Exchange Rates, Trade Deficits, and U.S. Prices

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Abstract

Granger Causality tests are run to examine the causal relationships between the trade deficit, another macroeconomic variable, and U.S. prices. The results show that strong causal relationships run from the trade deficit to agricultural prices but not to nonagricultural prices. Results of causality tests also indicate that the huge trade deficit is caused by a strong U.S. dollar.

Introduction

In the last two years, the U.S. trade deficit has soared to record levels, reaching $123.3 billion in 1984 and $148.5 billion in 1985. Because of its importance to the U.S. economy, particularly to the agricultural sector, this alarming trade deficit has been the subject of frequent discussions in both economic and political arenas. The unprecedented surge in the trade deficit has resulted from a sharp decline in U.S. exports, particularly agricultural exports, and a continuous rise in U.S. imports of foreign goods. The high value of the U.S. dollar, which makes imports cheaper and exports more expensive, is the major cause of the tremendous trade deficit. The resulting loss of competitiveness of U.S. farm products in the world market has important implications for U.S. agriculture. Because exports are a major component of the demand for U.S. farm products, the decrease in agricultural exports is often cited as the primary cause of lower prices of agricultural products.

The two objectives of this study are to examine the causal relationships between the U.S. trade deficit and U.S. price levels by using a Granger causality test and to present empirical evidence that the enormous U.S. trade deficit is caused by the high value of the U.S. dollar. Causality in the "Granger sense" is defined and statistical considerations are addressed; the data sources and the empirical results are presented; and the policy implications of large trade deficits are discussed.

The Model

Granger Causality

One method of investigating the relationship between trade deficits and U.S. prices, and between exchange rates and trade deficits, is causality analysis. The causal relationship between two variables, X_t and Y_t, can be represented by a covariance stationary bivariate system. Assume that X_t and Y_t may be expressed as a simple, bivariate autoregressive process with serially uncorrelated white noise processes u and v, respectively. $Eu_t v_s = 0$ for all values of t and s. If causality is unidirectional, from past and present X_t to current Y_t, the simple covariance stationary process is:

$$(1) \qquad \begin{bmatrix} B^{11}(L) & 0 \\ B^{21}(L) & B^{22}(L) \end{bmatrix} \begin{bmatrix} X_t \\ Y_t \end{bmatrix} = \begin{bmatrix} u_t \\ v_t \end{bmatrix}$$

where $B^{ij}(L)$ is a polynomial in L, which may be represented as $b_0 + b_1L_1 + b_2L_2 + \ldots + b_nL_n$. The b_i's are constant and L is the lag operator, $LX_t = X_{t-1}$. This testable definition is commonly known as causality in the "Granger sense."

The direct Granger test, which is employed in this study, consists of regressing the current observations of one series on its own past observations as well as on past observations of the other series. More specifically, the variable X is said to cause Y in the "Granger sense" if the current value of Y can be predicted more accurately using past values of X rather than past values of Y. Consequently, the test for the causality from X to Y can be represented by the following equations:

$$Y_t = \alpha_{10} + \sum_{i=1}^{p} \alpha_{1i} Y_{t-i} + \epsilon_{1t} \quad (2)$$

$$Y_t = \alpha_{20} + \sum_{i=1}^{p} \alpha_{2i} Y_{t-i} + \sum_{j=1}^{q} \beta_{2j} X_{t-j} + \epsilon_{2t} \quad (3)$$

where α_{1i}, α_{2i}, and β_{2j} are dynamic regression parameters, and ϵ_{1t} and ϵ_{2t} are independent, serially uncorrelated residuals with zero means and finite variances for all $t = 1, \ldots, T$. If causality runs from X to Y, regression coefficients (β_{2j}) in equation (3) should be significantly different from zero. Stated differently, the null hypothesis that X does not cause Y is that $\beta_{21} = \beta_{22} = \ldots = \beta_{2q} = 0$. The test of the null hypothesis can be based on the following F-statistic:

$$F^* = \frac{SSE_1 - SSE_2}{q} \bigg/ \frac{SSE_2}{T-P-q-1} \quad (4)$$

Here SSE_1 and SSE_2 are the sums of squared residuals derived from the ordinary least squares regressions on equations (2) and (3), respectively. T is the number of time series observations on Y_t. Under the null hypothesis, the statistic F^* has an $F_{(q,T-p-q-1)}$ distribution. For suitably large values of F^*, the hypothesis that X does not cause Y is rejected.

