Additional Thoughts on the Determination of Interest Rates in General and Partial Equilibrium

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Abstract

Bill Yang and Mark Yanochik, hereafter Y&Y, raise two main concerns in their comment [Yang and Yanochik, 2005] on our paper [Fields & Hart, 2003(a)]. The first is that our use of the long-run Classical model to analyze the liquidity preference (LP) and loanable funds (LF) approaches to interest rate determination is questionable because we “inconsistently” take the price level as given. The second is that we have failed to answer the primary question that Y&Y allege we raise in our paper. Specifically, the allegation is that we did not answer the question of which approach, LP or LF, should be used to determine the interest rate. We consider each of these points in turn.

Inconsistency in Using the Classical Model

Y&Y begin by questioning our demonstration that the “short-run partial-equilibrium” response of the interest rate (r) to a change in the money supply depends on whether r adjusts to clear the money market or the market for loanable funds. Their argument is that in taking price level (P) as given we violate the classical dichotomy and hence the neutrality of money embedded in the flexible-price Classical model that serves as the basis for our demonstration. However, we did no such thing. What we did do in our paper was to trace out the initial (or partial equilibrium) effect of a rise in the money supply (M) on the interest rate in a manner consistent with the stories typically told in macroeconomic textbooks. We fully agree that in the flexible-price, fixed-output Classical model, the price level is determined exclusively in the money market and the (real) interest rate is determined exclusively in the market for Loanable Funds. And, as Y&Y demonstrate, what this means is that a doubling of M in the Classical model has the effect of doubling P while leaving r unchanged.³ Similarly, we agree that the “...Classical model is not appropriate to discuss the short-run determination and behavior of interest rates.” But there is an enormous difference between an analysis of the short run (a period of time in which prices are sticky) and an analysis of the dynamics of the adjustment process by which an increase in M gets transmitted to a rise in P in the Classical model. It was the latter that we had in mind in our discussion of how a change in M impacts the interest rate.

And what is the story that textbook authors typically tell when analyzing the dynamics of the long-run impact of a rise in M on the economy? The answer is that the rise in M first lowers the interest rate in the money market. Then, the lower interest rate raises investment, hence aggregate demand, which creates an excess demand for goods that causes P to rise. Sequentially, the story is:

\[ \uparrow M \implies \text{excess supply of money} \implies \downarrow i \implies \uparrow y_d \implies y^* \implies P \uparrow \]

Our alternative is the following:

\[ \uparrow M \implies \text{excess supply of loanable funds} \implies \downarrow i \implies \uparrow y_d \implies y^* \implies P \uparrow \]

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³ This conclusion suggests that, in analyzing the long run, authors of macro texts should move away from the standard AD-AS model in which P clears the goods market (and r is determined behind the scenes in the money market) and adopt instead a “real business cycle” type model in which the AD-AS curves are plotted against the (real) interest rate while money demand and supply curves are plotted against P.
⁴ This rise in P does not actually clear the goods market (although many texts give this impression). Instead, the rise in P reduces the real money supply, causing r to rise in the money market. It is this rise in r that causes the aggregate quantity of goods demanded to fall as the economy adjusts along the AD curve back to equilibrium. So, even here we see that it is the interest rate that is clearing the goods market (something else that many texts do not make clear to students). For a more complete discussion, see Fields and Hart [2003b].
Notice that in both stories P is initially held constant. This is simply a heuristic device that allows one to observe and enumerate the excess supplies and demands that arise in the various markets before P is allowed to change, thus returning all endogenous variables to their new general equilibrium values. In no way is this equivalent to invalidating the classical dichotomy or denying the long-run neutrality of money.

Having said this, we reiterate that Y&Y are correct when they state that r is determined exclusively in the loanable funds market in the long run. Consequently, a short-run model in which the price level is fixed might be a more appropriate vehicle for evaluating the relative merits of the LP and LF approaches to interest rate determination.

What Should Be the Preferred Approach to Interest Rate Determination

Y&Y criticize us for not answering a question allegedly posed in our paper. Specifically, they state: “...[Fields and Hart] have not really answered their own question: Which model between the LF and LP approaches should be used for interest rate determination in partial equilibrium analysis?” Y&Y’s claim notwithstanding, we never actually posed this question. Instead, we demonstrated that the LP and LF approaches imply different interest rates when the economy is out of general equilibrium. We then argued for consistency in the textbook treatment of interest rate determination—that is, use one approach or the other but not both. Y&Y have, nonetheless, added an important contribution in their answer to the “which approach is better?” question, although we are not in complete agreement with their answer.

