A More Detailed IS-LM Story

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A More Detailed IS-LM Story

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Textbooks give a fairly short IS-LM story. This paper offers a more detailed one. As listed in section VII, this story has ten advantages vis-à-vis the usual textbook story, including: (a) it is clear about what it means by "money"; (b) it describes the central bank as targeting an interest rate; and (c) it covers the money multiplier and quantitative easing. To unfold, the more detailed story requires only minor adjustments to the IS-LM model, mostly the addition of the quantity equation of money – a mere identity.

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I. Introduction

Today, complex models dominate macroeconomic research. At the same time, simple models have preserved niches such as undergraduate teaching or policy advice.

A prime example for such a simple model is the IS-LM model of John Hicks (Hicks 1937) and Alvin Hansen (Hansen 1953).

As of 2017, the IS-LM model still features in many introductory macroeconomics textbooks such as Abel, Bernanke and Croushore (2017), Blanchard (2017), Dwivedi (2015), Froyen (2013), Gordon (2012), Heijdra (2017) or Mankiw (2016).

Moreover, it still influences policy decisions. Cohen-Setton and Kessler (2011) report that according to Lawrence Summers, the White House policy response to the financial crisis was "all IS-LM augmented by a liquidity trap". It can be assumed that such influence continues to this day, in the White House and in other corridors of power.

The thesis of this paper is that the IS-LM model might be even more successful – both in undergraduate teaching and in policy advice – if only textbooks would tell a more detailed IS-LM story, one that distinguishes between high-powered money on the one hand and M1 money on the other hand.

To see the potential of such a story, consider first the usual IS-LM text-book story and its main limitation.

II. The Usual IS-LM Textbook Story and Its Main Limitation

The IS-LM model is customarily given by the following equations.

(1) IS curve: $Y = C(Y) + I(i) + G$, where $0 \leq C'(Y) < 1$ and $I'(i) < 0$

(2) LM curve: $M = L(Y, i)$, where $L'(Y) > 0$ and $L'(i) < 0$

In the equations, Y denotes output, C consumption spending, I investment spending, i the interest rate, G government spending and M the money stock.

For the IS-LM model from equations (1) and (2), Figure 1 shows a fiscal expansion (left-hand panel) and a monetary expansion (right-hand panel).

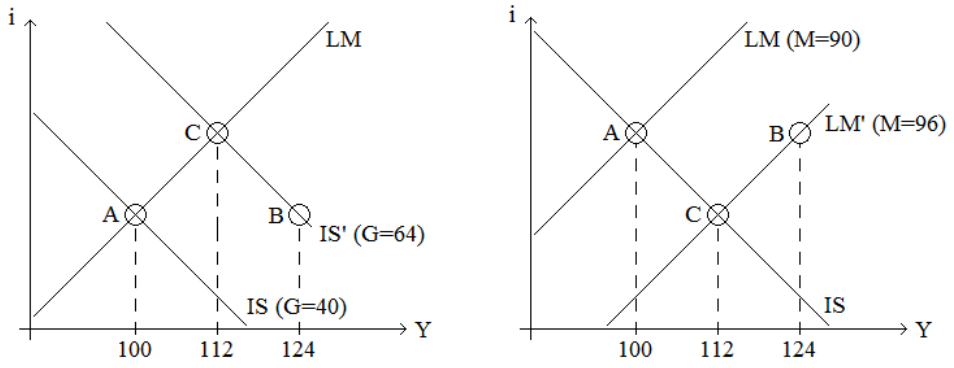

FIGURE 1. FISCAL EXPANSION (LEFT) AND MONETARY EXPANSION (RIGHT) IN THE IS-LM MODEL

A. The Usual IS-LM Textbook Story for a Fiscal Expansion

For Figure 1's fiscal expansion, the usual IS-LM textbook story is:

Increase in Government Spending.—The economy is at point A when the government increases its spending by 24 units from 40 units to 64 units. The IS curve shifts to the right by those 24 units, crossing through point B.

Increase in Output.—Output increases, although not by the full 24 units. This is because higher output comes with higher money demand as higher output means additional purchases of final goods and services (and thus additional transactions for which money is needed). The higher money demand drives up the interest rate i. This reduces investment spending by 12 units. Equilibrium is reached in point C, with government spending up by 24 units and investment spending down by 12 units, for an overall increase in output of 12 units.

In the example, the IS curve shifts to the right by 24 units while the increase in government spending is also 24 units. Mathematically, this means that C'(Y) equals zero. Economically, this means that there are no second-round effects along the lines of the Keynesian cross.

