Money and the UK Economy: An Empirical Study

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AN EMPIRICAL STUDY

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The question of how changes in the money supply affect an economy has occupied economists for centuries. The origins of the debate on the effects of money on an economy can be traced to the writings of John Locke, Richard Cantillon, and David Hume, among others. Essentially, the key issue is which economic variables, such as prices, output and employment, do monetary changes affect. Two major opposing views can be readily identified: the monetarist and the Keynesian. The monetarist view is based, to a large extent, on the postulates of the Quantity Theory of Money, first outlined by classical economists of the 17th and 18th centuries. Money, according to the monetarists, has no lasting influence on any real variables in an economy (variables such as quantities of output produced, investment, and employment). Monetary changes will ultimately result in price changes only, leaving an economy's real output and employment unchanged. Keynesians, on the other hand, maintain that under conditions of unemployment, changes in the money supply can and do permanently change output and employment.

Theoretically two closely related issues exist. The first involves the question of whether monetary changes lead to changes in nominal output. Nominal output can be defined as prices of goods and services times the number of goods and services produced; i.e., the monetary value of these goods and services. Once this issue is resolved, it becomes essential to determine which part of nominal output monetary changes affect. Are prices alone affected (as monetarists claim to be the ultimate outcome)? Or does an increase in the supply of money lead to an increase in physical quantities of output and employment (the Keynesian position)? In other words, can an expansionary monetary policy reduce unemployment and increase output, or will it merely lead to inflation?
The flavour of the debate between the monetarists and the Keynesians over the importance of money in an economy can perhaps best be illustrated by a quote from each camp. Professor Milton Friedman, doyen of monetary economists, represented the monetarist view in these words:

We have accepted the quantity theory presumption, and have thought it supported by the evidence we examined, that changes in the quantity of money as such in the long run have a negligible effect on real income, so that nonmonetary forces are "all that matter" for changes in real income over the decades and money "does not matter." On the other hand, we have regarded the quantity of money, plus other variables (including real income itself) [..] as essentially "all that matter" for the long-run determination of nominal income.1

For Professor Friedman in particular and the monetarists in general, monetary forces determine nominal income or nominal output, but have no lasting influence over real output. In other words, according to the monetarists, monetary changes determine prices, but not the actual physical quantities of output. A simple example can clarify this point. Let us assume that the entire output of a simple economy consists of 10 automobiles. These automobiles cost £5,000.00 each. Therefore, the nominal output of this economy equals £50,000.00 (10 x £5,000.00). Let's further assume that the money supply is doubled, and that this increase in the money supply doubles all prices in this economy. The nominal output now equals £100,000.00 (10 x £10,000.00). This increase in the money supply doubled the nominal output, while leaving the real output unchanged, as this hypothetical economy still produces only 10 automobiles. Therefore, even though increases in the money supply determine nominal output (prices x physical quantities of output produced) by increasing prices, monetarists maintain that these increases in the stock of money have no influence over real output (the actual number of automobiles produced). It follows that if there are no additional automobiles produced, there is no increase in
employment generated.

Keynesians maintain that monetary changes can permanently affect real economic variables, such as employment and real output. According to the Keynesians, increases in the money supply decrease interest rates. Lower interest rates induce more investment and consumption. The increased investment and consumption expenditures generate an increase in the aggregate demand. This, in turn, causes an expansion in output and an increase in employment. The Keynesian position can best be illustrated by a quote from Keynes' *General Theory*:

\[\text{[...]} \text{we must first consider the effect of changes in the quantity of money on the quantity of effective demand; and the increase in effective demand will, generally speaking, spent itself partly in increasing the quantity of employment and partly in raising the level of prices.}\]

Consequently, according to Keynes, both prices and employment (and, therefore, the quantities of output) are affected by increases in the money supply.