Y&Y argue that the choice of a market for analyzing changes in the interest rate depends, in part, on whether the relevant horizon is the short run or the long run. In the long run, in which prices are flexible and output is constant, they argue that the LF approach is the natural one to use. We agree completely. As Y&Y make clear: “...in the long run it is the price level and not the interest rate that adjusts to clear the money market.” Stated somewhat differently, “...the interest rate is determined exclusively in the LF market...”. Then, for the short run, the answer given by Y&Y to the “which approach is better?” question is: “…the choice between the LP and LF models should be consistent with the corresponding curve shifting in the [fixed price] IS-LM model.” In other words, when the shock is purely nominal (e.g., a change in the money supply that shifts the LM curve) Y&Y argue for the LP approach to interest rate determination. However, when the shock arises in the real sector (i.e., something that shifts the IS curve) they argue that the LF approach is preferable.

Y&Y thus argue for consistency based on 1) the relevant time horizon and 2) the origin of the shock. We, on the other hand, argue for consistency in terms of which approach is used. To restate a point we made in our paper: “Either the interest rate is determined in the money market or the loanable funds market but not both.” Clearly, the taxonomy proposed by Y&Y does not meet this consistency test. According to their criteria, the interest rate would sometimes be determined in the money market (shocks to the LM) and sometimes in the loanable funds market (shocks to IS and for long-run analysis). Given this, one might reasonably pose the following question to Y&Y: by which approach, LP or LF, would the interest rate be determined when there is a money-financed rise in government purchases that shifts both the IS and the LM curve simultaneously? 5

By contrast, our preference is to pick an approach and stick with it. And, since the interest rate is determined in the market for loanable funds in the long run, it makes sense to assume that it is determined in this market in the short run as well. Moreover, given that the price level is ultimately determined in the money market, any excess supply of money balances created by a rise in M in the short run (when P is fixed) will spill directly over to the market for loanable funds creating an excess supply there. Thus, to the extent that a change in M affects r in the short run it will be via its impact on the loanable funds market. A similar argument applies to real shocks. What this means for short-run, sticky price analysis is the addition of a separate and distinct loanable funds market to the standard textbook IS-LM model, the purpose of which is to capture the impact of both nominal and real shocks on the interest rate. In the following sections, we incorporate the market for loanable funds into the sticky-price, short-run IS-LM model and then compare our preferred approach to interest rate determination with that proposed by Y&Y.

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5 This taxonomy strikes us as problematic for yet another reason. The equilibrium conditions for the goods market \[y = c(y-t) + i(r) + g\] and the loanable funds market \[s(y-t) = i(r) + (g-y)\] are one and the same only when there is no spillover from the money market, something that we believe is highly unlikely in the short run with sticky prices. Once spillover from the money market is allowed, the loanable funds market and the goods market are separate and distinct. See Fields and Hart [2003b]. So when these two markets diverge, does the interest rate adjust to clear the goods market or the loanable funds market? Given Y&Y’s emphasis on the IS curve, we find it reasonable to interpret their preferred approach
The Fixed-Price IS-LM-LFM Model

The standard textbook IS-LM model incorporates two markets: the goods market and the money market. Equilibrium in the goods market occurs when aggregate demand equals output, or:

\[ y = c(y-t) + i(r) + g, \]  

where \( y \) is real output, \( c(y-t) \) is desired consumption, \( t \) is taxes, \( i(r) \) is desired investment, \( r \) is the interest rate, and \( g \) is government expenditures. Equilibrium in the money market occurs when the real money supply, \( m_1^r = M_1/P_1 \), equals real money demand, \( m_1^d(y,r) \), or:

\[ m_1^r = m_1^d(y,r). \]

To these two markets, we introduce a third—the market for loanable funds. Equilibrium in the loanable funds market occurs when the supply of loanable funds, \( LFs \) \{i.e., desired saving, \( s(y-t) \), plus the excess supply of money, \( m_1^r - m_1^d(y,r) \}\), equals the demand for loanable funds, \( LFd \) \{i.e., investment, \( i(r) \), plus the government deficit, \( g-t \)\}. Algebraically, this equilibrium condition is:

\[ s(y-t) + [m_1^r - m_1^d(y,r)] = i(r) + (g-t). \]

The slopes of the IS, LM, and LFM curves are:

(IS): \[ \frac{dr}{dy} = \frac{(1-c_y)}{i_r} < 0, \]

(LM): \[ \frac{dr}{dy} = \frac{-m_1^d}{m_1^d} > 0, \]

(LFM): \[ \frac{dr}{dy} = \frac{s_y - m_1^d}{i_r + m_1^d} = ? \]

Figure 1 depicts the standard IS and LM curves coupled with the LFM curve. The IS curve represents the combinations of \( r \) and \( y \) that yield equilibrium in the goods market, and the LM curve represents the combinations of \( r \) and \( y \) that make the real money supply equal to real money demand. The LFM curve, by contrast, shows the combinations of \( r \) and \( y \) that yield equilibrium in the loanable funds market. If we assume \( s_y > m_1^d \), then the slope of LFM is negative\(^7\) and smaller (in absolute value) than the slope of the IS curve.\(^8\)

