On the Determination of Interest Rates in General and Partial Equilibrium Analysis

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Abstract

This note attempts to clarify the determination of interest rate in the long-run and short-run general equilibrium models, and to address the choice between the loanable funds market and the liquidity preference model in partial equilibrium analysis.

Introduction

Recently, Professors Windsor Fields and William Hart (2003) ask whether the money market depicted by the Liquidity Preference (LP) model and the Loanable Funds (LF) market equilibrate at the same interest rate, and if not, which model one should use to study the determination of interest rate. By "adopt[ing] the Classical macroeconomic model in which wages and prices are perfectly flexible" (footnote 7, p.9,), the authors argue that when the economy is out of the long-run general equilibrium, the short-run partial equilibrium interest rates determined in LP and LF models will be different. Therefore, when teaching students about the determination of interest rate "the choice between the LP and LF approaches does matter (p. 6)."

Fields and Hart have asked a very good question that also puzzled us for some time. We were pleased to see their article; in fact, we even seriously considered incorporating their treatment into our Intermediate Macroeconomics course. Upon careful review, however, we find their analysis problematic. Employing the *long-run general equilibrium* Classical macroeconomic model, they try to show how a change in nominal money supply causes the (real) interest rate to change in the LF market and money market differently in *short-run partial equilibria*. The authors inconsistently treat the price level as a constant parameter while keeping the output at the long-run equilibrium level. This oversight in their study makes the classical dichotomy and hence monetary neutrality untrue. Moreover, although the inconsistency in their reasoning allows them to show the divergence in the determination of interest rates between the two markets, they have not really answered their own question: Which approach, Loanable Funds or Liquidity Preference, should one employ for illustrating the determination of interest rates in partial equilibrium analysis?

In this note, we attempt to articulate the determination of interest rate in general equilibrium macroeconomic models, and to address the choice between the LF and LP models in partial equilibrium analysis. We will show that in the long-run Classical macroeconomic model the interest rate is exclusively determined in the LF market without the money market (i.e., the LP model) involved. In the short run, on the other hand, the interest rate at the general equilibrium is determined together with the output level by the interactions between the Money Market and the Loanable Funds Market in the IS-LM model. For partial equilibrium analysis, we suggest a simple criterion: the choice between the LF and LP models must be consistent with the function played by the selected market embedded in the corresponding general equilibrium model. According to this criterion, therefore, when analyzing the determination of interest rate in the long run, we should employ the LF model but not the LP model. In the short-run analysis, the LF model should be adopted to explain the behavior of interest rate if economic shocks or policy changes shift the IS curve, while the LP approach should be employed to study the interest rate if the LM curve shifts.

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The Determination of Interest Rates in the Classical Macroeconomic Model

For simplicity, we adopt (in the same manner as Fields and Hart) "the closed-economy Classical model in which wages and prices are perfectly flexible. We also assume economic agents have perfect information. In this model, output is fixed at the natural (or full employment) level" (footnote 7, p. 9). The closed-economy Classical macroeconomic model is formally characterized by the following equations (Mankiw, 2003, pp. 375-376):

Factor markets:	$Y = Y^*$	(1)
Goods market:	$Y = C(Y - T) + I(r) + G$	(2)
Loanable funds market:[3]	$Y - C(Y - T) - G = I(r)$	(2a)
Money market:	$M/P = L(i, Y)$	(3)
Fisher equation:[4]	$i = r + \pi^e$	(4)

where Y^* = the full-employment output level
T = tax
G = government purchases
M = nominal money supply
π^e = expected inflation rate

are exogenously given, and

Y = output
r = real interest rate
i = nominal interest rate
P = (overall) price level

are endogenous variables. Note that Equations (2) and (2a) are mathematically equivalent, but they are interpreted differently, depending on the perspective: In (2), we have the output produced equals to the total expenditure in the goods market; while in (2a) we have national saving equals to business investment in the LF market.

Since prices are perfectly flexible in the long run, the equilibrium values of Y and r are obtained from Equations (1) and (2), respectively, without Equations (3) involved. Next, with Y and r already found out, Equation (3) determines the equilibrium price level P. Such theoretic separation of real and nominal variables is referred to as the *classical dichotomy*.[5] The best-known implication of the classical dichotomy is *monetary neutrality* -- changes in the nominal money supply do not influence real variables.

Another immediate, but very important, corollary of the classical dichotomy is often overlooked, however. The classical dichotomy also suggests that in the long run the interest rate is exclusively determined in the LF market, not in the money market. As the nominal money supply changes, it only affects the price level but not the real interest rate or real money supply (M/P). This is because it is the price level, not the interest rate, which adjusts to clear the money market in the long-run Classical model.[6] We summarize this result with the following proposition:

Proposition 1 (A Corollary of the Classical Dichotomy). In the Classical macroeconomic model, the real interest rate is determined in the loanable funds market, not in the money market.

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[3] We follow the treatment in Mankiw, i.e., national saving = business investment. Some other textbooks may adopt "private saving = total investment", i.e., $Y - C(Y - T) - T = I(r) + (G - T)$. Mathematically, these two equilibrium conditions are equivalent.

