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TARIFFS AND THE MACROECONOMY: EVIDENCE FROM THE USA

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## Abstract

This paper examines the macroeconomic impact of tariffs. The effects of unilateral tariff changes are reviewed in a variety of theoretical models. Three different sets of data are consistent with the hypothesis that tariff rates have no significant effect on a system consisting of the real exchange rate, the real trade balance, and real output (both foreign and domestic).

# Tariffs and the Macroeconomy: Evidence from the USA

Andrew K. Rose and Jonathan D. Ostry<sup>1</sup>

## I: Introduction

This paper is concerned with the macroeconomic impact of tariffs. We emphasize two points. First, a review of the theoretical literature indicates that the macroeconomic effects of tariffs are ambiguous; there is no presumption that an increase in the tariff rate is likely e.g., to raise output or to improve the trade balance. Second, there is little evidence that fluctuations in tariff rates have actually had significant effects on such important macroeconomic variables as the trade balance, the exchange rate and the level of economic activity.

Our analysis is motivated in part by the lack of empirical research on the macroeconomic impact of tariffs; we are aware of almost no econometric analysis which addresses the matter.<sup>2</sup> However, the subject is also of current policy concern. For instance, Branson (1987) suggests an across-the-board tariff increase to reduce the size of current American trade deficits<sup>3</sup>; proposals of trade restrictions against countries whose bilateral trade deficits with the U.S. exceed some critical value have also been widely discussed (e.g., the 1988 Gephardt Amendment). The infamous Smoot-Hawley Tariff Act was passed in part because of congressional beliefs that tariffs would be expansionary.<sup>4</sup>

In the next section, we review some popular theoretical models which have been used to analyze the macroeconomic effects of tariffs. Section III describes the data and the methodology

used in the empirical analysis, while the main empirical results are presented in Section IV. The final section concludes.

## II: Theoretical Overview

### A Keynesian Model

The usual textbook analysis of the macroeconomic effects of a tariff considers a small country, with fixed prices, flexible output and a fixed exchange rate.<sup>5</sup> Output is demand determined and world prices are given; the model is completely static. The domestic country produces good Y at price P (supply is perfectly elastic), but consumes both the domestic good and a foreign good. The price of the foreign good in domestic currency is  $eP^*$ , where  $e$  is the exchange rate (defined as units of domestic currency per unit of foreign currency) and  $P^*$  is the price in foreign currency of a unit of the foreign good. Imports are a function of relative prices,  $q = eP^*/P$ , and real income in terms of domestic goods,  $Y$ , while foreign imports (our exports) are a function of relative prices only, foreign output being assumed constant (or rather unaffected by shocks emanating from the domestic country). The trade balance equals the excess of the value of exports over the value of imports. Measured in terms of the domestic good, the balance of trade,  $BT$ , may therefore be written as:

$$BT = M^*(q) - qM(q, Y) \quad (1)$$

where  $M^*$  denotes foreign imports and  $M$  denotes domestic imports from the rest of the world. Output equals the sum of domestic

expenditure  $E(Y)$ , and net exports:

$$Y = E(Y) + BT(q, Y) \quad (2)$$

Consider the imposition of an ad valorem tariff on imports at rate  $\tau$ . The domestic relative price of imports rises to  $q(1+\tau)$  while the world relative price is unchanged. If the tariff revenues are not redistributed (so that the government runs a budget surplus), then (2) becomes:

$$Y = E(Y) + BT(q, \tau, Y) - \tau qM(q(1+\tau), Y) \quad (2')$$

Net exports depend on the tariff rate because imports are a function of the internal relative price,  $q(1+\tau)$ , while exports are a function of the world relative price,  $q$ . The last term in (2') reflects the negative demand for domestic goods by the government (i.e., the budget surplus).

Differentiating equation (2') around an initial equilibrium of free and balanced trade yields:

$$dY/d\tau = M^*(\alpha-1)/(1-E_Y+m) \quad (3)$$

where:  $\alpha$  is the absolute value of the price elasticity of import demand;  $m$  is the marginal propensity to import; and  $0 < 1-E_Y < 1$  is the marginal propensity to save.

Output rises if import demand is sufficiently price elastic (i.e.,  $\alpha$  exceeds unity) but falls otherwise. The intuition is straightforward. Because the tariff revenue is not

redistributed, the tariff is a combination of an expenditure switching policy and an expenditure reducing policy. The expenditure switching part serves to raise demand, and hence supply, of the domestic good. However, because the government does not redistribute the tariff revenue, there is in addition an income effect which tends to reduce demand for domestic goods. Only if import demand is sufficiently price elastic will the substitution effect dominate and the overall effect of the tariff be expansionary.

Differentiating the expression for the trade balance and using (3) yields:

$$dBT/dr = \{[\alpha(1-E_Y)+m]/(1-E_Y+m)\}M^* > 0 \quad (4)$$

A tariff switches domestic expenditure from foreign to domestic goods; the trade balance necessarily improves as a result. The improvement in the trade balance exceeds, falls short of, or is equal to the budget surplus, according to whether the tariff induces a rise, fall or no change in output.

Several aspects of the analysis are noteworthy. First, the revenue redistribution scheme adopted by the government will affect the magnitude, and possibly even the sign of the comparative static results. If the tariff proceeds are redistributed to consumers, then the only effect of the tariff is a pure substitution effect in favor of the domestic good, so that the output effect of a tariff is necessarily expansionary. At

the same time, the trade balance effect will be lower (but still positive).

Second, the assumption that the exchange rate is fixed is crucial for the comparative static results. Suppose that the exchange rate adjusts to maintain external balance, so that  $BT(.) = 0$ . Then it can be shown<sup>6</sup> that a tariff which would improve the trade balance, were the terms of trade to stay constant, instead leads to a real appreciation (improvement in the terms of trade) to maintain external balance. In this case, (2) reveals that the tariff has no effect on the level of output.

Third, the analysis above assumed that the level of expenditure,  $E(.)$ , is independent of relative prices. In general, however, there is no particular reason for this to be the case. There are two conflicting forces at work. A deterioration in the terms of trade serves to reduce expenditure on relatively more expensive foreign goods and hence raise spending on domestic goods via a substitution effect. In addition, however, the deterioration in the terms of trade lowers real income and this tends to reduce spending on domestic goods. The net effect is therefore ambiguous but is thought by some (e.g. Laursen and Metzler (1950) and Mundell (1961)) to be dominated by the substitution effect.

