Is Money Neutral in the Long Run?

by

Burton A. Abrams
University of Delaware

and

Russell F. Settle
University of Delaware
“…there is no theory of monetary effects on the real economy that can explain protracted nonneutrality.” (Bernanke, 1983)

Introduction.

The long-run neutrality of money—the proposition that a change in the money supply or a change in the steady-state growth rate for the money supply affects nominal variables without changing long-run equilibrium real variables—is a generally accepted theoretical proposition. The theoretical underpinnings for this proposition are demonstrated perhaps most clearly in various versions of the neoclassical model. Recent empirical work has explored issues concerning the non-neutrality of money in the short run. Money and real economic activity are correlated over the business cycle and various studies have attempted to determine whether this correlation runs from money to real variables or arises from endogenous growth in the money supply (King and Plossner (1984), Freeman and Huffman (1991) and Freeman and Kydland (2000)), or perhaps stems from nominal rigidities found in the economy (Ireland (2003)). In contrast to the conventional wisdom concerning money neutrality, we develop a model that suggests that money is not neutral in the long run. Expanding upon the work by Bernanke and Blinder (1988) for a closed-economy model, we add a market for bank loans to an open-economy neoclassical model. Notably, we find that the neutrality of money continues with respect to outside money, but is no longer neutral with respect to changes in inside money arising from changes in the money multiplier. This finding suggests possible explanations for statistical findings that economic activity correlates most strongly to changes in inside
money (King and Plossner, 1984) and for paradoxes regarding deviations of real exchange rates from those predicted by traditional models.

**The Neoclassical Model.**

For comparison purposes, we begin with the small, open economy neoclassical model (with four equations and four unknowns) that assumes perfect capital mobility in bonds. The four equations are (with signs for partials given above the equations):

\[ E(y, i, \varepsilon) = y \] \hspace{1cm} (1)

\[ L(y, i, \beta) = (mxB)/P \] \hspace{1cm} (2)

\[ i = i^* \] \hspace{1cm} (3)

\[ y = y^* \] \hspace{1cm} (4)

The four unknowns in the model are real output, \( y \), the real interest rate \( i \), the real exchange rate, \( \varepsilon \), and the price level, \( P \). Equation (1) describes the equilibrium for the goods market whose demand, \( E \), is a function of real income, the real interest rate and the real exchange rate. The real exchange rate here is defined as:

\[ \varepsilon = E \times (P/P_f) \] \hspace{1cm} (5)

Where, \( E \), is the nominal exchange rate, the number of units of foreign currency that are exchangeable for one unit of the domestic currency. \( P \) and \( P_f \) are the domestic and
foreign price levels. A rise in $\varepsilon$ represents a real appreciation of the domestic currency, decreasing real net exports and reducing real goods demand.

Equation (2) represents the equilibrium in the market for money. The real demand for money, $L$, is assumed to be a function of real income and the real interest rate. The variable, $\beta$, is an exogenous shock variable to be discussed later. The money supply is a Brunner-Meltzer type, composed of the product of a money multiplier, $m$, and the monetary base, $B$. The money supply is assumed to equal the sum of currency in circulation, $C$, plus bank deposits, $D$. Dividing the money supply by the price level, $P$, puts the money supply into real terms. We assume the following for the money multiplier:

$$m = \frac{(1+c)}{(r + e + c)} \quad (6)$$

Where, $c$ is the currency to deposit ratio $(C/D)$, $r$ is the required reserve ratio and $e$ is the desired excess reserve ratio ($(\text{desired excess reserves})/ D)$. We assume that the three variables determining the money multiplier are exogenous.\(^2\)

Equation (3) indicates the balance of payments equilibrium condition that the domestic interest rate on bonds equals the world interest rate, $i^*$. Equation (4) indicates the labor market equilibrium condition that real output equals $y^*$. The model reduces to two equations ((1) and (2)) with two unknowns, $P$ and $\varepsilon$. Inspection of equation (2) reveals that, absent an exogenous change in $y^*$, $i^*$, or the demand for money, the real money supply is fixed. This yields the classical neutrality of money; any change in the

\(^2\) Given the fixed interest rate assumption, discussed below, this assumption is reasonable.
money supply is met with a change in the price level that keeps the real money supply and all other real variables in the model unchanged.

A Neoclassical Credit-View Model.