[4] Following Fields and Hart, we also assume that the expected inflation rate equals to zero for simplicity. Then, the real and nominal interest rates coincide with each other.

[5] According to Ekelund and Hebert (1997, p. 134), among the Classical economists, David Hume gives the most eloquent statement of this phenomenon.

[6] See, for example, Mankiw (2004, pp. 238-245) on the classical theory of inflation, wherein the classical quantity theory of money (MV = PY) is employed without interest rate introduced at all. For a long-run analysis, however, the classical quantity theory of money and the Liquidity Preference model (M = L(r, Y)P) are equivalent, because the interest rate is already determined in the loanable funds market and hence is treated as parameter in the money market.

A key oversight in Fields and Hart's analysis is that they employ the Classical macroeconomic model in order to show why the *short-run* partial equilibrium interest rate may not be the same in the LF market and money market when the nominal money supply changes (p. 9). Immediately after emphasizing that "we adopt the closed-economy Classical model in which wages and prices are perfectly flexible," (footnote 7, p. 9) they actually conduct a short-run comparative static analysis (see their Figures 3 and 4, p. 10-11) where the price level is inconsistently treated as a constant parameter. As a result, the classical dichotomy becomes void in their "classical" model, because the implicitly assumed constant price level makes the interest rate *out of* the (long-run) general equilibrium.

If one attempts to discuss the determination of interest rate in the short run, the Classical macroeconomic model is not appropriate. Instead, a short-run macroeconomic model such as the IS-LM model should be employed.[7] In order to solidify this point, we examine next the determination of interest rate in the short run.

The Determination of Interest Rates in the Short Run

In the short run, prices are assumed sticky, i.e., the overall price level is treated as an exogenous parameter. On the other hand, the output level is endogenously determined by the total expenditure in the goods market. Formally, the short-run general equilibrium model is described as follows.

Goods market:	$Y = C(Y - T) + I(r) + G$	(2 - IS curve)
Loanable funds market:	$Y - C(Y - T) - G = I(r)$	(2a - IS curve)
Money market:[8]	$M/P = L(r, Y)$	(3 - LM curve)

In this model, the (real) interest rate r and the output level Y are endogenous variables, and the rest are exogenously given. In the r-Y space, Equation (2) yields the IS-curve: for a given interest rate r, it determines a unique Y in the goods market.[9] Equation (3) generates the LM-curve: for a given output level Y, it determines a unique interest rate r. However, neither (2) nor (3) unilaterally determines the equilibrium r or Y; rather, the (general) equilibrium Y and r are jointly determined by the interactions between the LF market and the money market. That is, the LF market and the money market equilibrate at the same (r, Y) combination. The equilibrium r and Y are associated with each other in a "fixed-point" manner: given the equilibrium Y, the money market equilibrates at the equilibrium r, whereas the equilibrium Y is obtained in the goods market when r is at its equilibrium level.

To show how the interest rate together with the output level responds to economic shocks or policy changes in the short run, ideally, one should employ the IS-LM model rather than the LF model or the LP framework alone when conducting comparative static analysis. For example, an increase in the nominal money supply will shift the LM curve rightward. As a result, the interest rate decreases and the output level increases. On the other hand, an increase in government spending will shift the IS curve to the right. This leads to an increase in both the interest rate and output level. In this general equilibrium model, strictly speaking, it is theoretically incorrect to ask what happens to the equilibrium interest rate if the output level changes. This is because r and Y are both endogenous variables and there is no causation between two endogenous variables. Comparative static analysis, properly considered, allows us to examine how endogenous variables respond to changes in exogenous variables.

Fields and Hart seem to have made the same mistake twice. First, claiming they "adopt the closed-economy Classical model in which wages and prices are perfectly flexible," they in fact treat the price level as a constant to show how a change in nominal money supply leads to two different "short-run partial equilibrium" interest rates in the LF market and the money market, respectively. Second, while actually conducting a short-run analysis (by assuming a constant price level) they nevertheless maintain a fixed output level as determined in the long-run Classical model. From what they have done, it is not clear whether they really mean to analyze the determination of interest rate in the long run or in the short run.

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[7] Hicks (1937). Also, see Hanson (1953).

[8] Recall that the expected inflation rate is assumed zero for simplicity. Hence, i = r.

[9] The IS-curve can also be derived from (2a); for a given Y, a unique r can be derived from (2a) in the loanable funds market. The two approaches yield the same IS schedule, though they are interpreted differently.

In spite of the inconsistency in their analysis, Fields and Hart have asked a relevant question: Which model, the LF or LP, should be used to study the determination of "*short-run* partial equilibrium interest rate" (p. 9, italic original)? Unfortunately, they do not really answer their own question, though they admit at the end of the paper that their "preference is to assume that the interest rate clears the loanable funds market (p. 15)." What is the basis for this statement? We address this question in the next section.