Suppose that the expenditure function in (2) is replaced by the more general function  $E(q, Y)$ , in which expenditure (in terms of domestic goods) depends on both relative prices and income, with  $E_q > 0$  (the Laursen-Metzler assumption). If the exchange

rate adjusts to maintain external balance, a tariff leads to an improvement in the terms of trade, i.e., to a fall in  $q$ , the effect of which is to raise real income and hence saving out of any given level of nominal income. The lower demand for domestic goods causes a fall in domestic production.<sup>7</sup> This result (originally proved by Mundell (1961)) stands in sharp contrast to the case in which relative prices are fixed so that higher tariffs have an expansionary effect on output.

Further, a tariff may have contractionary effects even in the absence of a Laursen-Metzler effect on saving. In the Mundell-Flemming model of flexible exchange rates and perfect capital mobility, the interest rate is exogenous; therefore the imposition of a tariff cannot have any lasting effect on the value of nominal income. Redistributed tariff revenues raise disposable income; therefore output from production must fall when tariffs rise. Moreover, since the marginal propensity to spend are less than unity by assumption, the tariff engenders a trade deficit and corresponding capital account surplus. The intuition is simply that the tariff leads to an incipient interest rate differential which causes a real appreciation; the latter crowds out net exports. Eichengreen (1981) and Krugman (1982) have shown that while these results are suggestive of the long run effects of permanent tariffs, temporary tariffs in general have ambiguous effects on macroeconomic variables of interest, at least in the short run.



Fifth, the model of equations (1) and (2) can be expanded to include repercussion effects due to changes in foreign output. Suppose that domestic exports,  $M^*(.)$ , depend on the level of foreign output,  $Y^*$ , and relative prices,  $q$ , and that the domestic country is no longer "small" in the world economy so that changes in the tariff have effects on the level of foreign output. It is easily shown that the (domestic) output effect of a tariff is smaller in this case than in the original case in which  $Y^*$  is exogenous. The intuition is simply that a tariff that increases domestic net exports has a negative effect on foreign output. The fall in  $Y^*$  reduces demand for domestic exports so that the repercussion effect on  $Y$  is negative.

Finally, the analysis thus far has assumed that foreigners do not respond to the tariff. If the foreign country retaliates by raising its own tariff, the effects on output (both foreign and domestic), the trade balance and the real exchange rate are in general ambiguous.<sup>8</sup>

To sum up, tariffs do not have clear cut effects on the macroeconomy in Keynesian models. Comparative static results depend critically on assumptions concerning inter alia: fiscal policies (especially whether tariff revenue is redistributed); the exchange rate regime; the Laursen-Metzler effect; the degree of capital mobility; and repercussion and retaliation effects.

### **A Monetary Model**

An alternative approach to the analysis of the macroeconomic effects of tariffs is provided by the monetary approach to the balance of payments; see Mussa (1974).

The monetary approach assumes that the economy's long run real equilibrium is given by the standard two sector (Heckscher-Ohlin) model of international trade. In such a model, a tariff raises the internal relative price of import competing goods and therefore leads to an increase in production and a fall in consumption of importables. Thus a tariff reduces the volume of imports. The tariff also increases consumption and reduces production of exportables, so that the volume of exports also declines. In fact, the main effect of a tariff in such a model is to reduce the volume of trade, leaving the trade balance unchanged. The interesting issue is therefore distributional; i.e., how does the tariff affect income distribution between the factors of production?<sup>9</sup>

Although the long run equilibrium is characterized by the condition of balanced trade, the adjustment path toward this long run equilibrium is characterized by changes in the economy's net borrowing position. Mussa (1974) shows that the dynamic trade balance effects of the tariff are ambiguous. Consider the case in which the economy is completely specialized in the production of the export good. Suppose further that the government raises a (pre-existing) tariff on imports and redistributes the proceeds to consumers in a non-distortionary fashion. Finally, suppose

that the demand for nominal money balances is proportional to the value of income in terms of the domestic good and that the monetary authorities hold the domestic component of the money supply fixed.

As long as the domestic economy is a price taker in world markets, the income of consumers (measured in terms of the domestic good) varies only according to the redistribution of the tariff proceeds. Income will rise, fall, or remain constant depending on whether the original tariff rate falls short of, exceeds, or is equal, to that tariff rate which maximizes revenue (i.e., the product of the tariff rate and the initial value of imports). Consequently, the excess flow demand of money (i.e., the trade surplus) will increase if the initial tariff rate is initially below the revenue-maximizing rate. Succinctly, both (disposable) income and the trade balance may either rise or fall when the tariff is raised.

### **An Optimizing Model**

A third approach to the analysis of the open economy has recently been developed. In this work, agents' spending and saving decisions are viewed as solutions to the problem of maximizing an intertemporal utility function subject to lifetime solvency constraints. Razin and Svensson (1983) consider a model of a small open economy which produces and consumes two goods in each period, and faces fixed world prices and interest rates. Firms maximize profits subject to the economy's endowment of

productive factors and given technology. Consumers maximize lifetime utility subject to the constraint that the present value of their spending not exceed the present value of their income. From the point of view of the economy, this constraint is equivalent to the condition that the present value of the sum of the economy's current and future trade surpluses equal the economy's historically given external debt commitment.

Razin and Svensson emphasize that the effects of tariffs on saving and therefore (*ceteris paribus*) the trade balance, depend crucially on the timing and expected duration of changes in the tariff rate. A temporary tariff will have very different effects on the trade balance from those of a tariff which is expected to be permanent. A temporary tariff raises the price of current consumption relative to future consumption. Agents will substitute consumption intertemporally (consuming less today and more in the future) by lending in the international capital market, *i.e.*, by running a trade balance surplus. Thus, tariffs which are viewed as temporary lead to a trade surplus.