B. The Usual IS-LM Textbook Story for a Monetary Expansion

For Figure 1's monetary expansion, the usual IS-LM textbook story is:

Increase in Money.—The economy is at point A when the central bank increases money by 6 units from 90 units to 96 units. The LM curve shifts to the right by 24 units, crossing through point B. The increase in money drives down the interest rate i.

Increase in Output.—Investment spending and output increase, although not by the full 24 units. This is because higher output comes with higher money demand as higher output means additional purchases of final goods and services (and thus additional transactions for which money is

needed). In Figure 1, the higher money demand uses up 12 units of the additional money provided by the central bank, dampening the decreases in the interest rate. Equilibrium is reached in point C, with investment and output up by 12 units.

C. Imprecise Use of the Term "Money" as the Main Limitation of the Usual IS-LM Textbook Story

In the usual IS-LM textbook story, money is described as controlled by the central bank, and as used for transactions (for the first description, see the first part of section II B; for the second description, see section II A or the second part of section II B).

Based on the first description one would say that "money" must mean high-powered money as high-powered money is controlled by the central bank. However, from the second description one has to say that "money" cannot mean high-powered money as high-powered money is not meant for transactions.

Vice versa, based on the second description one would say that "money" must mean M1 money as M1 money is meant for transactions. However, from the first description one has to say that "money" cannot mean M1 money as M1 money is not controlled by the central bank.

The root of the problem is that there is only one money measure in the model ("M"), yet there are two mutually exclusive descriptions of its main characteristic.

Since both descriptions have their place, the dilemma can only be solved if both money measures (high-powered money and M1 money) are introduced into the model. The next section adjusts the IS-LM model accordingly. Based on that, a more detailed IS-LM story unfolds.

III. Adjusting the IS-LM Model to Allow for a More Detailed IS-LM Story (Which Includes Both High-Powered Money and M1 Money)

The "M" in the LM curve is controlled by the central bank. It therefore makes sense to assume that "M" reflects high-powered money (HPM) as the central bank can control high-powered money.

$$M = HPM \tag{3}$$

Apart from that, the IS-LM model also includes spending through the IS curve. Spending implies transactions. Transactions involve some form of money. M1 money, which consists of currency held by the public and demand deposits, is the appropriate money measure here. It therefore makes sense to state Fisher's (1911) equation of exchange – the quantity equation of money – with respect to M1 money:

$$M1V1 \equiv PY \tag{4}$$

In the equation, M1 denotes M1 money, V1 denotes the velocity of M1 money, P denotes the price level and Y denotes output.

Let's assume that the price level is constant and can be set to one.

$$P = 1 \tag{5}$$

This is a standard assumption of the IS-LM model. We can drop the assumption anytime by adding an aggregate supply curve to the IS-LM model that distributes changes in aggregate demand between changes in the price level P and changes in output Y (IS-LM-AS model). However, doing so adds an additional layer of complexity to the IS-LM model which is not always necessary or helpful.

Let's also assume that the velocity of M1 money, V1, is constant and can be set to one.

$$V1 = 1 \tag{6}$$

This means that, within a period, every unit of M1 money is spent exactly once on a final good or service. In reality, (yearly) V1 is usually not close to one. For example, in the US from 1959 to 2016, yearly V1 rather varied between 3.6 and 10.7 (Federal Reserve 2017a).

Like the assumption on the price level, the assumption of V1 being equal to one is, however, a convenient simplification. We can drop it anytime as we will see in section VIII. For the time being, without dropping it, we can write equation (4) conveniently as:

$$M1 \equiv Y \tag{7}$$

Equation (7) is similar to a "cash-in-advance constraint" (Clower 1967), even though equation (7) refers to M1 money and not just to cash (cash, also called "currency held by the public", is one of two components of M1 money, with demand deposits being the other). Requiring that buyers have M1 money in advance of a transaction makes sense as "payment with M1 money" is generally the only accepted method of payment.

Payment with M1 money includes the use of currency, check, direct debit and bank wire transfer. Of course, purchases might also take place on credit. However, even there M1 money is needed in advance – this time by the creditor. We can see this from the fact that if a business sells a good on credit, its accounts receivable balance sheet item goes up. "Accounts receivable" is an asset which firms, if higher, have to match with an additional liability, that is, with a ceteris paribus higher borrowing of M1 money.

