreign producers to increase production and an incentive for foreign consumers to reduce consumption, in both cases making more imports available to the U.S. 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, i.e., at a price P* such that:

$$D(P^*,b) = S(P^*,a) + M(P^*,c) \tag{1}$$

An equilibrium of this type is illustrated by Figures 1a and 1b. Observe from the figures that changes in a and b will affect the equilibrium price P*, and thus the <u>level</u> 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 (i.e., a drop in a) would shift S(P,a) to the left, increasing P* and increasing imports.

This raises the problem of interpretation of Section 201 discussed in the Introduction. The alternative view (which we reject) is that the only increases in imports that should be deemed to have caused injury are those resulting from increases in c -- i.e., from 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 compare their effects to those from shifts in the domestic demand or supply schedules.

Let us begin with the equilibrium given by eqn. (1), and consider the effect of a change in a -- i.e. a shift in the domestic supply schedule. From eqn. (1) we see that this will result in the following change in price:

$$dP/da = \frac{\partial S/\partial a}{\partial D/\partial P - \partial S/\partial P - \partial M/\partial P} \tag{2}$$

and the following <u>total</u> change in domestic supply:

$$(dS/da)_T = \partial S/\partial a + (\partial S/\partial P)(dP/da)$$

$$= \partial S/\partial a + \frac{(\partial S/\partial P)(\partial S/\partial a)}{(\partial D/\partial P - \partial S/\partial P - \partial M/\partial P)} \tag{3}$$

This is illustrated in Figures 2a and 2b, which show the effect of a decrease in a to a', corresponding to say 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_o, say through a quota. Then the change in price would be:

$$dP/da = \frac{\partial S/\partial a}{(\partial D/\partial P - \partial S/\partial P)} \tag{4}$$

Because of this larger change in price, there is a smaller change in supply. This "constant import" change in domestic supply is given by:

$$(dS/da)_m = \partial S/\partial a + \frac{(\partial S/\partial P)(\partial S/\partial a)}{(\partial D/\partial P - \partial S/\partial P)} \tag{5}$$

As shown in Figure 2a, with imports held at M_o, price rises to P_2 and domestic supply only falls to S_2.

Thus, the total change in domestic output (ΔS_T) resulting from changing domestic cost conditions can be decomposed into two components: a change for constant imports (ΔS_m), and a change due purely to the shift in imports (ΔS_n). This latter change is given by:

$$(dS/da)_n = (dS/da)_T - (dS/da)_m$$

$$= \frac{(\partial S/\partial P)(\partial S/\partial a)(\partial M/\partial P)}{(\partial D/\partial P - \partial S/\partial P - \partial M/\partial P)(\partial D/\partial P - \partial S/\partial P)} \tag{6}$$

In Figure 2a, ΔS_m is given by $S_o - S_2$, 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 relative elastic ($\partial M/\partial P$ is large), ΔS_n can exceed ΔS_m. (That is the case in Figure 2a.) 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 makes a fall in a 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 among the possibly injured, as opposed to consumers. A narrow economic view might therefore limit injury to the loss of producer surplus, i.e. 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 of these variables as measures of industry welfare.

Let us denote these indicia of injury by I, and consider what I might depend on. 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:

$$I = g(S(P^*,a),a) \tag{7}$$

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. Now imports benefit the domestic industry; the total injury from a drop in demand is less than it would be had imports been held fixed.

Finally, note that a change in c (a shift in the import supply schedule) only has effects on the domestic industry via its effects on the level of imports. As shown in Figures 3a and 3b, an increase in c causes injury by increasing M, and thereby reducing price and domestic output.

3. <u>Statistical</u> <u>Approach</u>.

In assessing injury the ITC reviews data pertaining to some recent time period, usually the past five years. During such a period there are likely to have been shifts in all three schedules, S(P,a), D(P,b), and M(P,c), and as a result changes 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 of data are available for the indicia of injury, which we denote at time t by I_t, the level of imports M_t, as well as any variables that shift the supply and demand schedules, a_t and b_t. For simplicity, we assume that the relationships embodied in eqns. (1) and (7) are linear; this is always valid at least as a local approximation.[8] Then we can write supply, demand, and the indicia of injury at time t as:

$$S_t = s_o + s_1 a_t + s_2 P_t + \varepsilon_{st} \qquad (8a)$$

$$D_t = d_o + d_1 b_t + d_2 P_t + \varepsilon_{dt} \qquad (8b)$$

$$I_t = i_o + i_1 a_t + i_1 S_t + \varepsilon_{it}$$

$$= (i_o + i_2 s_o) + (i_1 + i_2 s_1) a_t + i_2 s_2 P_t + \varepsilon_{it} + i_2 \varepsilon_{st} \qquad (8c)$$

