

MUNIR QUDDUS

*University of Southern Indiana  
Evansville, Indiana*

JIN-TAN LIU

*National Chengchi University  
Taipei, Taiwan*

JOHN S. BUTLER

*Vanderbilt University  
Nashville, Tennessee*

## ***Money, Prices, and Causality: The Chinese Hyperinflation, 1946–1949, Reexamined\****

Expanding on recent work by Tang and Hu (1983), this paper tests for the direction of causality between the money supply and inflation in the three currency areas of China during the hyperinflation of 1946 to 1949. As in the previous study, we find a feedback relationship between money and prices for the mainland China currency area. However, this relationship seems to be statistically significant only after including the post-reform period (August 1948 to May 1949) in the causality tests. For Taiwan and Manchuria, we find a strong one-way causality from inflation to money. These results confirm the widespread belief among economic historians that the Chinese hyperinflation was basically caused by the Nationalist governments' desperate attempts to finance its mounting war expenditures by printing money.

### **1. Introduction**

In a recent issue of this journal, De-Piao Tang and Teh Wei Hu (1983, hereafter TH) tested for the direction of causality between the money supply and price level changes during the Chinese hyperinflation of 1945–1949. They found a two-way causality (feedback) between inflation and the money supply. They concluded that, as in the case of the post-World War I European hyperinflations, the money supply process was endogenous and that the feedback between monetary growth and inflation was an important factor in the Chinese hyperinflation. The results presented by TH can be improved on at least two grounds. First, in performing the tests they overlooked the important currency reform of August 1948. The

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reform, which was confined to the mainland China (Fapi currency area), although largely abortive, has been shown by Babcock and Makinen (1975) to have caused structural changes in the demand for money function. It is expected, therefore, that the relationship between the money supply and the inflation rate was also affected by this event. Second, they neglected the issue of multiple currency areas. Unlike the European episodes of hyperinflation, the Chinese hyperinflation simultaneously affected three different currency areas.

The main purpose of this note is to conduct within a framework of bivariate Sims-causal ordering a formal test of the hypotheses that money supply was endogenous during the Chinese hyperinflation of 1946–1949, and that the hyperinflation was largely a monetary phenomenon. In the analysis, we address the issues of the abortive currency reform of August 1948 and hyperinflation in a multiple currency setting. Our tests are based on data for the three currency areas—mainland China, Taiwan, and Manchuria—simultaneously affected by the hyperinflation. We investigate the impact of the abortive currency reform for mainland China by running our tests with data for the entire period and for the pre-reform period only. The data for the post-reform period is too limited to allow reasonable testing. Our major conclusion is that the hypothesis of endogenous money supply is statistically significant for mainland China only after including the post-reform period in the causality tests. The same is true for the feedback between money supply and prices. For Taiwan and Manchuria, the hypothesis of endogenous money holds for the entire period for which data are available.

## **2. Literature Survey**

Since Granger's (1969) work and its extension by Sims (1973), causality testing has been widely used to examine a whole range of relationships in a broad spectrum of areas in macroeconomics. Sargent and Wallace (1973) first applied the test to data from hyperinflations. For the European hyperinflations after World War I, they found considerable support for the hypothesis of endogenous money. Subsequent research has shown that most, if not all, hyperinflations are a purely monetary phenomena (causality from money to prices) caused by the central bank's efforts to monetize the government's budget deficits (causality from prices to money). This usually reflects a government's persistent efforts to maintain control over an increasing amount of real resources when higher taxes and public

borrowing are unavailable. Frenkel (1977) takes a closer look at the German hyperinflation and reaches a similar conclusion. Tang and Hu (1983) confirm this result for the Chinese hyperinflation, which is the focus of this paper.<sup>1</sup>

### 3. Test Procedures and Data

The hypothesis that the money supply process is endogenous is equivalent to the hypothesis that changes in the inflation rate cause changes in the money supply. This follows from the general causality model presented by Sims (1973), where a variable  $P$  is said to cause a variable  $M$  if the regression of  $P$  on values of  $M$  over time yields significant non-zero coefficients on future values of  $M$  tested as a group.

The variables  $P$  and  $M$  are taken to be a pair of linear covariance-stationary time series.

$$P_t = \sum_{j=-n}^m c_j M_{t-j} + U_t .$$
$$M_t = \sum_{j=-n}^m e_j P_{t-j} + V_t .$$

Note that  $(U_t, V_t)$  is a serially independent vector with zero mean and finite covariance matrix. The causality tests to be performed are

- (a)  $P$  causes  $M$  if  $H: c_j = 0, j = 1, \dots, m$ , is rejected;
- (b)  $M$  causes  $P$  if  $H: e_j = 0, j = 1, \dots, m$ , is rejected.

If both (a) and (b) hold, then there is "feedback" causation. In the present context  $P$  is the inflation rate and  $M$  is the money supply.

In view of the paucity of observations, the lag length is set at 4. Since every additional lag causes the loss of one more observation and adds regressors to the estimating equation, we avoid experimenting with longer lags. The data for the tests have been col-

<sup>1</sup>Causality tests, inspite of their popularity, have their share of critics. For a recent attack on econometric grounds, see Protopapadakis (1983), who points out that for the most part these tests are based on the "untested" assumption of a linear ARIMA model. Without this assumption, most results vanish, and in some cases are reversed. Our results must be interpreted with this caveat in mind.

lected from a variety of published and unpublished sources, not all of which is available in English.<sup>2</sup>

#### 4. Results

Table 1 presents *F*-statistics for the null hypotheses that there is no causal flow from the inflation rate (*P*) to the money supply (*M*), and that there is no causal flow from *M* to *P*. A high value of the *F*-statistic indicates that the hypothesis of "no causality" is rejected in the data, and a low value of the statistic leads to the opposite conclusion. The test statistic is reported for each of the three currency areas—mainland China, Taiwan, and Manchuria. For mainland China only, the results are reported for the sample period before the August 1948 currency reform as well as for the entire period.