Interest Rate Determination in Partial Equilibrium Analysis

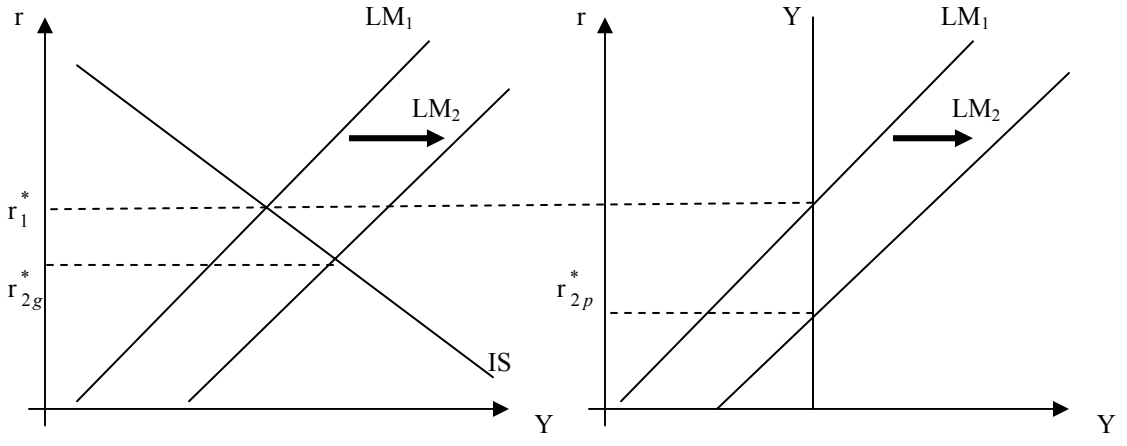
The question thus becomes: which model, the LF or LP, should one adopt in order to show interest rate determination in partial equilibrium analysis? To answer this question, we suggest the following:

Criterion: The choice between the LF and LP models in a partial equilibrium analysis must be consistent with the role played by the selected model embedded in the corresponding general equilibrium model.

In the long run, from Proposition 1 in an earlier section, we know that in the Classical macroeconomic model the real interest rate is exclusively determined in the LF market. From the above criterion, the following proposition therefore results:

Proposition 2. When studying the determination of interest rates under the assumption of price flexibility (i.e., in the long run), the LF model should be employed. The LP model is not appropriate for the long-run analysis of interest rates.

On the other hand, in the short-run general-equilibrium analysis, the interest rate is determined in the IS-LM model together with the output level. To investigate a specific problem related to the behavior of interest rate with a partial equilibrium model (i.e., LF *or* LP), we should choose a framework that generates a result qualitatively consistent with that obtained by using the IS-LM model. For example, to examine how an increase in nominal money supply affects the interest rate, we should use the LP model because a change in nominal money supply will shift the LM curve in the IS-LM model. In contrast, to show how government budget deficit influences the interest rate, we should adopt the LF model. This is because an increased government budget deficit will shift the IS curve.



(a) General equilibrium analysis **(b) Partial equilibrium analysis**

Figure 1. Interest rate change due to money supply increases

In the short-run partial equilibrium analysis with either the LF or LP framework employed, the output level is treated as an exogenous variable, as indicated by a vertical line in the IS-LM space shown in Figure 1. (b). For example, if the Fed increases nominal money supply, the LM curve shifts rightward. The

interest rate will fall, as illustrated in the IS-LM model (Figure 1(a)) as well as in the equivalent version of the LP model as shown in Figure 1 (b). Generally, when the IS (or LM) curve shifts due to an economic shock or a change in economic policy, the interest rate behavior predicted by the IS-LM model and by the LF (or LP) model will be consistent. The resulting difference between the general equilibrium analysis with the IS-LM model and the partial equilibrium study with the LF (or LP) framework is a matter of degree, not of direction (comparing r^*_{2g} with r^*_{2p} in Figure 1). We summarize this point in the following:

Proposition 3. For a short-run partial equilibrium analysis of interest rate determination, the choice of using the LF or LP model should be made with the corresponding (shifting) curve in the IS-LM model in mind. Specifically, if a shock or policy change causes the IS curve to shift in the IS-LM model, then the LF model should be employed. If a shock or policy change leads the LM curve to shift in the IS-LM, then the LP framework should be adopted.

Conclusion

Fields and Hart's paper on interest rate determination is an important contribution because it highlights a glaring weakness in macroeconomic pedagogy. The authors are correct in that textbook writers are often too informal when it comes to choosing between the Loanable Funds and Liquidity Preference models. Haphazardly switching between the LF and LP models is theoretically unsound. However, we find some inconsistencies in Fields and Hart's treatment of the problem. The purpose of this paper is to address these inconsistencies and to clarify them. In our discussion, we attempt to make clear the process of interest rate determination in short-run and long-run general equilibrium models. Additionally, we offer a set of propositions that we believe will aid instructors and students in choosing the correct model, LF or LP, to explain certain macroeconomic phenomena within a partial equilibrium framework. We agree with Fields and Hart that, depending on the problem to be studied, the choice of explanatory models does matter. Nevertheless, unlike Fields and Hart, who state their preference for the Loanable Funds model, we believe the correct choice of a partial equilibrium model between the LF and LP must be consistent with its part played in the general equilibrium framework that determines all of the endogenous aggregate variables, including the interest rate.

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