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); they emerge because of the myriad influences on supply, demand, and injury which cannot be captured by the variables we can measure. Now, substituting (8a) and (8b) for supply and demand into eqn. (1), we obtain the following for the equilibrium price:

$$P_t = (d_o - s_o + s_1 a_t + \varepsilon_{dt} - \varepsilon_{st} - M_t)/s_2 - d_2) \qquad (9)$$

Eqn. (9) can be substituted for P_t in (8c) to yield the following equation for I_t, the index of injury:

$$I_t = \psi + \alpha a_t + \beta b_t + \delta M_t + \varepsilon_t \qquad (10)$$

where:

$$\psi = i_o + i_2 s_1 - i_2 s_2 (d_o - s_o)/(s_2 - d_2)$$

$$\alpha = i_o + i_2 s_1 + i_2 s_1 s_2/(s_2 - d_2)$$

$$\beta = i_2 s_2 d_1/(s_2 - d_2)$$

$$\delta = -i_2 s_2/(s_2 - d_2)$$

and

$$\varepsilon_t = \varepsilon_{it} - i_2 d_2 \varepsilon_{st}/(s_2 - d_2) + i_2 s_2 \varepsilon_{dt}/(s_2 - d_2)$$

Eqn. (10) is a reduced form regression equation which 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 which shift supply and demand (a_t and b_t) not be correlated with the excluded variables embodied in the residual ε_t. Variables typically part of a_t are wage levels and other input prices, and these 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_d, eqn. (10) 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, etc., 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 eqn. (9) shows, an increase in ε_{dt} or 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.

Once α, β, ψ, and δ have been estimated, eqn. (10) can be used to compute the effects on the indicia of injury of the measured changes in a, b, and M from their base levels. That provides a direct comparision 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 eqn. (10). 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 also suggest an alternative procedure that allows for the possibility of dynamic adjustment. Unfortunately this procedure can only be used to determine whether imports and other variables have had any injurious effects at all, but cannot be used to measure the sizes of those effects. Thus, this procedure would be used to complement the one described earlier.

This alternative uses the test of causality introduced by Granger.[9] It is a test of the null hypothesis that a particular variable does not help predict some other variable. In particular, the variable x does not help 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 case, the data are not inconsistent with a relatively small role for x in the prediction or explanation of y.[10]

The application of this notion to the problem at hand involves running a regression explaining the value of an index of injury at t by past values of the index as well as 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 stronger test for lack of injury than discovering from the estimation of eqn. (10) that δ is insignificantly different from zero, because it allows the effects of imports to occur with a lag.

4. The United States Copper Industry.

The early 1980's 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 of refined and blister copper, and petitioned the ITC for relief.[12] Although there is little doubt that injury indeed occurred, our analysis using the framework described above shows that imports are not a "substantial cause." Instead, we find that most of the injury can be attributed to two much more important factors: high and rising domestic costs, and a decline in demand.

Our analysis has two parts. First, we estimate eqn. (10) for several indicia of injury, and 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 eqn. (10) 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 (i) the level or real GNP in the U.S. (a variable that shifts the demand for copper), (ii) the ratio of average hourly earnings for U.S. copper mining employees[14] to average hourly earnings for all U.S. manufacturing employees (a variable that shifts supply), (iii) 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 (iv) the level of imports.[15]

These regressions are estimated by ordinary least squares using annual data for 1950-83, and the results are shown in Table 1. Observe that all of the parameter estimates have the expected signs, and except in the equation for mining employment, all but the time trend are significant at the 95% level or above. Reestimation of these regressions by two-stage least squares has no material effect on the relative magnitudes of the parameter estimates.

One might argue that net imports, i.e. 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 1, 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 semi-fabricated 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 1, and again are substantially the same.

The parameter estimates in Table 1 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. We use the following reference values.

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. Our proxy measure for the shift in demand then is the difference between projected and actual GNP in each year. For the wage ratio, we take 1969 as a reference -- the last year of a period of relatively uninterrupted prosperity, and the year that preceeds a decade of wage-price controls, recessions, and energy shocks that should have produced a relative decline in the real wages of copper mining employees. 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, zero, so that any blister imports are treated as "increased imports" in our calculations. Actual and reference values are presented in Table 2 for the years 1981-1983.

