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# Excess Demand in the IS-LM Model

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Although it is well known from the work of Samuelson and Hicks that comparative statics is a meaningful exercise only in the context of a dynamically-stable model, so that presentation of any comparative-static result should always be accompanied by an explicit dynamic model leading the system from one equilibrium to another, the textbook presentation of the dynamics of the IS-LM model is quite limited. The standard case analysed is one in which the money market adjusts rapidly, so that the economy never leaves the LM curve, but the goods market, cushioned by inventory changes, adjusts more slowly. In response to an increase in the money supply, for example, the economy drops vertically to the interest rate associated with the new LM curve and then gradually moves up that LM curve to the new equilibrium.[1,2] That this movement is gradual results from specific assumptions concerning the economy's reaction to the excess demand gap created by the policy action.

A key step in any dynamic analysis is the formulation of the nature and size of the excess demand gap. Once this is done, assumptions concerning the character of the economy's reaction to this gap (including expectation formation and institutional or other constraints) allow derivation of the dynamic path followed by the economy.

This note focuses on this basic step in the formulation of a dynamic analysis, the determination of the excess demand gap, discussing the nature of this gap in the familiar IS-LM model. Some variations of the IS-LM model, suggested by this analysis, are also discussed. One motivation for writing this paper was our discovery that many of our colleagues, most of our graduate students, and practically all of our undergraduate students thought that the excess demand gap was portrayed on the IS-LM diagram by the horizontal distance between the IS and LM curves at the temporarily-given interest rate. One reason for this is that textbooks do not explicitly address this graphical problem (an exception is Kennedy (1975) p. 197). A comment by Peake (1976) indicates that this error is not confined to the classroom.

## *The Model*

Equations (1) through (4) below represent a simple dynamic version of the standard IS-LM model. Equations 3(a) and 4(a) are alternative versions of equations (3) and (4), used later to respecify the dynamics of the model. We have

$$Y = E + I, \tag{1}$$

$$\dot{Y} = -\alpha I, \tag{2}$$

$$E = a_o - a_1 r + a_2 r, \tag{3}$$

$$M = b_o - b_1 r + b_2 Y, \tag{4}$$

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[1]Throughout this note, "the economy moves from $A$ to $B$" means "the set of coordinates describing the economy's interest rate and income moves from $A$ to $B$."

[2]Some variations on this theme do appear in the textbooks. For example, in a model with a fractional-reserve banking system and lags in commercial-bank behavior, the LM curve shifts rightward in stages. As another example consider a model that specifies, as monetarists would stress, that there is a temporary increase in the demand for money (and thus a temporary leftward shift of the LM curve) as people switch from financial assets into consumer durables when they readjust their wealth portfolios. See Kennedy (1975, p. 156).

$$E = a_o - a_1 r + a_2 E, \text{ and} \qquad (3a)$$
$$M = b_o - b_1 r + b_2 E \qquad (4a)$$

where $Y$ is income, $E$ is planned expenditure (referred to as expenditure),[3] $I$ is unplanned inventory investment, $r$ is the interest rate, $M$ is the money stock, and $\alpha$, $a_i$, and $b_i$ are all positive parameters. We assume prices fixed.

Equation (1) is the national income identity (an equilibrium condition when $I = 0$). Equation (2) states that entrepreneurs adjust their output levels downward (or upward) at a rate proportional to the rate of inventory accumulation (or decumulation). Equations (3) and (3a) describe the determinants of expenditure, and (4) and (4a) describe the determinants of money demand.

The analysis below consists of an examination of four different specifications of this model, using different combinations of equations (3), (3a), (4), and (4a). For each case the reaction of the economy to an increase in the money supply is used as an example.