In contrast, a tariff which is expected to be in place permanently will not induce such an intertemporal substitution effect. In fact, if the initial equilibrium is stationary (in the sense that expenditure shares are constant through time), a permanent tariff will leave intertemporal consumption decisions, and hence the trade balance, completely unaffected.

The Razin-Svensson model has since been extended in a number of directions. Edwards (1989) and Ostry (1988) consider the

issue of how tariffs affect the real exchange rate, and, in turn, the trade balance. The dynamic behavior of the real exchange rate after a change in the tariff depends upon the ease with which agents substitute consumption within a period (i.e., the elasticity of substitution between tradables and nontradables in a given period) versus the degree of substitution in aggregate consumption across time periods (the intertemporal elasticity of substitution in consumption or the reciprocal of the coefficient of relative risk aversion). Depending on the parameter values, a temporary tariff may improve, worsen, or leave the trade balance unchanged.

Van Wijnbergen (1987) has extended the Razin-Svensson framework to include contract-based real wage rigidities. If nominal wages are indexed to consumer prices (which depend on the prices of both domestic and foreign goods), then a small country which raises a tariff temporarily will experience an increase in the internal price of the foreign good, although the domestic price of the domestic good will not be changed. The tariff therefore leads to a higher real product wage; if employment is demand determined, unemployment will consequently rise. This (transient) unemployment reduces real income temporarily; agents smooth their consumption by borrowing in the international capital market i.e., by running a trade deficit. Thus, with real wage rigidities, a temporary tariff may worsen the trade balance, in contrast to the Razin-Svensson result. A similar finding is obtained by Ostry (1988) without the assumption of real wage

rigidities by considering the case in which the government raises an initially positive tariff.

To summarize, a careful reading of the theoretical literature does not lead to a clear conclusion about the effect of a tariff on e.g., the trade balance or the level of output. The effect depends on the timing and expected duration of the tariff shock, on the behavior of real wages and exchange rates, on the values of a variety of elasticities, as well as on institutional factors such as the degree of capital mobility and the exchange rate regime. Any presumption that tariffs tend e.g., to improve the trade balance and raise output, must therefore be based on empirical rather than theoretical knowledge. With this in mind, we turn to the data.

### **III: Empirical Framework**

#### **Data**

The tariff data which we use are available through the Census Bureau, and are seasonally adjusted. Data are available on the values of: duty-free imports; dutiable imports; and calculated duties. These variables are available on a monthly basis from 1967 through 1988 (when the data was discontinued). The data exist on a bilateral basis, so that the value of, e.g., dutiable American imports from Japan is known, as are the relevant duties. We have collected data for bilateral trade between the US and the six other countries in the "Group of Seven" (G7): UK; Canada; France; Germany; Italy and Japan.<sup>10</sup>

Two measures of the tariff rate are immediately available from our data: tariff revenues divided by the value of dutiable imports (denoted  $\tau_1$  below); and tariff revenues divided by the sum of both dutiable and non-dutiable imports (denoted  $\tau_2$ ). We focus on the latter measure below, but use both measures in our empirical work.

Both measures of the tariff rate show a persistent downward trend throughout the period (a result of the Kennedy and Tokyo GATT rounds). A typical

tariff rate ( $\tau_2$  for Japanese imports) is depicted in Figure 1.<sup>11</sup> The tariff rates vary considerably from country to country as well as over time.

For instance, in November 1988, the second measure of the tariff rate ( $\tau_2$ ) ranged

from 1% for Canadian imports to 5.7% for Italian imports; in January 1967, the comparable rates were 2.3% and 15.3%.<sup>12</sup> The

growth rates of the tariff rates have positive but low correlations across countries.

Both measures of the tariff rate are clearly imperfect proxies for the ideal variable, which is the effective marginal tax on imports. Two considerations of particular interest are: a) substitution bias; and b) bias from the effect of non-tariff barriers (NTBs).

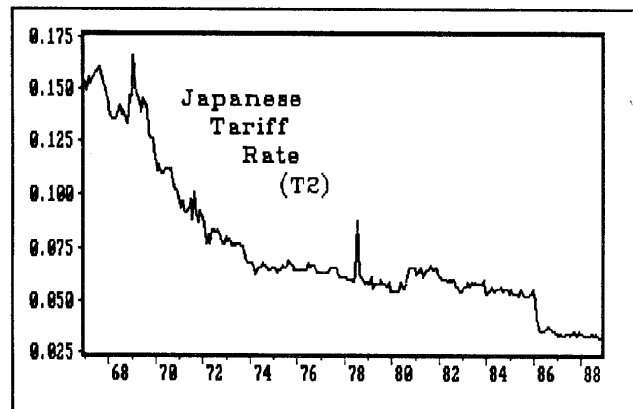


Figure 1: Japanese Tariff Rate

Substitution bias arises from the fact that a tax on a given product leads both foreign production and domestic consumption of that good to fall; goods with high tariffs tend not to be imported.<sup>13</sup> Succinctly, the (observed) average tariff rate is not the marginal rate. Our tariff rate measures will therefore tend, *ceteris paribus*, to understate the actual tariff rate; consequently the estimated tariff rate elasticity will tend to be biased upwards, and the null hypothesis of no effect of the tariff rate will tend to be rejected too frequently.<sup>14</sup>

The second consideration is more subtle: the tariff rate may be a poor proxy for the actual level of protection. Protection of imported intermediates implies that the effective rate of protection may differ considerably from our tariff rate. More importantly, for a variety of (mainly political) reasons, NTBs have recently been used for protection instead of tariffs. Particularly over the last part of our sample, our proxies for the tariff rate will therefore understate the actual rate of protection. Because fluctuations in the tariff rate may be (negatively) correlated with the unobservable "NTB rate", the former may not be statistically exogenous, at least during the latter portion of our sample. We attempt to address this difficulty by examining a variety of countries facing differing degrees of NTB protection, and also by examining the stability of our results over time.

Another potentially serious econometric problem results from the fact that changes in the American tariff rate may be highly



correlated with foreign tariff rates (data which, to the best of our knowledge, are not readily available). This could result either from foreign retaliation, or from coordinated rounds of GATT tariff reduction. We attempt to handle this issue by comparing our results with those obtained from the pre-GATT period.