To calculate the relative impacts 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 1. The results are shown in Table 3 where the relative impact of each variable in each year is measured relative to the impact 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 impact than increases in imports, and in most instances a much greater impact. In 1981, for example, real wage increases had by far the greatest impact on the industry. In fact, the parameter estimates in Table 1 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 to 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 1 imply that the combined effects of the recession and increased real wage caused production to decline by 650,000 to 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. Based on these results, imports hardly seem a "substantial cause" of injury to the domestic copper industry.

Conceivably the effects of imports occur with lags not captured by the model of eqn. (10). We therefore examine the relationship over time between imports and an additional index of industry welfare, price. Using the notion of Granger causality, we test the null hypothesis that changes in imports have not caused changes in prices.[16]

To perform this test, we use data for the U.S. producer price of refined copper, deflated by the PPI for all commodities, and U.S. imports for consumption of refined copper. Using annual data for 1950-1983, we run the two regressions

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

and $$P_t = a_o + a_1P_{t-1} + a_2P_{t-2} + b_oRIMP + b_1RIMP_{t-1} + b_2RIMP_{t-2},$$

and calculate the test statistic $F = N_1(SSR_1 - SSR_2)/N_2(SSR_2)$. (See note 12.) We obtain $SSR_1 = .071433$ and $SSR_2 = .066791$, so with $N_1 = 26$ and $N_2 = 3$, $F = 0.60$. At the 95% significance level the critical value of F(3/26) is 2.95, so that 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 1 to 3. Together, these results provide strong evidence that imports have not been a substantial cause of injury to the U.S. copper industry.

5. Statistical Implications of Alternative Interpretation of Section 201.

As explained in the Introduction, 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 (i.e., changes in the parameter c). We rejected 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, since others may use this interpretation when assessing injury,[17] we discuss the statistical issues involved in its implementation.

The simplest approach is to directly estimate 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:

$$I_t = \phi' + \alpha' a_t + \beta' b_t + \delta' c_t + \gamma_t \quad (11)$$

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.

Unfortunately, the use of eqn. (11) 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 of the injury resulting from changes in c is mediated through changes in imports, i.e., it does not make full use of all available information.[18] Thus a better approach is to estimate eqn. (10) together with an equation explaining the level of imports:

$$M_t = m_o + m_1 a_t + m_2 b_t + m_3 c_t + \eta_{mt} \quad (12)$$

where m_o, m_1, etc., are parameters and the η_m's are 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.

If c_t is uncorrelated with excluded domestic variables which affect I, there is an additional advantage to estimating (10) and (12) simultaneously. Suppose that M_t and ε_t in eqn. (10) are correlated, so that an estimate of δ from that equation is biased. This bias can be reduced by treating M as an endogenous variable in the system of equations (10) and (12). 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 eqn. (12), i.e., the η_m's, are neither attributed to domestic nor to foreign developments, and there is no a priori grounds for attributing them in total to either. This, of course, brings us back to the fundamental problem with this interpretation of Section 201; 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. A second difficulty is that this procedure requires data on c, which is likely to be much more difficult to obtain than 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_o, n_1, and n_2 in:

$$M_t = n_o + n_1 a_t + n_2 b_t + \eta_{nt} \tag{13}$$

Now 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 (13) can be attributed to c, and then multiplied by δ to yield an estimate of the extent of injury due to changes in "imports."

This procedure is also somewhat flawed, however. If a and b are positively correlated with c, eqn. (13) will attribute too much of the variation in M to a and b. On the other hand, because the entire residual in (13) is attributed to changes in c, the procedure overstates the importance of c by attributing to it all of the changes in M that are in fact due to excluded domestic variables. As a result, the use of (13) can make the division of import changes into those due to domestic and those due to foreign developments even more problematic.

This discussion should help to clarify why the implementation of this interpretation of Section 201 would be difficult, if not impossible, in practice. Consider the case of copper imports discussed earlier. Since there is no meaningful data available for c, one cannot estimate eqn. (11), and must instead use the alternative procedure, i.e., estimate (10) together with (13) as a simultaneous system. But as we have seen, the result will be a highly imperfect division of import changes into domestic versus foreign sources, and thus a possibly biased estimate of injury.

6. 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 impacts 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 there are naturally problems which arise. The main one is that statistical analyses using 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 which ought to be resolved when deciding such cases.

For example, if the petitioner in a Section 201 case presents a dynamic version of eqn. (10) 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 make it more productive.

FOOTNOTES

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**, §201, ¶(b)(1), p. 2330.

2. **Trade Act of 1974**, §201, ¶(b)(4), p. 2331.

3. Gene M. Grossman, "Imports as a Cause of Injury: The Case of the U.S. Steel Industry," National Bureau of Economic Research, Working Paper No. 1494, November 1984.

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

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.