Following, Bernanke and Blinder (1988), we add a market for bank loans and assume that loans are imperfect substitutes for bonds. We further assume that while bonds are traded internationally, loans are not. The loan market has its own interest rate, \( \rho \), that enters the equation for loan market equilibrium and also becomes an argument in the goods demand equation. Following Burger (1969), bank credit (BC), the dollar amount of non-reserve assets that the bank may acquire, equals:

\[
BC = (m - 1) \times B \quad (7)
\]

The loan market equilibrium is written:

\[
\mathcal{L}(y, i, \rho, \gamma) = \lambda(i, \rho, \alpha)(m - 1) \frac{B}{P} \quad (8)
\]

Where, the real demand for loans, \( \mathcal{L} \), is a function of real income, the real interest rate on bonds and the real interest rate on loans. Real loan supply depends on the nominal supply of loans divided by the price level. The nominal supply of loans is determined by the percentage of bank earning assets (non-reserve assets) that are allocated towards loans, \( \lambda \), multiplied by the total amount of bank credit, \((m-1)B\). The variables, \( \alpha \) and \( \gamma \), are exogenous shock variables to be discussed later. The goods market equilibrium equation is now:
The model now consists of the five equations (2), (3), (4), (8) and (9). Endogenous variables are \( y, i, P, \varepsilon \), and \( \rho \). Again, the real interest rate on bonds is set by the international capital market and real output is fixed at the level consistent with full employment in the labor market. The model reduces to three equations, (2), (8) and (9), with three endogenous variables, \( \rho \), \( \varepsilon \), and \( P \).

**Comparative Static Findings.**

Table 1 provides the major comparative static findings of the neoclassical model incorporating our version of the credit view. Mathematical proofs can be found in an appendix available from the authors. The model indicates that money is neutral if money shocks are caused by monetary base changes; that is, changes in the monetary base have no effect on equilibrium real variables. Effects of changes in the money supply arising from money multiplier changes are more complex. In contrast to the traditional neoclassical model, an autonomous change in the money multiplier (\( m \)) now causes a change in the real exchange rate and in the real interest rate on loans. An autonomous rise in the multiplier (caused by a fall in the currency-to-deposit ratio, for example) lowers the interest rate on loans and appreciates the currency. Inspection of equation (2) reveals that changes in the nominal money supply, either arising from changes in the monetary base or in the money multiplier, will have no effect on the real money supply. In keeping with the traditional neoclassical model, changes in the money supply cause proportional changes in the price level.
Also novel to this model is the result that an autonomous shift ($\alpha$) in the percent of bank earning assets allocated to loans affects the real exchange rate. For example, if banks autonomously increase the share of assets allocated to loans, the loan rate falls. To maintain goods-market equilibrium (eqn. 9) the currency must appreciate. Conversely, an autonomous increase in loan demand ($\gamma$) raises the loan interest rate and requires a depreciation in the currency for goods-market equilibrium.

Also in contrast to the standard neoclassical model, autonomous changes in the demand for money produce real effects on non-monetary variables. A rise in money demand would appreciate the currency while decreasing the interest rate on loans.

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**Table 1. Comparative Static Findings**

<table>
<thead>
<tr>
<th>Effect on Endogenous Variable</th>
<th>Autonomous Increase in:</th>
<th>Bank Loans</th>
<th>Money Demand</th>
<th>Goods Demand Financed with Bonds</th>
<th>Multiplier</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varepsilon$</td>
<td>($\alpha$)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>$\rho$</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>$P$</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>
Concluding Remarks.

We have shown that incorporating a credit channel into the standard neoclassical open-economy model provides a variety of new testable hypotheses concerning the non-neutrality of the money supply and the determinants of the real exchange rate. In particular, we find that money neutrality is rejected when money supply shocks originate with the money multiplier. The novel feature of the model presented in this paper is that it includes two earning assets: one tradable (bonds) and the other non-tradable (loans).

References


Ireland, P. N., “Endogenous Money or Sticky Prices?” *Journal of Monetary Economics*, 50 (2003), 1623-1648

MATHEMATICAL APPENDIX

Our model is:

\[ E( y^*, i^*, \rho, \varepsilon, \gamma) = y^* \]  \hspace{1cm} (A-1)

\[ L( y^*, i^*, \beta) = (mB)/P \]  \hspace{1cm} (A-2)

\[ L( y^*, i^*, \rho) = \lambda (i^*, \rho, \alpha) (m - 1) B/P \]  \hspace{1cm} (A-3)

The * indicates that a variable is fixed in markets outside this 3-equation version of the model. The three endogenous variables are \( \rho, \varepsilon, \) and \( P \). The explicit autonomous shift parameters are \( \alpha, \beta, \) and \( \gamma \) (see the text for further details about these parameters). Other shift parameters not of direct interest are suppressed for convenience.