Despite the imperfect nature of our data, we note in passing that the latent variable in question ("the tariff rate") is more likely to be econometrically exogenous than most variables traditionally used by macroeconomists. Since tariff rates tend to be set either in GATT rounds or on the basis of microeconomic issues, the rates are not likely to be influenced by cyclical considerations. Broadly speaking, tariffs can be characterized as non-discretionary fiscal policy.<sup>15</sup>

The other variables needed for estimation are more conventional and are fully described in the data appendix. They include measures of: foreign and domestic industrial production; the real bilateral exchange rate (CPIs are used as the price deflators); and the real trade balance. Trade flows are measured both at American and at foreign borders; consequently two measures of the trade balance are available (denoted by the superscripts "D" and "F" respectively).

## Methodology

We use a non-structural methodology to examine the impact of fluctuations of tariff rates on four aggregate variables which theory indicates to be of particular interest. In particular, we estimate vector autoregressions (VARs), which model domestic and foreign output, the real balance of trade and the real exchange rate as functions of lags of the (four) endogenous variables. We then test the hypothesis that (lags of the tariff rate do not add statistically significant explanatory power to this system. Our data do not reject this hypothesis at traditional significance levels.

The fact that a VAR does not deliver structural parameter estimates is both an advantage and a disadvantage. On the one hand, using an atheoretical statistical methodology implies that our inferences are not based on possibly fallacious auxiliary assumptions about the relevant data generation process. That is, our inferences are not restricted by the validity of secondary hypotheses concerning e.g., the appropriate structural models of trade flows, the exchange rate or output. On the other hand, our tests may be sensitive to the information set considered.<sup>16</sup> We attempt to account for this problem by checking the robustness of our results extensively. Further, some loss of power is inherent in the estimation of a non-parsimonious VAR system. Bayesian priors are used in some of the estimates in an attempt to improve statistical efficiency.

It is important to state from the outset that our goal is not to test a specific structural model of the transmission mechanism between tariffs and the macroeconomy. Rather, we attempt to discover the existence of a stable relationship consistent with any of the theoretical models discussed in Section II.

### **Preliminary Diagnostics**

We begin our empirical analysis by examining the time-series properties of our data. In particular, we test for unit-roots in the univariate representations of the variables and a co-integrating relationship between the four key macroeconomic variables and the tariff rate. For a recent survey on unit-roots and co-integration, see Stock and Watson (1988).

The null hypothesis that each of the variables (the real trade balance, domestic and foreign real output, the real exchange rate, and the tariff rate) has a unit-root cannot generally be rejected at conventional significance levels with standard tools. The Dickey-Fuller tests displayed in Table I have a constant and are augmented by four lags of the difference; the sample period is 1967:6 through 1988:10, for a sample size of 257 observations. A departure from the null hypothesis of a unit-root at the .05 (.01) level is indicated by an (two) asterisk(s). All variables except the trade balance are

initially transformed by natural logarithms.

**Table I: Augmented Dickey-Fuller Unit-Root Tests**

	UK	Canada	France	Germany	Italy	Japan
BT <sup>D</sup>	-3.25*	-2.54	-2.59	-1.39	-1.38	-.46
BT <sup>F</sup>	-3.84**	-2.15	-2.47	-1.40	-1.31	-.20
q	-1.62	-1.21	-1.86	-1.67	-1.90	-.97
Y*	-1.26	-1.13	-2.37	-3.53**	-1.57	-1.96
$\tau_1$	-1.62	-2.66	-1.67	-2.03	-2.15	-1.29
$\tau_2$	-1.63	-2.78	-1.02	-1.87	-2.06	-1.03
Critical Value .05		-2.88				
Critical Value .01		-3.46				

The unit-root tests are consistent with the presence of unit-root non-stationarity in most of the variables. The exceptions are both American and foreign measures of the bilateral US-UK real trade balance.<sup>17</sup> In addition, the German industrial production index does not appear to have a unit-root (although this result is extremely sensitive to the sample size). The results for the tariff rates are particularly important, as they are inconsistent with the hypothesis that most tariff shocks are expected to be temporary in nature (a matter to which we shall return below). This accords both with common sense and with the results of Gardner and Kimbrough (1988). In the context of the intertemporal approach to the trade balance, the apparently permanent nature of tariff shocks also leads to the

presumption that tariffs will have only minor effects.

The primary questions of interest in this paper are multivariate rather than univariate in nature; we are interested in examining the impact of the tariff rate on a variety of variables, including domestic and foreign output, the real exchange rate and the balance of trade. Given the presence of unit-root non-stationarity in our variables taken one at a time, the existence of stable relationships between our variables depends on whether our variables are jointly co-integrated. A vector of variables is (most commonly) said to be co-integrated if each element of the vector has a single unit-root, but some linear combination of the variables does not.

We tested for co-integration using the augmented Dickey-Fuller statistics recommended by Engle and Yoo (1987). These tests are augmented Dickey-Fuller tests for a unit-root in the residual of the "co-integrating equation". The latter is merely an OLS regression of one variable (e.g., the tariff rate) on the other variables (e.g., the real exchange rate, domestic and foreign output, and the real trade balance). The tests are augmented by four lags of the differenced residual, and contain a constant. The sample is again the 257 observations from 1967:6 through 1988:10. The tests are reported in Table II for both measures of the trade balance; the regressands are the tariff

rates.

**Table II: Augmented Dickey-Fuller Co-integration Tests**

Regressand	UK	Canada	France	Germany	Italy	Japan
American Trade Balance Measure						
$\tau_1$	-2.76	-2.87	-4.71*	-3.32	-3.12	-4.25
$\tau_2$	-2.88	-3.50	-3.60	-3.09	-3.18	-4.13
Foreign Trade Balance Measure						
$\tau_1$	-2.58	-3.05	-4.50*	-3.54	-3.14	-4.10
$\tau_2$	-2.48	-3.20	-3.40	-3.31	-3.05	-4.00
Critical Value .05		-4.50				
Critical Value .01		-4.96				

The co-integration tests show relatively little evidence of co-integration between the relevant variables.<sup>18</sup> The very weak signs of co-integration have also been confirmed in two additional ways: by co-integration tests of the "reverse" regressions<sup>19</sup>; and by the tests for co-integration proposed by Johansen (1988).<sup>20</sup> However, no method delivers strong evidence of co-integration. This finding is consistent with the hypothesis that there is no steady-state relationship between the tariff rate and the four macroeconomic variables of interest.