If we combine equations (3) and (7) with equations (1) and (2), an "adjusted" IS-LM model results:

(1') adjusted IS curve: $M1 = C(M1) + I(i) + G$, with $M1 \equiv Y$

(2') adjusted LM curve: $HPM = L(M1, i)$, with $M1 \equiv Y$

Figure 2 graphically compares the usual IS-LM model to the adjusted IS-LM model.

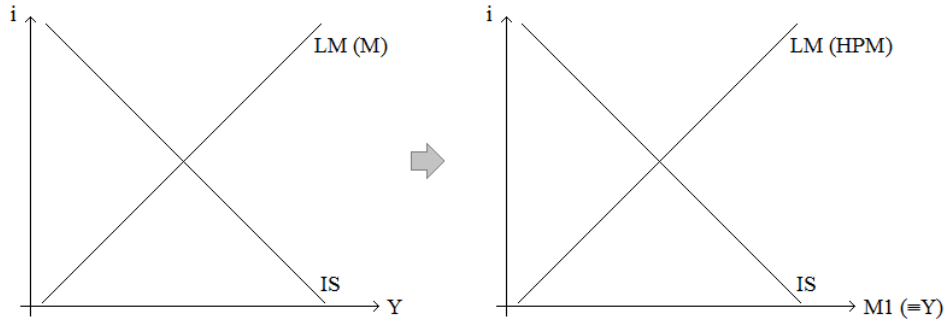

FIGURE 2. USUAL IS-LM MODEL (LEFT) AND ADJUSTED IS-LM MODEL (RIGHT)

IV. Interpreting the IS and LM Curves As Demand for and Supply of M1 Money

The adjusted IS-LM model consists both of an interest rate-output (i-Y) space and an interest rate-M1 money (i-M1) space, as Figure 2 shows. We can conveniently interpret the latter space as the market for M1 money with the IS curve reflecting demand for M1 money and the LM curve reflecting supply of M1 money. The interest rate i equates both.

Since borrowers borrow M1 money usually either from banks or from the bond market, we can picture the market for M1 money as consisting of the bank lending market and the bond market.

Interpreting the IS and LM curves as demand for and supply of M1 money means to deviate from the traditional interpretation of the curves. The traditional interpretation holds that the IS curve reflects goods market equilibrium and that the LM curve reflects money market equilibrium.

This interpretation is frequently criticized as there is only a single interest rate in the IS-LM model. A single interest rate can, however, not clear both the goods market and the money market as the two markets have in fact different interest rates (Romer 2000).

Such criticism cannot be leveled against the alternative interpretation offered here, as it musters one market for the one interest rate – the market for M1 money.

The next section makes maximum use of the alternative interpretation to give a more detailed IS-LM story.

V. A More Detailed IS-LM Story

Figure 3 shows a fiscal expansion (left-hand panel) and a monetary expansion (right-hand panel) for the adjusted IS-LM model from equations (1') and (2').

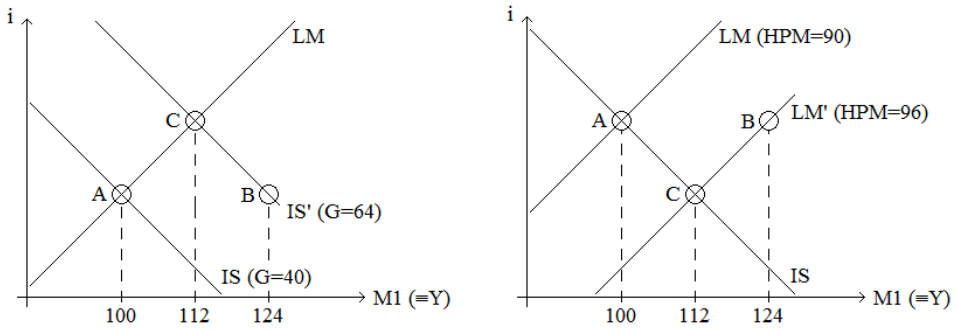

FIGURE 3. FISCAL EXPANSION (LEFT) AND MONETARY EXPANSION (RIGHT) IN THE ADJUSTED IS-LM MODEL

A. More Detailed IS-LM Story for a Fiscal Expansion

For Figure 3's fiscal expansion, a more detailed IS-LM story is:

Increase in Government Spending.—The economy is at point A when the government increases its spending by 24 units from 40 units to 64 units. To do so, the government needs 24 additional units of M1 money which it borrows at the market for M1 money (as discussed, the market for M1 money consists of the bank lending market and the bond market). The IS curve shifts to the right by those 24 units, crossing through point B.