These two theoretical positions on the effects of monetary changes are clearly irreconcilable. However, empirical research can shed some light on the validity of each of the two views. Statistical analysis of monetary and output data can provide empirical evidence in support of one of these views. The results of econometric tests designed to shed some light on these crucial economic issues are outlined and explained in the following section of this paper. The econometric analysis is confined to the data from the U.K. Because the details of the procedures used to analyze and test the data are somewhat complex, only a brief description of these procedures is given. The results of tests examining the role which money plays in determining the U.K. economy's output are outlined and interpreted in terms of monetary policy.
The Empirical Results: The Case of Money and Nominal Output

One way to empirically test the hypothesis that monetary changes determine nominal output is by statistically examining the money and nominal output relationship. In other words, the test can be structured to indicate whether changes in the money supply do not lead to (cause) changes in nominal output. The rejection of this hypothesis would indicate that monetary changes do lead to subsequent changes in nominal output. Therefore, in such a case, an expansionary monetary policy would lead to an increase in nominal output as the Keynesians claim.

A well-developed econometric method of testing causal relationships between economic variables is based upon the causality concepts outlined by Granger (1969). This method can indicate whether monetary changes lead to subsequent changes in nominal output, or vice versa.

To carry out tests determining the cause and effect relationship between money and nominal income (i.e., causality tests), appropriate measures of both of these variables had to be found. Consequently, the money supply was measured by the monetary base (BASE), essentially the actual amount of paper currency in circulation; while nominal income was indicated by the nominal gross domestic product (NGDP), a money value of all goods and services produced. To capture the effects of monetary expansion on nominal output in the 1970s and early 1980s, quarterly data from the first quarter 1970 to the fourth quarter 1984 were used for the estimation. This period is of particular interest since it is characterized by relatively high rates of growth of the money supply. The actual estimation procedure consisted of initially specifying relationships under consideration in mathematical equations.

Statistical procedures which examine the relationships between
variables rely on analyzing the impact of independent variables (such as the money supply) on the dependent variable (such as the nominal output). In this study these procedures indicate how well the past values of the money supply explain changes in nominal output. Therefore, in these tests it is necessary to decide how many past values of variables (time lags) will be used for each test. A critical issue in the causality testing of various economic data lies precisely in the method of selecting the time lags of the test variables. Many methods of testing causal relationships of economic variables rely on an arbitrary selection of the lag structure in their causality tests. The arbitrary selection of time lags may lead to unreliable results.

An alternative way of selecting the lag structure was outlined by Hsiao (1981) of Princeton University. Hsiao's method determines the number of lags through a relatively simple statistical procedure. This procedure is based upon a statistical criterion, rather than on an ad hoc selection of lags. This statistical criterion is the minimum final prediction error (FPE). Each FPE has a numerical value. Hsiao's procedure consists of calculating minimum FPEs for all test variables and basing economic judgements about relationships under investigations upon a comparison of the minimum FPE values. Given two economic variables, such as the money supply (BASE) and the nominal product (NGDP), the following relationships may exist:

1. changes in BASE can lead to subsequent changes in NGDP;
2. changes in NGDP can lead to subsequent changes in BASE;
3. BASE and NGDP can partially influence each another; or
4. BASE and NGDP can be determined independently of each another; i.e., they are determined by some other economic variables, such as
a government's fiscal policy, for example.

In the present study, Hsiao's causality technique is applied to the U.K. data. The minimum FPEs are calculated for each test equation. Inferences about the relationship between BASE and NGDP are made on the basis of comparing the FPEs so obtained. These inferences are essentially based upon a comparison of FPEs obtained in equations (1) and (2) and those reported for equations (3) and (4). Although the actual mathematical specifications of all estimated equations are not reported, their FPEs are reported in the last column of the Table. Generally speaking, given two variables such as NGDP and BASE as represented in equations (1) and (3), the inferences about the relationship between these two variables can be made by comparing the FPE obtained in equation (1) with that reported in equation (3). If the former exceeds the latter, then changes in BASE lead to subsequent changes in NGDP.10

There is evidence of changes in BASE (money supply) leading to changes in NGDP (nominal output). This is so because 0.4151 [FPE of equation (3)] is smaller than 0.4221 [FPE of equation (1)]. At the same time, it appears that changes in NGDP have no causal impact on BASE as 0.1358 [FPE of equation (4)] is greater than 0.1331 [FPE of equation (2)]. These results imply that changes in the monetary base lead to subsequent changes in nominal gross domestic product while at the same time there is no evidence of changes in nominal gross domestic product inducing any changes in the monetary base.