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\(^6\) Where: \( c_y \) is the marginal propensity to consume, \( i_r \) the interest responsiveness of investment, \( m_1^d \) the income responsiveness of money demand, \( m_1^d \) the interest responsiveness of money demand, and \( s_y \) the marginal propensity to save. As is well known, \( 0 < c_y < 1, i_r < 0, m_1^d > 0, m_1^d < 0, 0 < s_y < 1. \)

\(^7\) This seems a reasonable assumption for the short-run case in which fluctuations in \( y \) are temporary deviations from the long-run equilibrium level of output, \( y^* \). In this case, the permanent income hypothesis implies a relatively large (i.e., close to 1) value for the marginal propensity to save and a relatively small (close to 0) value for the marginal propensity to consume.

\(^8\) If \( s_y < m_1^d \) so that the LFM curve is positively sloped, it will be flatter than the LM curve.
The initial (short-run) equilibrium is at point A where the interest rate is $r_3$ and output is $y_1$. Since the economy is on the LM curve, the excess supply of money is zero and there is no spillover to the loanable funds market. Absent such a spillover, the goods and loanable funds markets are identical. This explains why the loanable funds market simultaneously equilibrates at any $r$-$y$ combination which also clears the money and goods market.\footnote{The standard IS-LM model admits of no spillover from the money market to the loanable funds market and thus has no need for the LFM curve.}

**Consistency in the Approach to Interest Rate Determination**

To compare our preferred approach to interest rate determination with that of Y&Y, we consider the effects of three shocks: (1) an increase in the money supply; (2) a bond-financed rise in government expenditures; and (3) a money-financed rise in government expenditures.

**An Increase in the Money Supply**

Suppose the economy is initially in (short-run) equilibrium at point A in Figure 2 where the interest rate is $r_3$ and output is $y_1$. Now suppose that there is an increase in the nominal money supply from $M_1$ to $M_2$ that increases the real money supply from $m^e_1 = M_1/P_1$ to $m^e_2 = M_2/P_1$. This rise in $m^e$ shifts the LM and LFM curves down and right to LM$_2$ and LFM$_2$, respectively. The IS curve is unaffected. The new short-run equilibrium is at point D where LM$_2$ and LFM$_2$ intersect the IS curve. Our concern, however, is not with the final equilibrium interest rate, $r_1$, since the LP and LF approaches both imply this interest rate. Instead, we are interested in the partial equilibrium impact of the rise in $m^e$ on $r$, which, in turn, depends on the model that one assumes to be appropriate. More precisely, the partial equilibrium impact on $r$ is determined by the vertical shift of the LM curve in the LP approach and by the vertical shift in the LFM curve in the LF approach. Notice that, in Figure 2, the vertical shift in the LM curve tells us how much $r$ must fall to restore equilibrium in the money market at the initial level of output, $y_1$. The vertical shift in the LFM curve, by contrast, indicates how much $r$ must fall to restore equilibrium in the loanable funds market at the initial level of output, $y_1$. Therefore, if $r$ clears the money market, the interest rate falls from $r_3$ to $r_0$ at point B in Figure 2. However, if $r$ clears the loanable funds market, the interest rate falls only from $r_3$ to $r_2$ at point C.\footnote{Mathematically, the initial partial equilibrium impact on $r$ in the LP and LF approaches is:} This divergence in outcomes between the LP and LF approaches was the primary point of our original paper.

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\textbf{Figure 2}
A Bond-Financed Rise in g

Consider now a real shock, say a bond-financed rise in government expenditures. As before, the initial (short-run) equilibrium is at point A in Figure 3 given by the intersection of the IS and LM and LMF curves. The interest rate is r₃, and output is y₁.

A bond-financed rise in g from g₁ to g₂ shifts both the IS and LFM curves up and to the right. The LM curve is unaffected. The new short-run equilibrium position is at point D where LFM₂ and IS₂ intersect the LM curve. In this case, the vertical shifts in the IS and LFM curves determine the partial equilibrium effect on the interest rate.