Excess Demand for M1 Money at Point B (24 Units).—At point B, there is excess demand of 24 units at the market for M1 money. In turn, the interest rate i increases as the economy moves to point C. There, equilibrium is restored, partly through lower demand for M1 money (12 units) and partly through higher supply of M1 money (12 units).

Lower Demand for M1 Money (12 Units).—Demand for M1 money decreases as firms wish to borrow less M1 money if the interest rate is higher. In Figure 3, firms borrow 12 units of M1 money less, as can be seen from the horizontal distance between point B and point C.

Higher Supply of M1 Money (12 Units).—Supply of M1 money increases as banks create additional M1 money if the interest rate is higher. In Figure 3, banks create 12 additional units of M1 money, as can be seen from the horizontal distance between point A and point C. The process is illustrated below – see subsection "Illustration of the Interest Rate-Induced Increase in M1 Money".

Increase in Output (12 Units).—Output increases by the increase in government spending (24 units) minus the crowded out borrowing by firms (12 units). The intuition is that those 24 units of M1 money which the government additionally spends have to come from somewhere. Here, 12 of the 24 units come from higher M1 money supply. This is good for output. The other 12 units come from lower M1 demand as firms borrow 12 units of M1 money less. This is not so good for output. After all, firms that borrow 12 units less also spend 12 units less as borrowing and spending go hand in hand (there is no point in borrowing if there is no intention of spending).

The underlying change in borrowing, saving and spending is illustrated below – see subsection "Change in Borrowing, Saving and Spending." The effect on bank and central bank balance sheets is also illustrated below – see subsection "Effect on Bank and Central Bank Balance Sheets."

Illustration of the Interest Rate-Induced Increase in M1 Money.—The story holds that banks create 12 additional units of M1 money because of the higher interest rate. Table 1 illustrates how this works.

TABLE 1—INTEREST RATE-INDUCED 12-UNIT INCREASE IN M1 MONEY

		(1)	(2)	(3)
Currency held by the public (CHP)		80	76	76
Excess reserves (ER)		5	9	5
Required reserves (RR)		5	5	9
High-powered money (HPM)	[HPM = CHP + ER + RR]	90	90	90
Reserve ratio (rr)		0.25	0.25	0.25
Additional bank loans		.	.	+16
Demand deposits (D)	[D = RR / rr]	20	20	36
M1 money (M1)	[M1 = CHP + D]	100	100	112

Column (1) shows the economy at point A. As in Figure 3, M1 money is assumed to equal 100 units. The values for currency held by the public, excess reserves, required reserves, high-powered money and demand deposits are chosen accordingly. The reserve ratio is assumed to equal 25%. This means that the economy has a fractional-reserve banking system, as opposed to a full-reserve banking system with a 100% reserve ratio.

In column (2), the higher interest rate makes the public (households or firms, but let's say households) pay 4 units of currency into their savings accounts as the higher interest rate increases the opportunity cost of holding non-interest bearing currency. Currency held by the public thus decreases to 76 units while banks' excess reserves increase to 9 units.

In column (3), banks use the additional 4 units of excess reserves to make loans totaling 16 units. When banks make such loans, they credit the demand deposits account of the borrower with a demand deposit of the size of the loan (so that the borrower can use the money). This is why demand deposits increase by 16 units to 36 units. Required reserves increase by 4 units to 9 units, in line with the 25% reserve ratio.

In consequence, M1 money increases by 12 units, as described above.

Change in Borrowing, Saving and Spending.—Table 2 shows by sector the change in borrowing, saving and spending that has to take place for the economy to move from point A to point C (assuming realistically that the government borrows from the bond market and not from banks).

TABLE 2—CHANGE IN BORROWING, SAVING AND SPENDING

	Borrowing from banks	Bond market borrowing	Saving at banks	Spending
(1) Government	.	+24	.	+24
(2) Firms	+12	-24	.	-12
(3) Households	+4	.	+4	.

Row (1) has the government borrow 24 additional units of M1 money from the bond market for a 24-unit increase in spending. Row (2) has firms borrow 12 additional units of M1 money from banks, and 24 units of M1 money less from the bond market, for a 12-unit decrease in borrowing and spending. Row (3) has households borrow 4 additional units of M1 money from banks, and has other households save 4 additional

units of M1 money at banks, for an unchanged net borrowing and spending. In sum, borrowing from banks is up by 16 units (as above), bond market borrowing is overall unchanged (as above), saving at banks is up by 4 units (as above), and spending is up by 12 units (also as above).