6. This was the point of view of the Federal Trade Commission in their 1984 report on copper to the ITC. (**Unwrought Copper, supra**)

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 impact on profits.

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, eqn. (7) is not valid in logarithms, so that in equilibrium the log of output is generally not a function of the log of imports.

9. Clive W.J. Granger, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," **Econometrica**, 1969, 37:424-38. Also, see Christopher Sims, "Money, Income, and Causality," **American Economic Review**, 1972, 62:540-52, and Thomas Sargent, "Estimation of Dynamic Labor Demand Schedules Under Rational Expectations," **Journal of Political Economy**, 1978, 86:1009-44.

10. Note that failure to reject the hypothesis that imports did not cause injury is <u>not</u> 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 disentagle 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, and the second including them. Then one can utilize the following statistic:

$$F = N_1(SSR_1 - SSR_2)/N_2(SSR_2)$$

where SSR_1 and SSR_2 are the sums of squared residuals from the first and second regressions respectively, N_1 is the number observations less the number of estimated parameters in the second rgression, 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, and Sargent, supra, note 24.

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 5 cent/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 avalable 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 onwards indicate that the earnings of smelting and refining employees have increased faster than the earnings for mining.

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.

16. In the regressions of the form of (10), imports had no statistically significant negative effect on prices. On the other hand, the statistically significant coefficients reported in Table 1 imply that Granger tests of lack of causality from imports to the other indicia we have considered would have been rejected.

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

18. 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 (11).

TABLE 1 :

ESTIMATION OF EQUATION (10)

(1950-1983, t-statistics in parentheses)

Dep. Var. | Independent Variables | RSQ | D.W.

A. Imports

Dep. Var.	CONST	GNP	WAGERAT	RIMP	RBIMP	TREND	RSQ	D.W.
RP	1817316	1983483	-1046669	-1.6497	--	-27088	.76	2.41
	(3.39)	(2.63)	(2.27)	(-4.64)		(-1.14)		
SP	2400498	2019087	-2013854	--	-0.7141	-30299	.62	2.04
	(4.89)	(2.58)	(4.26)		(2.99)	(-1.25)		
MP	2022446	1956602	-1780360	--	-0.6404	-24547	.76	1.93
	(4.69)	(2.85)	(-4.29)		(-3.05)	(1.15)		
ME	55967	41741	-41583	--	-0.0104	-715.0	.35	0.95
	(3.85)	(1.80)	(-2.97)		(-1.47)	(-1.00)		

B. Net Imports

Dep. Var.	CONST	GNP	WAGERAT	NRIMP	RBIMP	TREND	RSQ	D.W.
RP	547141	3642210	-910578	-1.3555	--	-76480	.83	2.31
	(0.99)	(4.72)	(-2.34)	(-6.50)		(-3.19)		
SP	1555741	3146011	-1857710	--	-0.7326	-64771	.69	1.84
	(3.05)	(3.72)	(-4.34)		(4.06)	(-2.48)		
MP	1345475	2767790	-1637460	--	-0.5986	-49381	.78	1.77
	(2.87)	(3.57)	(-4.17)		(-3.62)	(-2.06)		
ME	45867	52673	-39225	--	(0.00908)	-1050	.36	0.88
	(2.79)	(1.93)	(-2.84)	--	(-1.56)	(-1.25)		

C. Downstream Imports

Dep. Var.	CONST	GNP	WAGERAT	IMP1	IMP2	IMP3	TREND	RSQ	D.W.
RP	1845535	2148157	-1189418	-1.3515	--	--	-27121	.69	2.21
	(2.90)	(2.18)	(-2.29)	(-3.39)			(-0.90)		
SP	2089519	2646124	-2013806	--	-0.7299	--	-48879	.61	2.22
	(3.82)	(2.65)	(-3.91)		(-2.56)		(-1.58)		
MP	1627442	2123178	-1489734	--	--	-0.5432	-31693	.76	2.11
	(3.39)	(2.50)	(-3.45)			(-2.56)	(-1.18)		
ME	42854	44009	-31563	--	--	-0.00690	-869.0	.37	1.08
	(2.84)	(1.65)	(-2.33)			(-1.03)	(-1.03)		

TABLE 1 (cont'd):

Variable Definitions and Data Sources:

RP, SP, MP = U.S. Refined Production, Smelter Output, and Mine Output, all in metric tons of copper content (Source: Bureau of Mines).

ME = U.S. Mining Employment, in number of workers (Source: Department of Labor).

GNP = U.S. Real GNP, in trillions of 1972 dollars (Source: Commerce Department).