Statistical Considerations

The first step in applying the Granger causality test is to choose the lag length parameters p and q. The values of p and q should be large enough to remove substantial autocorrelation in the regression residuals. A number of methods have been suggested for choosing the values of p and q. One method is to rely on a prior knowledge of leads and lags (Bessler and Brandt, 1982; and Barnett, Bessler, and Thompson, 1983). Where such information is lacking, an alternate statistical method suggested by Akaike (1969) has often been used. (Bessler and Binkley apply the method to univariate model building.) This method is commonly called Final Prediction Error (FPE) criterion. For lag length n, the FPE of a variable Z is given by the following equation:

(5) $$\mathrm{FPE}(n) = \frac{T + n + 1}{T - n - 1} \left[\sum_{t=n+1}^{T} (Z_t - \hat{Z}_t(n))^2 \Big/ T \right]$$

where $\hat{Z}_t$ is the predicted value of Z_t from an autoregression of order n, and T is the number of observations. The Akaike criterion is defined so that the error sum of squares, adjusted for the degrees of freedom factor in equation (5), will be minimal for the appropriate lag length n. FPE(n) tends to be unnecessarily large when the value of n is greater or smaller than the true order of autoregression. Thus, by selecting the minimum FPE(n), an order n is chosen that balances the risk of bias associated with a model that is too small against the risk of variance associated with a model that is too large.

A check to see if the chosen autoregression order n is appropriate can be based on the portmanteau test statistic or Box-Pierce Q-Statistic for white noise:

(6) $$Q = T\left(\sum_{k=1}^{M} r_k^2\right)$$

where r_k^2 is the k^{th} lag autocorrelation of the residuals. M is the number of autocorrelations used. It is selected according to the formula $M = \min(T/2, 3T^{1/2})$. Q has a $X^2_{(M-K)}$ distribution (K is the number of regressions) if the null hypothesis of no autocorrelation is true. See Doan and Litterman (1983) for details on the Q-statistic.

Empirical Results

Given the above statistical considerations for the causality test, this section examines the choice of appropriate lag length and the causal relationships of trade deficits on U.S. prices (aggregate agricultural products price index, wheat price, and nonagricultural products price index). An analysis of the impact of exchange rates on trade deficits is also included. Among commodity prices, wheat price was considered since wheat is one of the major export crops. The monthly data from January 1979 to June 1985 were used for the analysis. The data for these variables were obtained from various issues of surveys of current business conditions (for trade deficits and nonagricultural prices), from the USDA (for the aggregate agricultural price index and for wheat prices received), and from the Federal Reserve Board (for the multilateral trade-weighted real exchange rate).

The appropriate orders of autoregressions, i.e., the lag lengths, estimated for the variables mentioned above based on the FPE criterion are given in Table 1. The table also includes diagnostic Q-statistics associated with the residuals from within sample application of each autocorrelation. Since calculated Q-statistics were considerably smaller than the table chi-squared values, we accept the null hypothesis that the residuals from each fitted autoregression are white noise and that lag lengths are appropriately long to filter each series. Using the autoregressive order given for the variables in Table 1, Granger causality tests utilizing equations (2) and (3) were applied for the time series considered. The summary F-statistics are presented in Table 2.

Table 1. Selection of autoregressive orders based on Akaike Final Prediction Error (FPE) method.

Variables	Order of Autoregressions	Q-Statistics[a]
Trade deficits	3	20.40 (31.41)
Multilateral trade weighted real exchange rate	7	20.76 (26.30)
Aggregate agricultural products price index	2	12.43 (33.92)
Wheat prices received	4	25.94 (30.14)
Nonagricultural product price index	4	6.85 (30.14)

[a]The critical chi-squared values of significance level of 0.05 appear within the parentheses. The calculated Q-statistics are smaller than their corresponding chi-squared table values. This suggests that the residuals from the fitted regressions are white noise.