TABLE 1. *F*-statistic for Tests of Granger Causality Between Money Supply (*M*) and Inflation Rate (*P*) During the Chinese Hyperinflation, 1946–49<sup>a</sup>

Currency Area and Period	Direction of Causality	<i>F</i> -Statistics
Mainland China		
Before Reform	$M \rightarrow P$	0.46
(January 1946–August 1948)	$P \rightarrow M$	1.25
Total Period	$M \rightarrow P$	12.91 <sup>c</sup>
(January 1946–May 1949)	$P \rightarrow M$	6.41 <sup>b</sup>
Taiwan		
Total Period	$M \rightarrow P$	0.72
(January 1946–May 1949)	$P \rightarrow M$	3.88 <sup>b</sup>
Manchuria <sup>d</sup>		
Total Period	$M \rightarrow P$	0.68
(January 1946–August 1948)	$P \rightarrow M$	13.67 <sup>c</sup>

NOTES:

<sup>a</sup>We used an ARIMA (1,1,1) model to pre-whiten the money supply and inflation series to transform these into a white-noise process.

<sup>b</sup>Significant at least at 10% level.

<sup>c</sup>Significant at least at 5% level.

<sup>d</sup>Manchuria fell to the forces of Mao Zedong in August 1948. No data are available after this period.

<sup>2</sup>The data used in this study may be obtained from authors on request. For information on data sources and variable definitions, see the appendix.

The preponderance of evidence favors the hypothesis of a uni-directional causal flow from the inflation rate to the money supply (endogenous money). This is true for all the three currency areas when the entire period is taken into consideration. However, a feedback relationship for mainland China is significant only after the post-reform period is included. This first result is consistent with Tang and Hu's (1983) findings. By splitting our sample for mainland China, we are able to gain the additional insight that before the reform no significant causal relationship had existed. The evidence suggests that the money supply process became endogenous only after the failed reform.<sup>3</sup>

## **5. Concluding Remarks**

We have tested for the hypothesis that the money supply process was endogenous during the course of the Chinese hyperinflation of 1946–1949. In the analysis, we account explicitly for the effects of the abortive currency reform of August 1948, and for the fact that three different currencies were affected simultaneously by the hyperinflation. For the entire sample period, money supply is found to be determined endogenously for mainland China, Taiwan, and Manchuria. This is best explained in terms of the civil war going on and the very limited assets in the hands of the government to finance war-related expenses. In fact, the Nationalist regime had a planned strategy of financing their war expenditures by printing money.<sup>4</sup> Finally, for mainland China only, a feedback re-

<sup>3</sup>For mainland China, the sample before August 1948 does not yield statistically significant results. The sample for the entire period, however, gives statistically significant results to support the two-way causality hypothesis. From this we can conclude that a feedback relationship existed in the post-reform period only if the increase in the value of the *F*-statistics is higher by several factors, which is the case here. Otherwise, the increase in the value of *F*-statistics may be attributed to the increase in the sample size. A referee has pointed out that the improvement in the statistical significance could be due to one of the following reasons: increased sample size, increased variation of the testing variables after the reform period, or two-way causality after the reform period. As far as which of the three it is, or whether it is all of them, it cannot be claimed without having the testing of the post-reform period only. We agree with this analysis and thank the referee for bringing this to our attention.

<sup>4</sup>Campbell and Tullock (1954) report that Mr. Kung, the finance minister in the Nationalist government wrote: "When Japan invaded China in 1937, China's monetary system was prepared for the emergency. . . . The new system enabled the government to rely on increase of bank credit as a means of emergency war finance."

lation, also found to be statistically significant after the post-reform period, is included. Part of the difference in the results among the currency areas can be explained by the fact that these regions faced different political and economic realities. First, the civil war and the accompanying loss of confidence in the government was peculiar to mainland China. Taiwan did not suffer directly from the civil war. Second, the monetary and fiscal regime existing in these currency areas was different. In particular, the currency reform of August 1948, which attempted to replace the existing currency by a new currency, the gold yuan, did not extend beyond Shanghai due to the limited power in the hands of the government to enforce the strict price controls. Because of these and other differences, the Chinese hyperinflation affected the three currency areas in varying degrees.

While interpreting the above results, several limitations of this analysis must be kept in mind. The causal relationship we have considered has to be distinguished from causality in the philosophical sense. Most tests of causality are based on temporal precedence across variables and do not constitute tests of causality in any stronger sense of the term. More importantly, the changes in our results for mainland China, as sample size was varied, may indicate that our assumption of a linear ARIMA model is inappropriate. This has been pointed out by Protopapadakis (1983) in his econometric critique of causality tests in general. Nevertheless, we believe that the results reported in this paper are fairly robust and they add to our knowledge of a historically important episode of monetary and financial crisis.

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## **Appendix**

The data has been collected from several sources. A number of these sources are unavailable in English. These include Wu (1958) and the *Shanghai Bank Weekly* (1917–1949). The sources in English are Chang (1958) and Chou (1963). However, both of these are currently out of print. The data for both the Chinese and English sources used here may be obtained from the authors on request.

The price index used for mainland China is the wholesale price index for Shanghai, which was the major financial center in prerevolutionary China. For Taiwan and Manchuria, the price indices of Taipei and Sheng-Yeung have been used respectively. The money supply measure in each case is the bank currency (roughly speaking M1) issued by the Bank of Taiwan and the Central Bank in Manchuria.