The vertical shift in the IS curve tells us how much r must rise to restore equilibrium in the goods market at the initial level of output, y₁. The vertical shift in the LFM curve indicates how much r must rise to restore equilibrium in the loanable funds market at the initial level of output, y₁. If, as Y&Y apparently prefer, r adjusts to clear the goods market,¹¹ the interest rate rises from r₃ to r₆ at point B in Figure 2. If, as we prefer, r clears the loanable funds market, the interest rate rises from r₃ to r₅ at point C.¹²

A Money-Financed Rise in g

Finally, consider a shock that simultaneously affects the real and financial sectors, say a money-financed rise in government expenditures. As before, the initial (short-run) equilibrium is at point A in Figure 4 given by the intersection of the IS and LM and LMF curves. The interest rate is r₃, and output is y₁. Now suppose that there is a rise in government expenditures from g₁ to g₂ financed by an increase in the real money supply from m₁ to m₂. In this case, the IS curve shifts up and to the right while the LM curve shifts down and to the right. The LFM curve, by contrast, remains stationary at its initial position. This is because the rise in m to finance the higher level of g increases the supply of loanable funds by exactly the same amount that the rise in g increases the demand for loanable funds (i.e., ∆LF = ∆m = ∆g = ∆LFₜ). This means that the demand for and supply of LF remain in balance so that no change in r is required to restore equilibrium at the initial level of output, y₁. The new short-run equilibrium is at point D where IS₂ and LM₂ intersect the stationary LFM curve.¹³ As before, the vertical shifts in the IS, LM, and

\[
\frac{dr}{dm} \bigg|_{LM} \frac{r_1}{m^d} = \frac{1}{m^d} < 0 \quad \text{when } r \text{ is determined in the money market, and} \quad \frac{dr}{dm} \bigg|_{LM} \frac{r_1}{m^d} = \frac{1}{m^d + l} < 0 \quad \text{when } r \text{ is determined in the loanable funds market.}
\]

¹¹ See footnote 4.

¹² Mathematically, the partial equilibrium impact on r in the goods market (IS) and loanable funds (LF) approaches is:

\[
\frac{dr}{dg} \bigg|_{IS} \frac{r_1}{l} = -\frac{1}{l} > 0 \quad \text{when } r \text{ is determined in the goods market, and} \quad \frac{dr}{dg} \bigg|_{LF} \frac{r_1}{l + m^d} > 0 \quad \text{when } r \text{ is determined in the market for loanable funds.}
\]

¹³ The equilibrium interest rate, r₂, is less than r₁ because the LFM curve is negatively sloped. If the LFM curve were positively sloped (i.e., if s, < m₁^d) the short-run equilibrium interest rate would be greater than r₁.
LFM curves determine the change in $r$ under alternative approaches to interest rate determination. If $r$ adjusts to clear the goods market, the partial equilibrium impact will be to raise the interest rate from $r_3$ to $r_4$ (point A to point B) in Figure 4. If $r$ adjusts to clear the money market, then the interest rate falls from $r_3$ to $r_1$ (point A to point C) in Figure 4. Finally, if $r$ is determined in the market for loanable funds, there will be no change in the interest rate.

**Conclusion**

Table 1 summarizes the partial equilibrium impact on the interest rate based on Y&Y’s preferred approach to interest rate determination versus our preferred approach:

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Type of Shock</th>
<th>Impact on $r$: Approach Preferred by Yang &amp; Yanochik</th>
<th>Impact on $r$: Approach Preferred by Fields &amp; Hart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Run:</td>
<td>Nominal (i.e., shock to LM)</td>
<td>Liquidity Preference: $r$ falls</td>
<td>Loanable Funds: $r$ falls</td>
</tr>
<tr>
<td></td>
<td>Real (i.e., shock to IS)</td>
<td>Goods market/Loanable Funds: $r$ rises</td>
<td>Loanable Funds: $r$ rises</td>
</tr>
<tr>
<td></td>
<td>Mixed (i.e., shock to both IS &amp; LM)</td>
<td>?</td>
<td>Loanable Funds: no change in $r$</td>
</tr>
</tbody>
</table>

With the exception of a joint real-financial shock, the direction of the partial equilibrium impact on $r$ is the same in both the Liquidity Preference and Loanable Funds approaches to interest rate determination. The magnitude of the impact on $r$ does, however, differ in the two approaches. In particular, the Loanable Funds approach results in smaller fluctuations in the interest rate. However, when there is a joint real-financial shock, even the direction of the interest rate response is open to question in the approach suggested by Y&Y.

As regards the “best approach,” our preference is the LF approach to interest rate determination. It is well established that the interest rate is determined entirely in the market for loanable funds in the long run. And if the long run is just a series of short runs, it makes sense that the interest rate would be determined in the loanable funds market in the short run as well. Y&Y would have us employ different models depending on whether the analysis is for the short run or the long run. Even worse, Y&Y would have us jump back and forth between the LF and LP approaches in the short run depending on the sector of origin of the disturbance. This does not strike us as a recipe.
for developing a coherent understanding of interest rate determination. That said, we end with a note of thanks to Y&Y. Not only have they made an interesting contribution to this topic, but they have also stimulated our own thinking on the subject—and this can never be a bad thing.

References