Totally differentiating the above three equations (and ignoring \( y^* \) and \( i^* \) which we take as constant for this analysis), we obtain:

\[ E_\rho d\rho + E_\varepsilon d\varepsilon = -E_\gamma d\gamma \]

\[ P^2 mB dP = -L_\beta d\beta + BP^{-1} dm + mP^{-1} dB \]

\[ (\mathcal{L}_\rho - (m - 1)BP^{-1} \lambda \rho) d\rho + \lambda P^{-2}(m-1)B dP = \]

\[ (m - 1)BP^{-1} \lambda d\alpha - L_\gamma d\gamma + \lambda BP^{-1} dm + \lambda (m-1)P^{-1} dB \]

A. Proof that \( d\varepsilon/d\alpha > 0 \)

The numerator matrix for \( d\varepsilon/d\alpha \) is:
The numerator expression implied by the above matrix is:

\[-(m-1)BP^{-1} \lambda_{\rho} mBP^{-2} E_{\rho} > 0.\]

Therefore, \(d\varepsilon/d\alpha = -[(m-1)BP^{-1} \lambda_{\alpha} mBP^{-2} E_{\rho}] / D \)

For applying Cramer's rule, the denominator, D, for \(d\varepsilon/d\alpha\) is:

\[
\begin{vmatrix}
E_{\rho} & E_{\varepsilon} & 0 \\
0 & 0 & mBP^{-2} \\
\mathcal{L}_{\rho} - (m-1)BP^{-1} \lambda_{\rho} & 0 & \lambda (m-1)BP^{-2}
\end{vmatrix}
\]

Or,

\[D = E_{\varepsilon}(mBP^{-2}) \begin{vmatrix}\mathcal{L}_{\rho} - (m-1)BP^{-1} \lambda_{\rho}\end{vmatrix} > 0\]

Therefore, \((d\varepsilon/d\alpha) > 0\); that is, an autonomous increase in bank loans relative to other bank assets causes an appreciation in the real exchange rate.

**B. Proof that \(d\varepsilon/dm > 0\)**
The numerator matrix for \( \frac{d\varepsilon}{dm} \) is:

\[
\begin{bmatrix}
E_{\rho} & 0 & 0 \\
0 & BP^{-1} & mBP^{-2} \\
\mathcal{L}_{\rho} - (m-1)BP^{-1} \lambda_{\rho} & \lambda BP^{-1} & \lambda (m-1)BP^{-2}
\end{bmatrix}
\]

This translates into:

\[
E_{\rho} BP^{-1} \lambda (m-1)BP^{-2} - E_{\rho} \lambda BP^{-1} mBP^{-2} = -E_{\rho} B^3 P^3 \lambda > 0
\]

Therefore, \( (d\varepsilon/dm) = \frac{-(E_{\rho} B^3 P^3 \lambda)}{D} > 0 \),

since \( D > 0 \). So, an increase in the multiplier, \( m \), causes the real exchange rate to appreciate in our model.

**C. Proof that \( d\varepsilon/d\beta > 0 \)**

The numerator matrix for \( d\varepsilon/d\beta \) is:

\[
\begin{bmatrix}
E_{\rho} & 0 & 0 \\
0 & -L_{\beta} & mBP^{-2} \\
\mathcal{L}_{\rho} - (m-1)BP^{-1} \lambda_{\rho} & 0 & \lambda (m-1)BP^{-2}
\end{bmatrix}
\]
This translates into:

\[-E \rho L_\beta \lambda (m-1)BP^2 > 0\]

Therefore, \(d\varepsilon/d\beta = [-E \rho L_\beta \lambda (m-1)BP^2]/D > 0\).

**D. Proof that \(d\varepsilon/d\gamma > 0\) when change in \(E\) is bond financed.**

The numerator matrix for \(d\varepsilon/d\gamma\) is:

\[
\begin{pmatrix}
E \rho & -E \gamma & 0 \\
0 & 0 & mBP^{-2} \\
L \rho - (m-1)B^{-1} \lambda \rho & 0 & \lambda (m-1)B^{-1} \lambda \rho
\end{pmatrix}
\]

This matrix translates into:

\[-E \gamma mBP^{-2} (L \rho - (m-1)B^{-1} \lambda \rho) > 0.\]

**E. Proof that \(d\varepsilon/dB = 0\).**

\[
\begin{pmatrix}
E \rho & 0 & 0 \\
0 & mP^{-1} & mBP^{-2} \\
L \rho - (m-1)B^{-1} \lambda \rho & \lambda (m-1)P^{-1} & \lambda (m-1)B^{-1}
\end{pmatrix}
\]

This translates into:

\[E \rho \ mP^{-1} \lambda (m-1)BP^{-2} - E \rho \ \lambda \ mP^{-1} (m-1)BP^2 = 0\]
Therefore, $\text{d}e/\text{dB} = 0/D = 0$

**F. Proof that $\text{d} \rho / \text{d} \beta < 0$**

The numerator matrix for $\text{d} \rho / \text{d} \beta$ is:

\[
\begin{pmatrix}
0 & E_{\epsilon} & 0 \\
-L_{\beta} & 0 & \text{mBP}^2 \\
0 & 0 & \lambda (m-1)\text{BP}^2
\end{pmatrix}
\]

This translates into:

$E_{\epsilon} L_{\beta} \lambda (m-1)\text{BP}^2 < 0$. Therefore, $\text{d} \rho / \text{d} \beta = [E_{\epsilon} L_{\beta} \lambda (m-1)\text{BP}^2]/D < 0$. 