WAGERAT = U.S. Ratio of Average Hourly Earnings of Copper Mining Employees to Average Hourly Earnings of All Manufacturing (Source: Commerce Department).

RIMP, RBIMP = U.S. Imports for Consumption of Refined Copper, and of Refined and Blister Copper, in metric tons (Source: Bureau of Mines).

NRIMP, NRBIMP = U.S. Imports for Consumption of Refined Copper, less U.S. Exports of Refined Copper, and of Refined and Blister Copper, in metric tons (Source: Bureau of Mines).

IMP1 = RIMP plus SEMIIMP plus SCRAPIMP, where:

SEMIIMP = U.S. Imports of Copper and Copper Alloy Semi-Fabricated Products, in metric tons of copper content (Source: World Bureau of Metal Statistics).

SCRAPIMP = U.S. Imports of Copper and Copper Alloy Scrap, in metric tons of copper content (Source: World Bureau of Metal Statistics).

IMP2 = IMP1 plus U.S. Imports for Consumption of Blister Copper.

IMP3 = IMP2 plus OREIMP, where:

OREIMP = U.S. Imports of Ores and Concentrates, in metric tons of copper content (Source: World Bureau of Metal Statistics).

TABLE 2:
ACTUAL AND REFERENCE VALUES FOR GNP, THE WAGE RATIO, AND IMPORTS

Actual Values

	GNP*	Wage Ratio	Total Imports+	Refined Imports+
1981	1.51384	1.48060	360,703	330,584
1982	1.48540	1.47412	355,804	258,461
1983	1.53555	1.48190	505,945	459,587

Reference Values

	GNP*	Wage Ratio	Total Imports+	Refined Imports+
1981	1.59098	1.44420	272,160	272,160
1982	1.64983	1,14420	272,160	272,160
1983	1.71085	1.14420	272,160	272,160

*In trillions of 1972 dollars

+In metric tons

TABLE 3:
RELATIVE IMPACT OF ALTERNATIVE SOURCES OF INJURY
(Column A Based on Parameter Estimates for Total Imports, Column B for Net Imports.)

Year, and Independent Variable	Index of Injury							
	Refinery Production		Smelter Production		Mine Production		Mining Employment	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
1981								
Real GNP	-0.43	-0.92	-0.23	-0.39	-0.25	-0.39	-0.23	-0.31
Wage Ratio	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Refined Imports	-0.27	-0.26	-0.06	-0.07	-0.06	-0.06	-0.04	-0.04
Blister Imports	--	--	-0.03	-0.04	-0.03	-0.03	-0.02	-0.02
Refined & Blister Imports	--	--	-0.09	-0.11	-0.09	-0.09	-0.06	-0.06
1982								
Real GNP	-0.95	-2.00	-0.50	-0.85	-0.55	-0.85	-0.50	-0.67
Wage Ratio	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Refined Imports	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blister Imports	--	--	-0.10	-0.12	-0.11	-0.11	-0.07	-0.07
Refined & Blister Imports	--	--	-0.10	-0.12	-0.11	-0.11	-0.07	-0.07
1983								
Real GNP	-0.98	-2.08	-0.52	-0.88	-0.57	-0.88	-0.52	-0.70
Wage Ratio	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Refined Imports	-0.87	-0.83	-0.20	-0.22	-0.20	0.20	0.14	-0.13
Blister Imports	--	--	-0.05	-0.05	-0.05	-0.05	-0.03	-0.03
Refined & Blister Imports	--	--	-0.25	-0.27	-0.25	-0.25	-0.17	-0.16