Table 2. Causality tests of exchange rates, trade deficits, and U.S. prices.[a]

	Causal Variables	
Dependent variables	Trade deficits	Multilateral trade weighted real exchange rates
Aggregate agricultural products price index	2.91 (2.75)[b]	--
Wheat prices received	3.38 (2.75)	--
Nonagricultural product price index	0.13 (2.75)	--
Trade deficits	--	4.09 (2.76)

[a]The lag lengths are given in Table 1.

[b]The critical F-values of significance level of 0.05 appear within the parentheses.

Three points of interest can be observed directly from Table 2. First, these results provide strong evidence that trade deficits directly influence aggregate agricultural prices and wheat prices. Second, no significant causal relationship runs from trade deficits to nonagricultural prices. Finally, the exchange rate does directly influence the trade deficit.

Implications and Conclusions

The results clearly indicate that huge trade deficits have a significant influence on farm product prices. This should be of no surprise since exports are a major source of demand for U.S. farm products and the U.S. farming industry depends heavily on the export market for its revenue. For example, from 1970 to 1984, 26 percent of the gross farm income was derived from export sales. Furthermore, the high U.S. agricultural and food prices in the early 1970s were attributed to the export boom, and this dependency on export markets for higher U.S. farm product prices continued well into the 1980s. It is reasonable to conclude, therefore, that the present depressed farm product prices are the result of a decline in U.S. exports of farm products. Furthermore, the magnitude of the trade deficit is increased by the reduction in U.S. farm exports.

A second point of interest is the weaker relationship between trade deficits and the nonagricultural price index. This suggests that the nonfarm sector, unlike the farm sector, does not depend on the export market for its goods. In fact, the United States is a major importer, rather than an exporter, of nonfarm manufactured goods. Thus, the high trade deficits affect the farm sector more than they affect the nonfarm sector.

Thirdly, a significant causal relationship from exchange rates to trade deficits presents evidence, as suggested by many economists, that the high value of the U.S. dollar is the major cause of such large trade deficits. For example, Samuelson contends that a 50 percent overvaluation of the dollar under the Reagan administration has exacerbated the trade deficits in recent years.

Recent studies by Chambers and Just (1982), Denbaly and Williams (1985), and Devadoss, Meyers, and Starleaf (1985) endogenized the exchange rates in their trade models. Their studies indicate that the U.S. dollar value has a significant impact on U.S. farm product prices.

Closer examination of the causes of the unprecedented trade deficits would reveal that the contractionary U.S. monetary policy coupled with the alarming budget deficits of this decade are the two main causes of the higher trade deficits. A restrictive monetary policy directly puts upward pressure on the value of the dollar. Furthermore, the huge fiscal deficits and contraction in the money supply bid up real interest rates in the United States. Chasing these elevated yields, capital funds flow in from abroad and increase the value of the free-floating dollar exchange rate. This high dollar value increases import expenditures and decreases export revenues and thereby exacerbates the trade deficit. The conditions leading to these trade deficits have a depressing effect on U.S. farm prices.

The policy implication of this study is, as suggested by many economists, that the U.S. government should continue to pursue its correct macropolicies (easy monetary policy and reduction in the budget deficits) in order to put strong downward pressure on the U.S. dollar. A strong decline in the relative value of the dollar is likely to recapture the loss of competitiveness suffered by U.S. farm products in foreign markets. Any increase in U.S. farm exports will raise agricultural product prices and help the depressed farm economy. Since U.S. agriculture is closely integrated with the general economy, the U.S. farm economy largely depends on macroeconomic developments. This study provides further evidence that the formulation of U.S. farm policy must include careful analysis of macrovariables such as money supply growth, budget deficits, trade deficits, and exchange rates.

In summary, this study applies Granger causality tests to examine the causal relationships from exchange rates to trade deficits and from trade deficits to price levels. The results suggest that strong one-way causal relationships exist from exchange rates to trade deficits and from trade deficits to aggregate agricultural prices and wheat prices. However, no significant causal relationship runs from trade deficits to nonagricultural prices. This indicates that the recent growth in the trade deficit has affected the farm economy more adversely than the nonfarm economy. Finally, given the significance of the macroeconomy to the U.S. farm sector, farm policymakers should carefully examine developments in macroeconomic variables, such as trade deficits, in making their farm policy decisions.

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