#### IV: Bilateral Results

Given the relatively strong evidence of unit-roots in our variables, and the weak evidence of co-integration, we estimate our VARs in differences, but include the residual from a co-integrating equation as a regressor to ensure consistent estimation.<sup>21</sup> To check the robustness of our findings, we also estimate our VARs in levels.

Most of our empirical results arise from a VAR of the form:

$$\Delta x_t = \alpha + \beta(L)\Delta x_{t-1} + \delta u_{t-1} + \Phi(L)\Delta \tau_{jt} + \epsilon_t \quad (5)$$

where:  $L$  is the lag operator,  $Lz_t = z_{t-1}$ ;  $\Delta$  denotes the difference operator  $(1-L)$ ;  $x_t' = (BT^i, q, y, y^*)$ ;  $BT^i$  is one of the two measures of the real bilateral trade balance;  $q$  is the logarithm of the real bilateral exchange rate;  $y$  is the logarithm of the domestic (US) industrial production index;  $y^*$  is the logarithm of the foreign industrial production index;  $\tau_j$  is the logarithm of the  $j$ th measure of the bilateral tariff rate;  $u$  is the residual from a (co-integrating) regression of  $BT^i$  on a constant,  $q$ ,  $y$ ,  $y^*$  and  $\tau^j$ ; and  $\epsilon$  is a random disturbance term which represents omitted factors, assumed to be iid.

We include twenty-four (monthly) lags in our basic VAR results. While standard likelihood ratio tests indicate that the systems could be reduced to twelfth-order systems, we are wary of an excessive reduction in the lag length, given the existing literature which stresses the long lag length of price variables in international trade flow equations, e.g., Goldstein and Khan

(1985). Allowing for two years' worth of lags sets our sample period of estimation at 1969:2 through 1988:9. There are no indications that more than two years' worth of lags is warranted.

The hypothesis of interest to us is that the tariff rate has no effect on any of the four macroeconomic variables of interest, i.e.,  $\phi(L) = 0$ . The relevant test statistics appear in Table III. Under the null hypothesis that the tariff rate does not affect any of the variables of interest, the test statistics are distributed as chi-squares, with 96 degrees of freedom.

**Table III: Chi-Square Tests of the Joint Impact of Tariff Rates**

	UK	Canada	France	Germany	Italy	Japan
Domestic Trade Balance Measure						
$\tau_1$	105	86	61	101	88	109
$\tau_2$	98	88	98	98	99	108
Foreign Trade Balance Measure						
$\tau_1$	97	78	76	78	96	87
$\tau_2$	96	76	84	76	99	89
Critical Value .10	114					

The data are manifestly unable to reject the hypothesis that the tariff rate has not had a stable and statistically discernible joint effect on the four variables of primary interest.



While the evidence presented in Table III presents the impact of the tariff rate on the system of four endogenous variables, it is of interest to examine the impact of the tariff rate on each of the four variables of interest. Indeed, the negative results of Table III could conceal a strong and consistent impact of the tariff rate on (say) one of the variables of interest, or a variety of important but transient effects.

Table IV presents some evidence relevant to this issue. F-tests are tabulated for the hypothesis that twenty-four lags of the (difference) of the bilateral tariff rate have no joint impact on the macroeconomic variable in question, once the effects of (twenty-four) lags of all four macroeconomic variables have been partialled out (these F-tests are the single-equation analogues to the system-wide chi-square tests of Table III). Also tabulated are the point estimates of the cumulative impact of the twenty-four lags of the tariff rate. Test statistics which are significantly different from zero at the .05 significance level (thereby rejecting the null hypothesis of no effect of the tariff rate) are denoted by an asterisk. None of the test statistics is significant at the .01 level. The tests were computed using the US measure of the trade balance and the

$\tau_2$  measure of the tariff rate.

**Table IV: Hypothesis Tests of  $\beta = 0$  by Variable**

	UK	Canada	France	Germany	Italy	Japan
<b>Trade Balance</b>						
F(24,114)	1.80*	.96	.75	1.50	1.00	1.51
$\Sigma\Phi$	26.59	13.48	-49.66	14.00	-3.31	-11.55
<b>Exchange Rate</b>						
F(24,114)	1.49	1.39	.86	1.10	.67	1.10
$\Sigma\Phi$	.38	.07	-.52	-.46	.11	-1.09*
<b>Output</b>						
F(24,114)	.84	1.00	.59	1.39	1.20	1.53
$\Sigma\Phi$	.08	-.03	-.05	.09	.20	-.30*
<b>Foreign Output</b>						
F(24,114)	.70	.55	.50	.64	1.23	1.03
$\Sigma\Phi$	.09	-.05	.30	-.16	-.74	-.21

\* denotes significance at the .05 level

There is little evidence that (lags of) the tariff rate have a consistent but transitory impact on the macroeconomic variables, or that the tariff rate tends to have a noticeably stronger impact on some of the macroeconomic variables than on others. The F-tests do not typically reject the hypothesis that twenty-four monthly lags of the tariff rate jointly have no significant impact on each of the four variables of interest. The cumulative impact of the tariff lags varies considerably by country; that is, the tariff rate does not appear to affect any of the variables in a uniform way across countries. Increases in

the tariff rate are associated with worsening of the bilateral trade balances vis-a-vis France, Italy and Japan, but with improvements for the other countries; increases are also associated with appreciations for France, Germany and Japan. Virtually none of the cumulative point estimates are statistically distinguishable from zero. The economic size of the tariff rate coefficients is generally reasonable, but varies widely by both variable and country. The (cumulative) exchange rate elasticities are typically less than unity, while the output elasticities tend to be much smaller.

### **Robustness**

We have extensively checked the sensitivity of the results of Tables III and IV to a variety of economic and statistical perturbations of our basic methodology. In this section of the paper, we describe briefly these checks for robustness. However, there is no evidence that our results are affected by changes in the way in which our system is estimated.