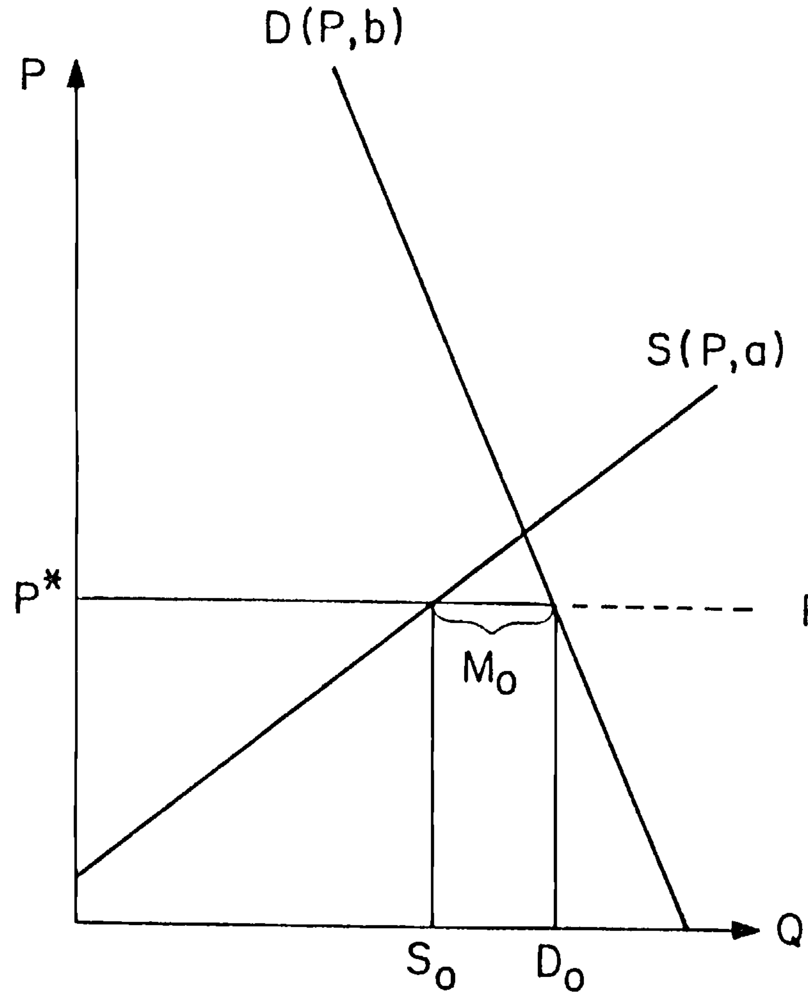

Fig. 1a

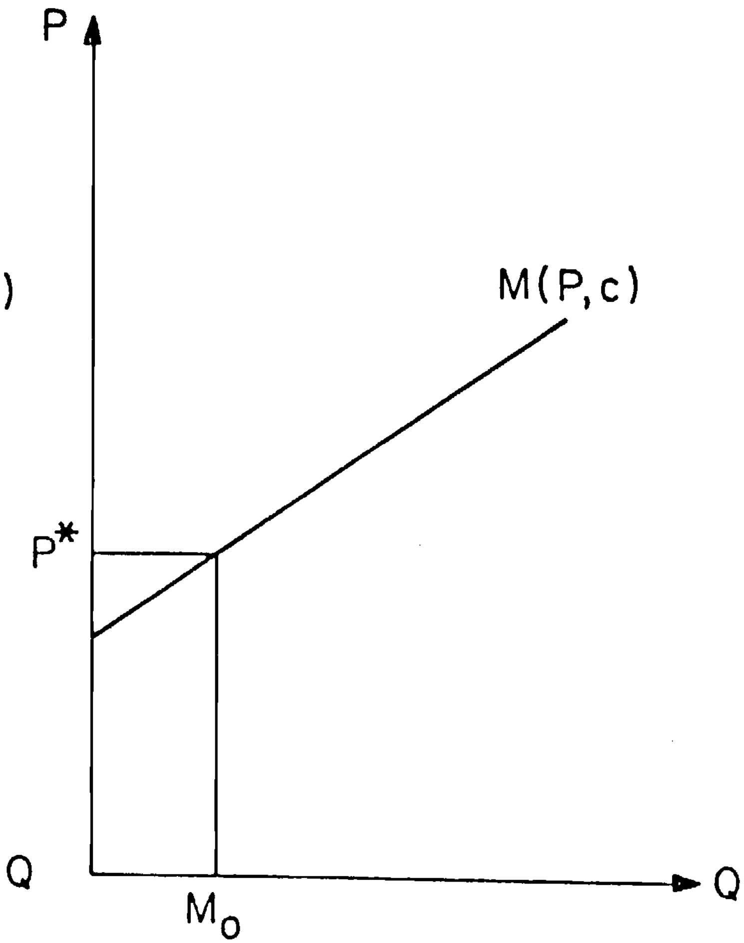

Fig. 1b