Effect on Bank and Central Bank Balance Sheets.—As the economy moves from point A to point C, banks' assets and liabilities increase by 20 units: On the assets side, required reserves increase by 4 units and loans increase by 16 units. On the liabilities side, savings deposits increase by 4 units and demand deposits increase by 16 units.

Central bank assets and liabilities are overall unchanged, although on the liabilities side currency held by the public decreases by 4 units while required reserves increase by 4 units.

B. A More Detailed IS-LM Story for a Monetary Expansion

For Figure 3's monetary expansion, a more detailed IS-LM story is:

Cut in the Central Bank Policy Rate.—The economy is at point A when the central bank cuts its policy rate, which is the interest rate which banks charge one another for overnight loans of high-powered money. (Note that although an interest rate, too, this is not the interest rate i from the equations or the figures.)

To meet the lower policy rate, the central bank's traders lend additional high-powered money to banks. In Figure 3, it is assumed that they have to increase high-powered money by 6 units (from 90 units to 96 units). The LM curve shifts to the right by 24 units, crossing through point B, as the additional 6 units of high-powered money make banks create 24 additional units of M1 money.

Banks create the additional 24 units of M1 money through 24 additional units of loans. The process is illustrated below – see subsection "Illustration of the High-Powered Money-Induced Increase in M1 Money". The 24 units of additional loans hit the market for M1 money (which as discussed consists of the bank lending market and the bond market).

Excess Supply of M1 Money at Point B (24 Units).—At point B, there is excess supply of 24 units at the market for M1 money. In turn, the interest rate i decreases as the economy moves to point C. There, equilibrium is restored, partly through higher demand for M1 money (12 units) and partly through lower supply of M1 money (12 units).

Higher Demand for M1 Money (12 Units).—Demand for M1 money increases as firms wish to borrow more M1 money if the interest rate is lower. In Figure 3, firms borrow 12 additional units of M1 money, as can be seen from the horizontal distance between point A and point C.

Lower Supply of M1 Money (12 Units).—Supply of M1 money decreases as banks destroy M1 money if the interest rate is lower. In Figure 3, banks destroy 12 units of M1 money, as can be seen from the horizontal distance between point B and point C. The process is illustrated below – see subsection "Illustration of the Interest Rate-Induced Decrease in M1 Money".

Increase in Output (12 Units).—In sum, banks create 12 additional units of M1 money (plus 24 units because of the additional high-powered money, and minus 12 units because of the lower interest rate). While monetary policy is thus partly self-defeating, there is still a 12-unit net increase in M1 money. The 12-unit net increase is borrowed by firms and spent (there is no point in borrowing if there is no intention of spending).

The underlying change in borrowing, saving and spending is illustrated below – see subsection "Change in Borrowing, Saving and Spending." The effect on bank and central bank balance sheets is also illustrated below – see subsection "Effect on Bank and Central Bank Balance Sheets."

Illustration of the High-Powered Money-Induced Increase in M1 Money.—The story holds that banks create 24 additional units of M1 money, and 24 additional units of bank loans, because of the additional high-powered money. Table 3 A illustrates how this works.

TABLE 3 A—HIGH-POWERED MONEY-INDUCED 24-UNIT INCREASE IN M1 MONEY

		(1)	(2)	(3)
Currency held by the public (CHP)		80	80	80
Excess reserves (ER)		5	11	5
Required reserves (RR)		5	5	11
High-powered money (HPM)	[HPM = CHP + ER + RR]	90	96	96
Reserve ratio (rr)		0.25	0.25	0.25
Additional bank loans		.	.	+24
Demand deposits (D)	[D = RR / rr]	20	20	44
M1 money (M1)	[M1 = CHP + D]	100	100	124

Column (1) shows the economy at point A. As in Figure 3, high-powered money is assumed to equal 90 units and M1 money is assumed to equal 100 units. The values for currency held by the public, excess reserves, required reserves and demand deposits are chosen accordingly. The reserve ratio is assumed to equal 25%. This means that the economy has a fractional-reserve banking system, as opposed to a full-reserve banking system with a 100% reserve ratio.

In column (2), high-powered money increases by 6 units as the central bank cuts the policy rate. In consequence, bank excess reserves increase by 6 units.

In column (3), banks use the additional 6 units of excess reserves to make loans totaling 24 units. When banks make such loans, they credit the demand deposits account of the borrower with a demand deposit of the size of the loan (so that the borrower can use the money). This is why demand deposits increase by 24 units to 44 units. Required reserves increase by 6 units to 11 units, in line with the 25% reserve ratio.