We estimated our VAR systems with both more (36) and less (12) lags to test the sensitivity of the results. However, the results do not seem to be affected by the lag length.<sup>22</sup>

We have argued that the tariff rate can be treated as an exogenous variable. If this is appropriate, the reduced form of the structural system which leads to (5) would include the contemporaneous values of the tariff rate, as well as lagged

values. However, when the contemporaneous values of the tariff rate are added to our system, the results are not changed.

Theory suggests that the effects of tariffs may depend on the exchange rate regime. We have changed our period of estimation in a variety of ways to ensure that our results do not depend on the fact that our sample spans fixed and flexible exchange rate regimes. Our results are quite insensitive to exact choice of sample period (e.g., test statistics are similar when only the post-Bretton Woods regime of floating rates is used in estimation).

Estimating our system in (logarithms of) levels instead of differences does not lead to different results.

Using the PPI instead of the CPI does not change any results. Also, using employment in place of industrial production does not affect the results.<sup>23</sup>

As stated in the previous section, the theoretical effects of a tariff depend on whether the tariff is expected to be temporary or permanent. We used the Beveridge and Nelson (1981) technique to decompose the tariff into temporary and stationary components. This technique makes an important and potentially restrictive identifying assumption, namely that the two unobserved components are perfectly correlated; for a survey of related issues, see Stock and Watson (1988).<sup>24</sup> Negative results are again obtained when we estimate the system in levels and replace the actual tariff rate with either the temporary or permanent component of the tariff rate.

Our results do not change when the effects of the real American federal budget deficit are taken into account.<sup>25</sup> Thus, controlling for possible effects of the revenue redistribution scheme does not seem to make a difference.

Finally, we have used a variety of Bayesian priors in an attempt to improve the precision of the fit of our system by using non-sample information. Our priors take the form of maintaining that the VAR system can be well approximated as a first-order univariate autoregression. That is, we use non-sample information to specify zero coefficients and moderate standard deviations for the coefficients of the non-lagged dependent variable (further details are available upon request). However, our use of Bayesian techniques does not affect the finding that the tariff rate has no discernible impact on the variables of interest. This negative result does not depend on the exact number of lags used in the system.

### **Aggregate Results**

Our negative results are characteristic not only of bilateral trade between the USA and other G7 countries; they also hold true for aggregate trade flows between the USA and its trading partners collectively.

We have estimated our system with aggregate variables, using the US real net trade balance, an effective exchange rate in place of the bilateral rate, and global indices of the CPI, industrial production and the tariff rates, in place of their

bilateral counterparts. The methodology used on the bilateral data yields similar results when applied to aggregate data. In particular, two years' worth of lags of the aggregate tariff rate have no statistically discernible impact on the four variables of interest. This result is true of both measures of the tariff rate, and is insensitive with respect to the lag length, estimation in levels or differences, and the exact sample period chosen.

### Annual US-UK Evidence

We now confirm the relevance of our monthly results by using a long span of historical evidence on American-British trade flows. We test and cannot reject the hypothesis that our system is not affected by the tariff rate when annual data from 1889 to 1970 are used in place of the monthly post-war data.

There are a number of advantages to using long historical series. NTBs are likely to be less of a problem during the pre-GATT era. Further, the stochastic nature of foreign tariff rates may have changed dramatically as a result of GATT, which coordinates tariff reductions internationally. If tariffs have the same observable effects on

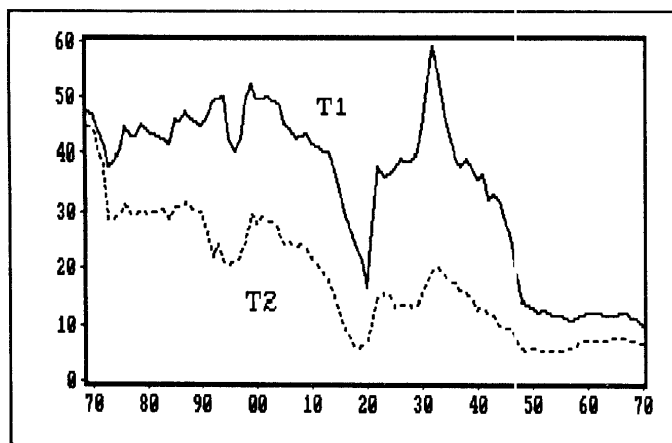


Figure 2: Historical Tariff Rates

macroeconomic variables before and after GATT, it is less likely that GATT is responsible for our negative results. Finally, many economic time series appear to be more variable in the pre-war period (although this has been the source of much recent debate). Tariff rates were certainly both high and volatile during the period in question. Figure 2 provides a plot of both measures of the tariff rate against time.

Data on bilateral trade flows between the US and a variety of its trading partners are available on a historical basis from the early nineteenth century to the present. Measures of real output and prices for both the UK and the US are available from the late nineteenth century to the present, as is the bilateral exchange rate (consistent data for other countries does not appear to be available). However, to the best of our knowledge, no data on bilateral tariff rates is available until 1967. We therefore use measures of the aggregate US tariff rate in place of the unknown US-UK bilateral tariff rate. Clearly, these measures will be poor proxies for the relevant bilateral tariff rate if US-UK trade differed significantly in composition from aggregate American trade<sup>26</sup> or if the US tariff structure discriminated against the UK. During the period in question, American imports from Britain averaged 10% of total US imports (the maximum was 24%), while 23% of all American exports were sold in the UK (at the beginning of the sample over half of all American exports went to the UK).

We employ the same techniques as were used on our monthly data. In particular, we estimate VARs, treating real bilateral trade balances, American and British real output, and the bilateral real exchange rate as the variables of interest. The VARs are estimated from 1892 through 1970, with two (annual) lags, a constant term, and the residual from a co-integrating equation. We also check the robustness of our results by: estimating the equations in levels; increasing the lag length to three years; and changing the sample size. As in Table III, we test the hypothesis that the tariff rate has no significant impact on the system; under the null hypothesis, the test statistics are distributed as chi-squares, with tabulated degrees of freedom. The actual test statistics, (together with their marginal significance levels in parentheses) are reported in Table V.