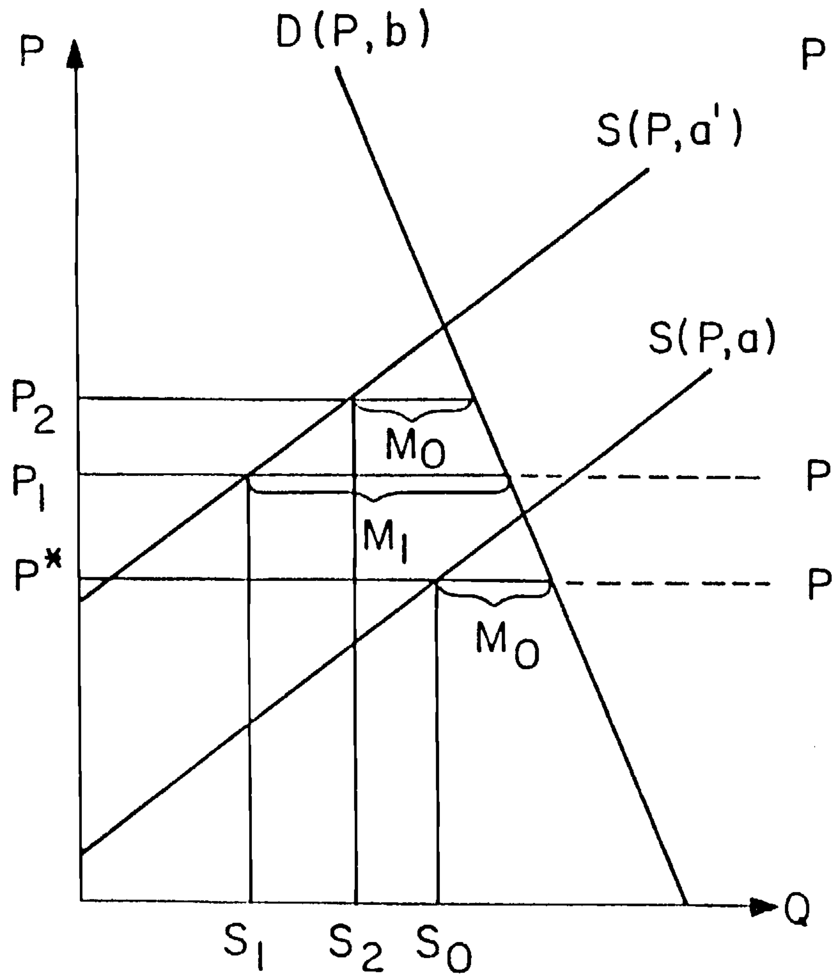

Fig. 2a

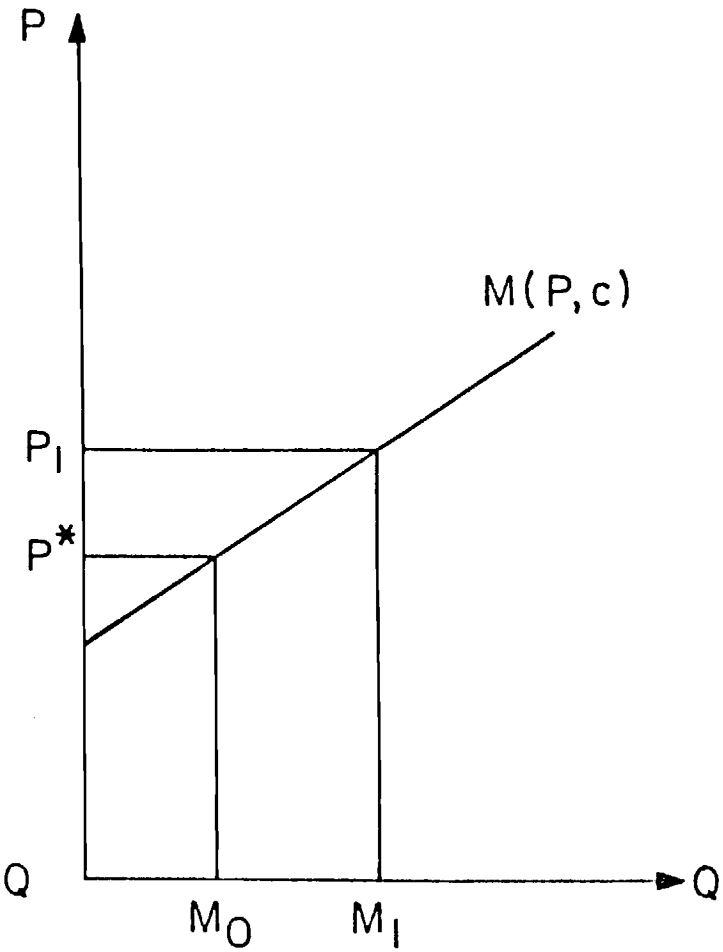

Fig. 2b