### Case I: *Income is the Argument in Both the Expenditure and Money Demand Functions*

This is the standard textbook version. In Figure 1 the economy moves from $A$ to $B$ when the money supply is increased. The income and interest rate combination $(Y, r)$ then moves along $LM_2$ from $B$ to the new equilibrium $C$. From equation (3), so long as the economy is still at $B$ with income unchanged, excess demand for goods and services is given by $\Delta E = -a_1 \Delta r$. This implies that when the economy is at $B$ expenditure is given by the intersection of a horizontal line through $B$ with a line, such as $AZ_1$ or $AZ_2$,

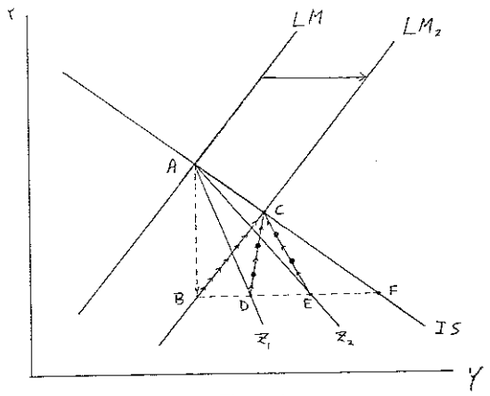


**Figure 1**

with slope $-1/a_1$. (The slope of $IS$ is $-(1 - a_2)/a_1$.) This point, $D$ or $E$ in Figure 1, must always lie to the left of $F$. Aggregate demand cannot exceed the point on the $IS$ curve at $B$'s interest rate (point $F$) because by definition this point on the $IS$ curve represents aggregate demand only when income is also at that level; because $B$'s income is less than this level, aggregate demand must also be less.

Since all equations are linear, $(E, r)$ will trace a linear path to equilibrium at $C$. This yields two alternative paths for expenditures, an upward-sloping path such as $DC$ and a backward-sloping path such as $EC$. During adjustment excess demand and therefore the rate at which inventories fall is given by the horizontal gap between the expenditure path (the interspersed beads and arrows) and the income path (the arrows).

### Case II: *Expenditure is the Argument in the Expenditure Function*

Although the results of the previous section reflect the standard textbook IS-LM model, the excess demand representation is at odds with what many students (and instructors) believe. The mistaken but common view is that the level of aggregate demand at $B$ is given by the IS curve at that interest rate

[3]We do not include in planned expenditure that expenditure necessary to eliminate eventually any cumulated unintended inventory investment. A complete dynamic analysis would of course require that this element of aggregate demand be taken into account. Its omission, for expositional purposes, follows a tradition in the macrodynamics literature. For discussion of this problem, see Blinder (1977).



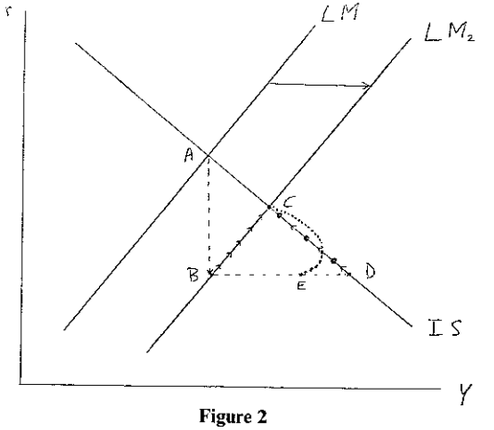


**Figure 2**

(point $D$ in Figure 2), and that expenditure moves from $D$ to $C$ along the IS curve as income moves along $LM_2$ to its new equilibrium. Under what circumstances could this view be correct?

Suppose an economy is at point $B$ in Figure 2, where expenditure, according to equation (3), is given by $E$. However, if expenditure, rather than income, is the argument in the expenditure function, the expenditure level, $E$, implies even higher expenditure, implying in turn that expenditure would be higher still. There is a mini-multiplier process here whereby expenditure changes lead to further expenditure changes. Since by definition points on the IS curve can be interpreted as points at which expenditure equals the argument in the expenditure function, the working out of this mini-multiplier process implies an expenditure level of $D$ associated with point $B$. Thus if equation (3) is replaced by equation (3a), although the comparative statics of the IS-LM model are unchanged, the dynamics are altered so as to allow an excess demand representation in line with the common view. In particular, if this mini-multiplier process works itself out very quickly, the path for expenditures is given by the IS curve from $D$ up to $C$. If the process works itself out slowly, the path for expenditures will be similar to that shown in Figure 2 by the dotted line from $E$ to $C$.