**Table V: Historical Chi-Square Tests of the Impact of Tariff Rates**

Sample	Transformation	Lags	DF	$\tau_1$ Test	$\tau_2$ Test
1892-1970	Differences	2	8	8.5 (.39)	10.2 (.25)
1891-1970	Levels	2	8	14.9 (.06)	2.1 (.98)
1893-1970	Differences	3	12	20.2 (.06)	14.9 (.24)
1892-1945	Differences	2	8	7.3 (.51)	9.3 (.31)

In no case is the null hypothesis of no impact of the tariff rate on our system rejected at the .05 significance level. Further, the impact of the tariff rate on each of the dependent variables appears to be small. Finally, the result is robust with respect to changes in the number of lags, the levels/differences transformation and, most importantly, to changes in the sample size. Our sample period covers a number of different exchange rate and fiscal regimes, as well as differing degrees of capital mobility. As summarized above, theory suggests that results may be sensitive to such factors. However, our results are in fact insensitive to the choice of sample period. For instance, when the post-war (GATT) period is excluded, the tariff rate still does not have any discernible

impact. The latter evidence seems inconsistent with the view that the coordinated tariff reductions fostered by GATT are wholly responsible for our negative monthly findings.

#### **Evidence from a Panel of Data**

As a final check, we now test out results on a third data set. This data set is a panel of annual data spanning thirty-eight countries from 1978 through 1985. Again we find that our null hypothesis of no significant impact of the tariff rate on our system of macroeconomic variables, cannot be rejected.

The data is taken from Government Finance Statistics (GFS) and International Financial Statistics, both IMF publications. We collect data on both "import duties"<sup>27</sup> and the more narrowly defined "customs duties"<sup>28</sup> from GFS; IFS data is used for: imports; exports; nominal and real output; and the real effective exchange rate. Our choice of countries<sup>29</sup> and sample period was dictated by data availability. Our sample includes a number of developing countries who use tariff revenues as a major source of government revenue.

The equations that we estimate take the form:

$$\Delta x_{i,t} = \alpha + \beta(L)\Delta x_{i,t-1} + \Phi(L)\Delta \tau_{i,t} + \epsilon_{i,t} \quad (5')$$

where  $x$  is a now vector of three variables (the real exchange rate, the real trade balance, and real domestic output), and all other notation remains unchanged.

We note that (5') is expressed in growth rates, so that country-specific "fixed-effect" intercepts are consistent with the setup. We are forced to drop the co-integrating residual because of the time-series size of the sample, although results are not changed if (5') is estimated in levels.

We estimate (5') and use a likelihood ratio statistic to test the hypothesis  $\Phi(L)=0$ . When two lags of the regressors are included, the test statistics indicate that the hypothesis cannot be rejected even at the 50% significance level. The same result is true of each of the variables taken one by one; tariffs do not have noticeable effects on any of the variables of interest. These results are robust with respect to: choice of tariff rate measure; choice of lag length and sample period; addition of time-specific dummies; addition of a measure of global output; and estimation in levels. In other words, there is no evidence that tariffs have a discernible impact on real exchange rates, output and trade balances, even after pooling data across both countries and time.

#### **V: Summary and Conclusion**

Economic theory does not deliver strong implications about the macroeconomic effects of a tariff. Depending upon the nature of the economy, a given change in the tariff rate is consistent with a wide range of fluctuations in the trade balance, output and the exchange rate, including no effect at all.

In actual fact, we are unable to isolate statistically significant effects of the tariff rate on bilateral trade flows,

real exchange rates, or output, either domestically or abroad. These results appear to be quite robust statistically.

However, we certainly do not wish to claim that tariffs do not have potentially important effects on economic welfare. Trade theory predicts that the primary impact of a tariff is to shrink the volume of international trade, rather than e.g., the balance of trade. While we are not concerned in this paper with modelling the volume of international trade, our data is suggestive of significant links between tariff rates and trade volume. In particular there are indications of Granger Causality from tariff rates to the sum of real exports plus real imports.<sup>30</sup> Further, increases in tariff rates are correlated with declines in the volume of American trade with: Canada; Germany; Italy; and Japan (the evidence from UK and France is more ambiguous). This is consistent with the evidence of Rose (1989) who finds that tariffs are strongly negatively correlated with the volume of international trade, using a panel of twelve countries over thirty-five years.

Our inability to isolate significant macroeconomic effects of a tariff is consistent with a number of hypotheses. For instance, tariffs on imported intermediates or NTBs may render the effective rate of protection small and stable, despite fluctuations in measured tariff rates. Alternatively, the behavior of foreign tariff rates may be responsible for our results. "Pricing to market", which results in low passthrough of exchange rate changes to import prices may also account for

negligible effects of tariffs, if firms treat exchange rates and tariffs.

However, given that three very different data sets yield similar results, we are most attracted to the conclusion that the important effects of the tariff are not macroeconomic, but instead are distributional in nature (as documented by e.g., Hufbauer et.al. (1986)). We conclude that there is little evidence that tariffs have important effects on the macroeconomy, and believe that further research on tariffs should focus on microeconomic aspects.

## Data Appendix

The data and programs used in this project are available upon request. The data has been carefully checked through a variety of diagnostic procedures, including descriptive statistics on the levels and differences of the data, and plotting the levels and differences. Numerous errors in the IFS data have been corrected.

Most of the relevant monthly data was collected from the IMF's International Financial Statistics data base. The bilateral variables (IFS mnemonics) are as follows: period average bilateral (US \$ PFX) exchange rates (rf and rh); industrial production index (66..c); CPI (64); PPI (63); and employment (67, 67..c, 67ey and 67eyc). The additional aggregate variables are: the US MERM effective exchange rate (amx); the US net merchandise trade balance (70-71); the global CPI (001..64x); and the industrial country industrial production index (110..66).

The monthly nominal bilateral trade data (all measured in US dollars) is taken from the IMF's Direction of Trade data base; mnemonics for exports and imports are given by xy...ZDz where "x" represents the country doing the trade; "z" represents the trading partner; and "y" is 71 for imports, 70 for exports. It is interesting and distressing that the data for e.g., German exports to the US are quite different from US imports from Germany. The two variables are highly correlated in levels, but their growth rate have only a low (and, in the case of the UK, negative) correlation.