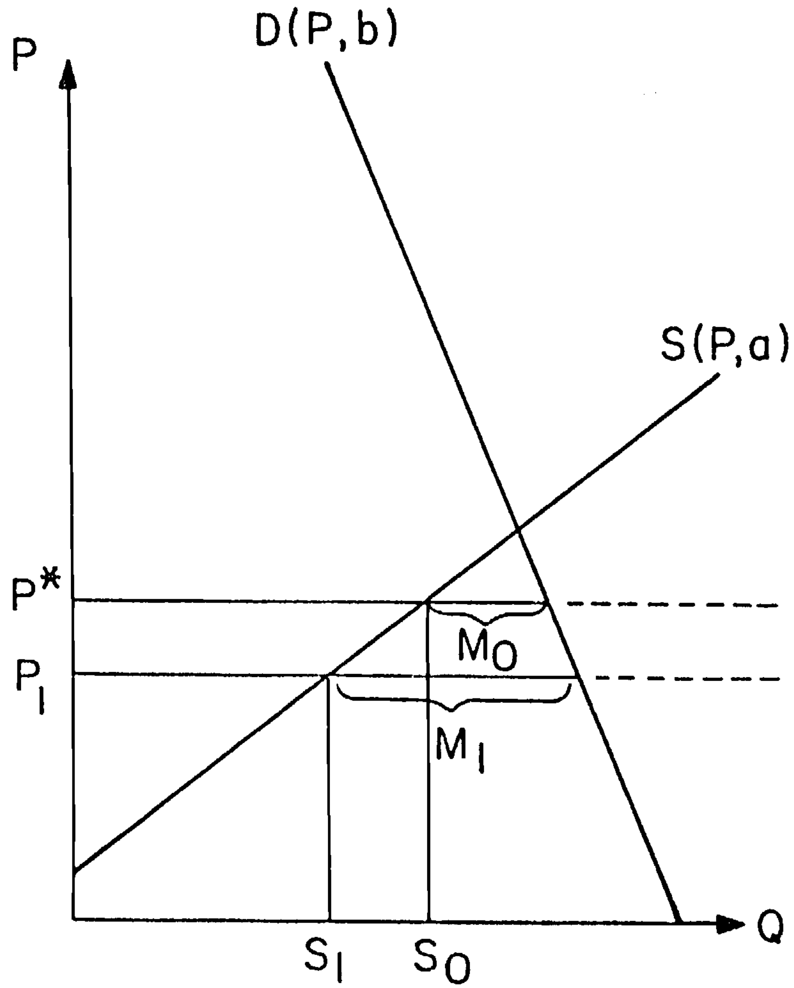

Fig. 3a

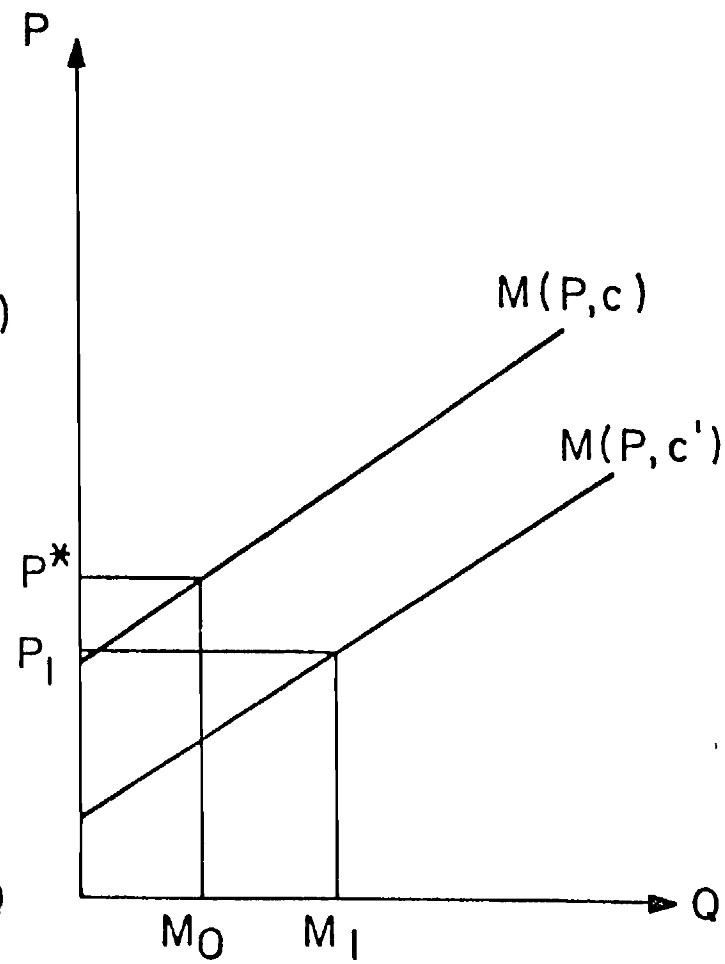

Fig. 3b