Specifying that expenditure rather than income is the argument in the expenditure function seems reasonable if one notes the strange implication of the traditional formulation that an increase in income has the same impact on spending regardless of whether that extra income corresponds to inventory accumulation or to spendable cash receipts. If, for example, an increase in income (i.e., an increase in actual physical output) occurs with no corresponding increase in expenditure, unplanned inventory accumulation forces owners of firms to suffer a (temporary) reduction in profits. Although the spendable cash receipts of the workers who produced the extra output have increased, the spendable cash receipts of the owners of firms have decreased by an equivalent amount, implying no net change in aggregate spending (assuming identical marginal propensities to consume for the two groups). Using expenditure as the argument in the expenditure function ensures that it is spendable cash receipts that determine spending.[4]

### Case III: *Expenditure is the Argument in the Money Demand Function*

Using expenditure as the argument in the demand for goods and services function

[4]This argument is strengthened by recognizing the need to adjust inventory holdings. When expenditures exceed income, for example, inventories fall, so that aggregate demand should be large to incorporate the desire to rebuild inventories; making expenditures a function of expenditures, rather than income, helps meet this requirement. For example, suppose the expenditure were written as

$$E = a_0 - a_1 r + a_2 Y - h I$$

where $h < 1$. Since, from (1), $I = Y - E$, this can be rewritten as

$$E = a_0 - a_1 r + (a_2 - h) Y + h E$$

which if $h = a_2$ yields equation (3a).

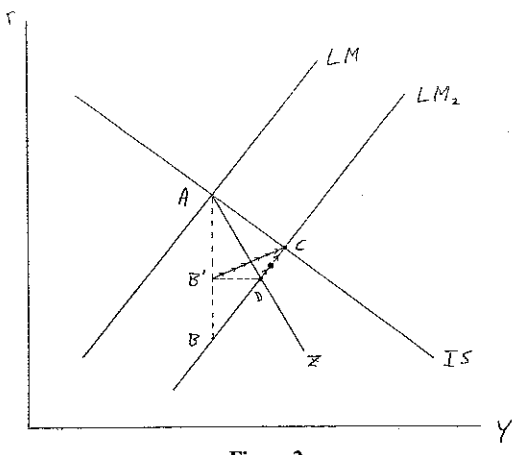


Figure 3

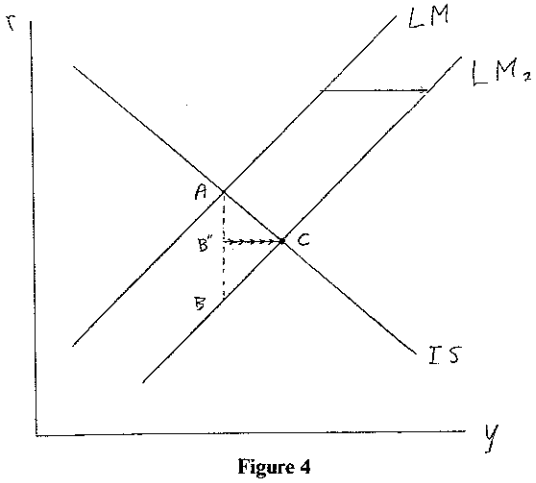


Figure 4

suggests that it could also be the argument in the money demand function. This is accomplished by replacing equation (4) with equation (4a) in the original model. This respecification seems reasonable if we consider money demand to be motivated by the considerations raised in the models of the transactions demand for money of Baumol and Tobin. In addition, Davidson (1965) has argued that such an assumption more accurately reflects Keynes's conception of the demand for money.

As in Case I presented earlier, with no change in income, planned expenditure is given by the line $AZ$ in Figure 3. Where this line cuts $LM_2$, the money market is in equilibrium, implying that expenditure jumps initially to $D$ while the economy drops from $A$ to $B'$ instead of $B$. The economy then moves from $B'$ to $C$ as shown in Figure 3, while expenditure moves along $LM_2$ from $D$ to $C$.

### Case IV: *Expenditure is the Argument in Both the Expenditure and the Money Demand Functions*

The analysis of Cases II and III can be used to deduce that in Case IV planned expenditure must be given by the intersection of the IS and new LM curves, which in Figure 4 is position $C$. The economy will therefore drop from $A$ to $B''$ in Figure 4, and will make its way, with the interest rate unchanged from this level, to position $C$.

### *Summary*

The versions of the IS-LM model analysed above have clarified the graphical portrayal of the excess demand for goods and services, which is instrumental in determining the rate of inventory change. In addition, they have illustrated some alternative dynamic formulations of the IS-LM model beyond those usually obtained by simply varying the relative rates of adjustment in the money and goods markets.

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