The monthly tariff data is available from Highlights of U.S. Export and Import Trade (FT 990), published by the U.S. Department of Commerce, Bureau of the Census. The data is taken from Section B, "Imports for Consumption -- World Area and Country of Origin" (the exact table number varies over time). "Imports for Consumption" measures total merchandise cleared through Customs, either because it directly enters consumption channels, or because it is withdrawn for consumption from warehouses under Customs custody. The data is available on a "Customs Value Basis", which represents the price actually paid for merchandise when sold for exportation to the US, excluding US import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States. Relationships between buyers and sellers should not influence the customs value.

Much of the annual data is available in Historical Statistics of the United States. This includes both measures of the tariff rate, bilateral imports and exports, and real GNP. The British measure of real output is spliced from a variety of series, mostly taken from the Abstract of British Historical Statistics. Jeff Frankel kindly provided us with the bilateral exchange rate and both British and American net national product price deflators (the data is mostly taken from Friedman and Schwartz). Further documentation is available along with the data.

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**Endnotes**

1. University of California, Berkeley and International Monetary Fund respectively. The first author was a visiting scholar in the Financial Studies Division of the IMF Research Department and a visiting scholar in the International Finance Division of the Board of Governors of the Federal Reserve System during the course of this research. This paper represents the views of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. We thank: Haydon Merkle and Mattie Halsey of the Foreign Trade Division of the Bureau of the Census, and Jeff Frankel for assistance with the data; Kellett Hannah for computer support; Eduardo Borensztein, Peter Garber, Charles Kindleberger, Cathy Mann and seminar participants at the Board of Governors of the Federal Reserve System for comments; and Robert Flood and Doug Purvis for discussions.
2. Helkie et. al. (1988) use simulation techniques on a large macroeconomic model and conclude that protectionist policies are ineffective in reducing trade imbalances while avoiding recession.
3. See also Dornbusch (1987).
4. See e.g., Mann (1987). Kindleberger (1986) argues that the macroeconomic effects of Smoot-Hawley were in fact contractionary.
5. The exposition that follows is drawn from Dornbusch (1980, pp. 65-6) although similar analysis may be found in other texts.
6. We assume in what follows that the government runs a balanced budget.
7. The presumption of a contractionary effect is strengthened when money is introduced into the model, since the redistributed tariff revenue creates an additional demand for money, requiring a fall in income from production to clear the money market (see Chan (1978), Eichengreen (1981) and Krugman (1982)).
8. Krugman (1982) argues that, even in those circumstances when a tariff raises output and improves the terms of trade when other countries are passive, "symmetric retaliation" will result in lower output and unchanged terms of trade.
9. Standard trade theory shows that the tariff will tend to benefit the factor used intensively in the import competing sector.
10. We choose the G7 countries for intrinsic interest, noting that they account for over half of US imports (both dutiable and duty-free) and tariff revenues during the sample in question. However,

the bilateral tariff data exists for other countries, and it would be interesting to extend the results to e.g., developing countries.

11. There does not appear to be any fundamental explanation of the apparent outlier in August 1978.

12. The volatilities of the growth rates of the tariff measures also vary noticeably, both across country and tariff rate measure.

13. If there is incomplete specialization, there will be additional effects on domestic production and foreign consumption which may also contribute to substitution bias.

14. As our empirical work below indicates that the null hypothesis cannot generally be rejected, this bias strengthens our results, so long as standard errors are not substantially biased.

15. The data indicate that tariff revenues do not seem to be redistributed. In particular, the tariff rate, and, to a much smaller degree, tariff revenues, have positive but small correlations with the Federal budget surplus.

16. This statement is true of all tests of Granger "Causality".

17. In all cases, the hypotheses that imports and exports separately, as well as the nominal trade balance have unit-roots cannot be rejected at traditional significance levels.

18. Using the nominal trade balance in place of the real trade balance does not change results.

19. There is no reason for the tariff rate to be used as the sole regressand; the "reverse" regression with e.g., the trade balance as the dependent variable, (and the remaining four variables as regressors) can also be used as the co-integrating equation. We have calculated the Augmented Dickey-Fuller co-integration tests for all 96 (6 countries x 2 measures of trade balance x 2 measures of tariff rate x 4 alternative regressands) reverse regressions. Almost uniformly (in 92 out of 96 cases), they are consistent with the hypothesis that there is no co-integration between the trade balance, the exchange rate, domestic and foreign output and the tariff rate.

20. The Johansen tests indicate that there is one and possibly two co-integrating vectors in the five-variable system. This result is robust to various measures of the trade balance and the tariff rate.

21. The results do not change if the co-integrating residual is dropped.

22. The only exception occurs when the lag length is reduced to one year and the US measure of trade with Italy is used, in which case (lags of)  $\tau_2$  are statistically significant.
23. The relevant data is available for three countries: Canada; Germany; and Japan.
24. To implement the Beveridge and Nelson methodology, we assumed that (the logs of the) tariff rates follow IMA(1,6) processes, univariate models which appear to fit the data reasonably well.
25. Use of national accounts data necessitates estimation at the quarterly frequency.
26. In principle, the hypothesis that US-UK trade is similar in composition to aggregate American trade is testable on the basis of existing data. In particular, bilateral data exists at the annual frequency on a historical basis from Foreign Commerce and Navigation of the US, but only at the commodity level.
27. All levies collected on goods because they enter the country.
28. Duties levied under the customs tariff schedule and annexes, but excluding consular fees, tonnage charges, statistical taxes, fiscal duties and other taxes.
- 29.\* The countries included are (listed by IFS code): UK; Austria; Denmark; Germany; Italy; Netherlands; Norway; Sweden; Switzerland; Canada; Japan; Finland; Greece; Iceland; Ireland; Malta; Portugal; Spain; Australia; New Zealand; Colombia; Costa Rica; Dominican Republic; Nicaragua; Paraguay; Venezuela; Guyana; Cyprus; Nepal; Philippines; Burundi; Cameroon; Zaire; Malawi; Morocco; Uganda; Zambia; and Fiji.
30. These tests were conducted using the bilateral data in logarithms, allowing for twelve lags of both variables.

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