These results have very important economic implications. They indicate that increases in the monetary base can be expected to increase nominal gross domestic product. Therefore, an expansionary monetary policy will increase nominal output in the United Kingdom. These results support the
### Table

Causality Testing by Computing Final Prediction Error (FPE) of Economic Variables: U.K. Data from 1970I - 1984IV*

<table>
<thead>
<tr>
<th>Equation</th>
<th>Dependent Variable</th>
<th>First Independent Variable</th>
<th>Second Independent Variable</th>
<th>FPE x 10^-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>NGDP (3)</td>
<td></td>
<td></td>
<td>0.4221</td>
</tr>
<tr>
<td>2</td>
<td>BASE (8)</td>
<td></td>
<td></td>
<td>0.1331</td>
</tr>
<tr>
<td>3</td>
<td>NGDP (3)</td>
<td>BASE (2)</td>
<td></td>
<td>0.4151</td>
</tr>
<tr>
<td>4</td>
<td>BASE (8)</td>
<td>NGDP (1)</td>
<td></td>
<td>0.1358</td>
</tr>
<tr>
<td>Section II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RGDP (1)</td>
<td></td>
<td></td>
<td>0.2392</td>
</tr>
<tr>
<td>6</td>
<td>CPI (1)</td>
<td></td>
<td></td>
<td>0.1260</td>
</tr>
<tr>
<td>7</td>
<td>RGDP (1)</td>
<td>CPI (1)</td>
<td></td>
<td>0.2403</td>
</tr>
<tr>
<td>8</td>
<td>CPI (1)</td>
<td>RGDP (9)</td>
<td></td>
<td>0.1118</td>
</tr>
<tr>
<td>9</td>
<td>RGDP (1)</td>
<td>CPI (1)</td>
<td>BASE (1)</td>
<td>0.2471</td>
</tr>
<tr>
<td>10</td>
<td>CPI (1)</td>
<td>RGDP (9)</td>
<td>BASE (2)</td>
<td>0.1086</td>
</tr>
</tbody>
</table>

* Numbers in parentheses indicate the number of past quarters for each minimum FPE specification.
monetarist position with respect to the nominal output determination. They imply that monetary changes play an important causal role in the determination of nominal output in the United Kingdom.

Analysis of Effects of Monetary Changes on Prices and Real Output

The causality test results reported above provide important information about the causal flow in the money - nominal output relationship in the United Kingdom. The results imply that increases in the monetary base will lead to increases in nominal gross domestic product of the United Kingdom. However, these results do not indicate whether monetary changes affect only the price level, or only real output, or both the price level and real output. In other words, and within the framework of the previously described simple economy, it is not clear whether only the prices of automobiles will increase, or whether more automobiles will be produced. Finding an answer to this puzzle is even more important than merely establishing the existence of a cause and effect relationship between the money supply and nominal output.

The statistical procedure outlined above can be utilized to provide answers to the question of the effects of monetary changes on prices and real output. This procedure can be extended into a three variable framework for this purpose. Essentially, two additional variables must be found and statistically examined—one measuring inflation, the other indicating an economy's real output. The choice of the real output variable is obvious, as real output can be measured by the real gross domestic product (RGDP). Domestic inflation can best be indicated by the percentage changes in the consumer price index (CPI). Consequently, these two additional variables were used to measure the effects of monetary changes on the price level and real output.
The actual estimation procedure involved initially specifying the real output equation [equation (7)] and the inflation equation [equation (8)]. The minimum FPEs were computed in each case. Then the monetary base (BASE) was added to each of these equations [generating equations (9) and (10)] and again the minimum FPEs were calculated. As in the two-variable case, causality inferences can be made by comparing the FPEs so obtained.