In consequence, M1 money increases by 24 units, as described above.

Illustration of the Interest Rate-Induced Decrease in M1 Money.—The story holds that banks destroy 12 units of M1 money because of the lower interest rate. Table 3 B illustrates how this works.

TABLE 3 B—INTEREST RATE-INDUCED 12-UNIT DECREASE IN M1 MONEY

		(1)	(2)	(3)
Currency held by the public (CHP)		80	84	84
Excess reserves (ER)		5	1	5
Required reserves (RR)		11	11	7
High-powered money (HPM)	[HPM = CHP + ER + RR]	96	96	96
Reserve ratio (rr)		0.25	0.25	0.25
Additional bank loans		.	.	-16
Demand deposits (D)	[D = RR / rr]	44	44	28
M1 money (M1)	[M1 = CHP + D]	124	124	112

Column (1) of Table 3 B takes over where column (3) of Table 3 A left of, with M1 money standing at 124 units.

In column (2), the lower interest rate makes the public (households or firms, but let's say households) withdraw from their savings accounts 4 units of currency to reduce shoe leather costs. Currency held by the public thus increase to 84 units while banks' excess reserves decrease to 1 unit.

In column (3), banks restore their initial level of excess reserves by making 16 units of loans less than they would otherwise do.

In consequence, M1 money decreases by 12 units, as described above.

Change in Borrowing, Saving and Spending.—Table 4 shows by sector the change in borrowing, saving and spending that has to take place for the economy to move from point A to point C.

TABLE 4—CHANGE IN BORROWING, SAVING AND SPENDING

	Borrowing from banks	Bond market borrowing	Saving at banks	Spending
(1) Government	.	.	.	.
(2) Firms	+12	.	.	+12
(3) Households	-4	.	-4	.

Row (1) has the government changing neither its borrowing, saving or spending. Row (2) has firms borrow 12 additional units of M1 money from banks for a 12-unit increase in spending. Row (3) has households borrow 4 units less of M1 money from banks, and has other households save 4 units of M1 money less at banks, for an unchanged net borrowing and spending. In sum, borrowing from banks is up by 8 units (as above), bond market borrowing is unchanged (as above), saving at banks is down by 4 units (as above), and spending is up by 12 units (also as above).

Effect on Bank and Central Bank Balance Sheets.—As the economy moves from point A to point C, banks' assets and liabilities increase by 10 units: On the assets side, required reserves increase by 2 units and loans increase by 8 units. On the liabilities side, central bank borrowing increases by 6 units, savings deposits decrease by 4 units, and demand deposits increase by 8 units.

Central bank assets and liabilities increase by 6 units: On the assets side, central bank lending increases by 6 units. On the liabilities side, currency held by the public increases by 4 units and required reserves increase by 2 units.

VI. Different Parameter Values

Figure 3 makes assumptions about the size of the shift in the IS curve, the size of the shift in the LM curve, and the slope of the IS and LM curves. The underlying parameter values are, however, chosen purely for convenience. No claim is made that those parameter values are necessarily close to their real-world values. This section looks at different parameter values which may, or may not be, more realistic.

Larger Shift in the IS Curve.—In Figure 3, the IS curve shifts to the right by 24 units while the increase in government spending is also 24 units. Mathematically, this means that C'(Y) equals zero. Economically, this means that there are no second-round effects along the lines of the Keynesian cross. In contrast, if C'(Y) would be between zero and one, such second-round effects would exist as the IS curve would shift to the right by more than the increase in government spending.

Larger or Smaller Shift in the LM Curve.—In Figure 3, the LM curve shifts to the right by 24 units while the increase in money is 6 units. Mathematically, this means that L'(Y) equals 0.25. For smaller values than 0.25, the LM curve would shift to the right by more than by 24 units. For greater values than 0.25, the LM curve would shift to the right by less than 24 units. For L'(Y) approaching infinity, the LM curve would not shift at all.

Table 3 A shows why there might be a relatively small shift in the LM curve. For a given increase in high-powered money, M1 money creation (i.e. the "M1 money multiplier") is the lower the higher currency drain, the higher excess reserves and the higher the reserve ratio.

For example, if in column (3) excess reserves would be 10 units instead of 5 units, M1 money would increase by 4 units instead of by 24 units.

Banks accumulate excess reserves if they hold high-powered money but do not use it to make loans. This may be because of competitive pressure, cyclical over-pessimism, or strict capital requirements (Goodhart et al. 2004, McLeay et al. 2014, Stein 2013).

