We develop a structural vector-auto-regression (SVAR) model to test for long-run super-neutrality when money growth may be endogenous. An identified exogenous permanent increase in inflation is estimated to have a positive and statistically significant long-run effect on output for the United States. This finding rejects superneutrality in favor of a Mundell-Tobin effect. We further show that previous approaches which treated money growth as exogenous resulted in downwardly-biased estimates of the output effects from permanent increases in inflation. Our overall conclusion is that Mundell-Tobin effects are likely more prevalent than was once perceived.

**Abstract**

• Based on Friedman’s famous dictum that a permanent movement in “inflation is always and everywhere a monetary phenomenon” we equate inflation and money growth.

• We use long-run restrictions to identify structural shocks to technology and inflation in a three-variable SVAR consisting of the natural log of output per hour, inflation, and the natural log of output.

• We estimate this model on quarterly US data over multiple sample periods and study the long-run responses to technology and inflation shocks.

• We focus on the long-run inflation response to productivity shocks (i.e. endogenous money growth) and the long-run output response to inflation shocks (super-neutrality vs. Mundell-Tobin).

**Baseline SVAR Model: Long-run Responses**

Table 1: Long-Run Inflation Response to a 1 pp. Productivity Shock

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<tbody>
<tr>
<td>Point Estimate</td>
<td>-0.04</td>
<td>-0.04</td>
<td>-0.30</td>
<td>-0.27</td>
</tr>
<tr>
<td>90% Error Band</td>
<td>(-0.46, 0.38)</td>
<td>(-0.35, 0.25)</td>
<td>(-0.66, 0.06)</td>
<td>(-0.47, 0.04)</td>
</tr>
</tbody>
</table>

Estimates from a 3 variable model with \( \Delta \ln(y_t) \), \( \Delta \ln(p_t) \) that allows for the Federal Reserve to endogenously respond to changes in productivity

** Main Findings **

• We estimate that technological improvements generally lead to permanent reductions in inflation, suggesting that money growth is in fact endogenous (Table 1).

• The endogeneity of low-frequency inflation to productivity is consistent with the Federal Reserve’s productivity misperceptions in the 1970’s and the growth gamble in the 1990’s.

• After accounting for the endogenous response of long-run inflation to productivity changes, we estimate that exogenous permanent increases in inflation increase output, consistent with Mundell-Tobin effects (Table 2).

• In samples that money growth is endogenous, the long-run output response to a permanent increase in inflation is biased downward in a bi-variate SVAR consisting only of inflation and output (Figure 1).

**Endogenous vs. Exogenous Money Growth**

![Output Response to 1 pp. Inflation Shock](sample-image.png)

**Table 2: Long-Run Output Response to a 1 pp. Inflation Shock**

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<tbody>
<tr>
<td>Point Estimate</td>
<td>0.41**</td>
<td>0.59**</td>
<td>0.56**</td>
<td>0.62**</td>
</tr>
<tr>
<td>90% Error Band</td>
<td>(0.12, 0.69)</td>
<td>(0.23, 0.79)</td>
<td>(0.09, 0.14)</td>
<td>(0.15, 1.10)</td>
</tr>
</tbody>
</table>

Estimates from a 3 variable model with \( \Delta \ln(y_t) \), \( \Delta \ln(p_t) \) that allows for the Federal Reserve to endogenously respond to changes in productivity

** ** Zero is excluded from the 90% error band

* Zero is excluded from the 68% error band