Section II of the Table contains the estimation results. In particular, the last two rows of this table enable us to reach conclusions about the effects of monetary changes on prices and real output. There appears no empirical evidence indicating that monetary changes lead to changes in the real gross domestic product. This is so because $0.2471$ [FPE of equation (9)] is greater then $0.2403$ [FPE of equation (7)]. At the same time $0.1086$ [FPE of equation (10)] is less than $0.1118$ [FPE of equation (8)]. An interpretation of these statistical results is straightforward. The results imply that the major impact of monetary changes on nominal output operates through an increase in prices and not through an increase in the rate of growth of real output. Empirically, therefore, the results support the monetarists' long-run position with respect to the effects of monetary changes on the price level and real output.

Summary and Some Conclusions

This article empirically investigates the issue of the effects of monetary changes on an economy. Within this framework two separate but closely related issues are addressed. The first deals with the question of the effects of monetary changes on nominal output, while the other investigates the issue of which components of nominal output are affected by monetary changes. The initial test results indicate that changes in the money supply (as approximated by the monetary base) lead to subsequent
changes in the U.K. economy's nominal output (measured by nominal GDP). This result supports the monetarists' position on the nominal output determination. It, therefore, implies that monetary policy does play an important role in the nominal output determination in the United Kingdom.

An important contribution of this study is contained within its analysis of the effects of monetary changes on the price level and real output. Although numerous empirical studies provide useful information about the role of money as a causal force in the determination of nominal output, the resolution of the issue of the effects of monetary changes on the two components of nominal income is perhaps of even greater importance. For this reason the results of the tests involving the effects of the monetary base on prices and real output are crucially important. These results indicate that, contrary to conventional economic wisdom, monetary changes appear to have no impact on the real output of the United Kingdom economy. The test results indicate that the causal impact of monetary changes on nominal output operates through an acceleration of inflation, not through increases in the real output of the United Kingdom's economy.

Economic implications of the above reported results are clear. They imply that although an expansionary monetary policy does lead to an increase in the U.K. economy's nominal output, this increase can be entirely accounted for by price level increases and not (as commonly believed) by increases in real output and accompanying decreases in unemployment. Therefore, an expansionary monetary policy is ineffective in increasing real output and/or reducing unemployment. On the other hand, such monetary policy will lead to inflation.

One important economic policy lesson can be learned from this study: decision makers should resist the idea of "remedying" economic problems,
such as those of falling output and rising unemployment, by throwing money on these problems. The end result of such a policy will not be increased output, but the creation of yet another serious economic problem—that of inflation.
Notes


3. According to Granger (1969), given two variables X and Y, X causes Y if the prediction of Y (using the past values of X) is more accurate than without using them.

4. Given two variables X and Y, the most common Granger causality testing technique involves regressing past values of X and Y on Y and calculating corresponding F statistics. Causality inferences are made upon the basis of the significance of the F statistics so generated. Interested readers are referred to Sims (1972) and Guilkey and Salemi (1982) for detailed explanations of such tests.

5. All equations were estimated in the first differences of logarithms form. Initially the procedure consisted of estimating the following equations:

\[
\begin{align*}
NGDP_t &= a_0 + \sum_{j=1}^{3} a_j NGDP_{t-j} + \sum_{j=1}^{2} b_j BASE_{t-j} + U_t \\
BASE_t &= a_0 + \sum_{j=1}^{8} \alpha_j BASE_{t-j} + \beta_1 NGDP_{t-1} + V_t
\end{align*}
\]

where \( j \) refers to the number of previous quarters of each variable, \( t \) indicates the time period, and \( U_t \) and \( V_t \) are stochastic terms with all assumed properties.

6. These methods are statistical regression analyses. The main
objective of a regression analysis is to determine whether there exists an explanatory relationship between the dependent variable and the independent or explanatory variables.

7. For a detailed discussion of this point, see Hsiao (1981), Thornton and Batten (1985), and Biswas and Saunders (1986).

8. The final prediction error can be calculated as $(\text{SEE})^2 \cdot \frac{(T + K)}{T}$, where SEE is the standard error of the regression, $T$ is the number of observations, and $K$ is the number of parameters.

9. A detailed description of this procedure is beyond the scope of this paper. Interested readers are, therefore, referred to Hsiao (1981) for an in-depth outline of this procedure.

10. The overall causality implications are obtained by additionally estimating equations (2) and (4) and by comparing the FPEs so obtained.
References