This is not merely a theoretical point. A massive increase in excess reserves took place in many countries in recent years, forcing central banks all over the world into unprecedented monetary policy measures (quantitative easing) in order to still get M1 money into the economy.

Vertical (instead of downward sloping) IS Curve.—If the IS curve is vertical, firms are unwilling to change borrowing in response to a changing interest rate. In this case, fiscal policy is highly efficient (no crowding out), while monetary policy is inefficient (completely self-defeating).

Horizontal (instead of downward sloping) IS Curve.—If the IS curve is horizontal, firms are extremely willing to change borrowing in response to a changing interest rate. In this case, fiscal policy is inefficient (complete crowding out), while monetary policy is highly efficient (not at all self-defeating).

Vertical (instead of upward sloping) LM Curve.—If the LM curve is vertical, banks are unwilling to create or destroy M1 money in response to a changing interest rate. In this case, fiscal policy is inefficient (complete crowding out), while monetary policy is highly efficient (not self-defeating at all).

Horizontal (instead of upward sloping) LM Curve.—If the LM curve is horizontal, banks are extremely willing to create or destroy M1 money in response to a changing interest rate. In this case, fiscal policy is highly efficient (no crowding out), while monetary policy is inefficient (completely self-defeating). As discussed, banks may be extremely willing to create M1 money (which is to say, may be extremely willing to make

additional loans) because of low currency drain, high excess reserves, competitive pressure, cyclical over-optimism or lax capital requirements. Vice versa, banks may be extremely keen to make fewer loans because of high currency drain, low excess reserves, competitive pressure, cyclical over-pessimism or strict capital requirements.

VII. Advantages of the More Detailed IS-LM Story

Vis-à-vis the usual IS-LM textbook story, the more detailed IS-LM story has ten advantages.

A. Advantage 1

While the usual IS-LM textbook story does mention "money", it does not say which money measure it actually means. At times it seems to refer to high-powered money, at other times to M1 money. The more detailed IS-LM story removes any ambiguity, clearly distinguishing between high-powered money on the one hand and M1 money on the other hand. This makes the IS-LM model more "tangible" and easier to understand.

B. Advantage 2

Based on the usual IS-LM textbook story, the IS-LM model is often criticized for describing a central bank that targets money. This is considered a weakness since most central banks today target an interest rate rather than money. The criticism has led to attempts to replace the LM curve with an interest rate rule (e.g. Romer 2000 in his IS-MP model).

The more detailed IS-LM story shows that the criticism may be overdone. Once a distinction is made between high-powered money and M1 money, the IS-LM model is extraordinarily well suited to describe monetary policy as it actually takes place (i.e.: central bank sets a policy rate and adjusts high-powered money so that the policy rate is met).

C. Advantage 3

In 2016, excess reserves in the US were about 1,600 times above their 1987-2007 average (2,204 vs. 1.36 billion USD, Federal Reserve 2017b). This is a remarkable increase. Together with quantitative easing, this is probably the main macro phenomenon of our times. Yet, the usual IS-LM textbook story is silent on excess reserves and quantitative easing.

The more detailed IS-LM story, in contrast, introduces excess reserves by distinguishing between high-powered money (which includes excess reserves) and M1 money. It shows that the efficiency of conventional monetary policy suffers if banks accumulate excess reserves. By this, it shows what prompted central banks in recent years to employ quantitative easing as a way of bypassing the clogged bank lending channel.

D. Advantage 4

Fractional-reserve banking is common today. This makes the money multiplier, which relates high-powered money and M1 money, an important concept. Unlike the usual IS-LM textbook story, the more detailed IS-LM story contains the money multiplier as it distinguishes between high-powered money and M1 money. It thus offers the chance to teach the money multiplier within the IS-LM model. This has the advantage that it becomes immediately apparent how both frameworks relate.

Bank and central bank balance sheets can also be easily introduced.

E. Advantage 5

Equations (1) and (2) above specify that $0 \leq C'(Y) < 1$ holds and that $L'(Y) > 0$ holds.

For $C'(Y)$ equal to zero, the IS curve shifts to the right by the increase in government spending; and for $C'(Y)$ between zero and one, the IS curve shifts to the right by more than the increase in government spending. Textbooks provide an intuition for the comparatively strong shift in the latter case (Keynesian cross).

For $L'(Y)$ between zero and one, the LM curve shifts to the right by more than the increase in money; for $L'(Y)$ equal to one, the LM curve

shifts to the right by the increase in money; and for L'(Y) greater than one, the LM curve shifts to the right by less than the increase in money. Textbooks do not provide an intuition for the comparatively strong shift in the first case. Nor do they provide an intuition for the comparatively weak shift in the third case.

In contrast, the more detailed IS-LM story provides such an intuition by showing that it is the M1 money multiplier which makes the LM curve shift. Depending on currency drain, excess reserves and required reserves, the LM curve may shift by very much or by very little.

F. Advantage 6

The IS-LM diagram depicts a quantity on the x-axis, a price (an interest rate) on the y-axis and a downward and an upward sloping curve. Thus, it appears like a market diagram. Yet, with the usual IS-LM textbook story, the analogy does not go through. This is because the usual IS-LM textbook story does not contain a "commodity" that is demanded and supplied subject to market forces. In contrast, the more detailed IS-LM story introduces just such a commodity (M1 money), allowing for a market diagram interpretation of the IS-LM model. Thus, students can put to good use prior knowledge of the market diagrams which they likely have.

G. Advantage 7

From the usual IS-LM textbook story, there is considerable uncertainty about the nature of the IS-LM model's interest rate (Romer 2000). In contrast, the more detailed IS-LM story is precise: The IS-LM model's interest rate is the interest rate which clears the market for M1 money. This market, in turn, consists of the bank lending market and the bond market.

H. Advantage 8

The IS-LM model includes money M and output Y. It also includes the price level P, although P is usually set equal to one and dropped from the IS-LM model. Because of the quantity equation of money ($MV \equiv PY$), the

IS-LM model thus implicitly includes also velocity of money, V. From the usual IS-LM textbook story it is, however, unclear which "velocity of money" might be meant as "money" itself is not defined. In contrast, the more detailed story defines money clearly, distinguishing between high-powered money on the one hand and M1 money on the other hand. Thus, velocity of money is also clearly defined.

I. Advantage 9

The usual IS-LM textbook story can be confusing for students as expansionary fiscal policy is said to increase output while "money" is assumed to be constant. Some students argue that, by closer inspection, output may thus actually not increase. After all, they say, the money that the government additionally spends has to come from somewhere. And if the money is by assumption not printed, it has to be taxed, or borrowed, out of the economy. Given that whoever gives up the money might have spent it as well, it is not obvious why output should increase.

This argument is sometimes called the "Treasury view" as it was advanced by staff of the UK Treasury in the 1930ies (Peden 2004). The argument is frequently "rediscovered" as Bridel (2014) notes. The usual IS-LM textbook story provokes such rediscoveries as it indeed leaves open the question where the government's additional money comes from.

The more detailed IS-LM story resolves the issue by distinguishing between high-powered money on the one hand and M1 money on the other hand. While high-powered money is assumed to be constant, M1 money increases with output in response to a fiscal expansion.

J. Advantage 10

Full-reserve banking is a relevant concept. More than one notable economist has advocated it over the years (Benes and Kumhof 2012). Switzerland is on the brink of a referendum regarding its possible introduction. Yet, from the usual IS-LM textbook story it appears as if the IS-LM model does not touch full-reserve banking. After all, required re-

serves do not seem to play a role. In contrast, the more detailed IS-LM story creates a link between the IS-LM model and full-reserve banking as it distinguishes between high-powered money (which includes required reserves) and M1 money.

VIII. Velocity of M1 Money

In section III, we assumed that velocity of M1 money, V1, equals one. We can drop this assumption anytime. In this case, equation (7) becomes:

$$M1V1 \equiv Y \tag{8}$$

For V1 greater than one, equation (8) means: For a given increase in M1 money, output increases by more than the increase in M1 money. This is because the newly created M1 money is spent on average more than once during the period under consideration. This "re-spending" brings about second-round effects which drive up output.

For V1 less than one, equation (8) means: For a given increase in M1 money, output increases by less than the increase in M1 money. This is because some of the newly created M1 money is not spent.

Apart from those "accelerating" or "decelerating" effects, the more detailed IS-LM story is unchanged for V1 being unequal to one.

IX. Conclusion

If "simplicity is the ultimate sophistication", as Leonardo da Vinci is alleged to have said, then simple models such as the IS-LM model have a place next to more complex models.

This paper aims to further improve the IS-LM model by being specific about its money measure(s). It does so in two steps.

Firstly, it assumes that the "M" of the LM equation reflects high-powered money.

Secondly, it adds the quantity equation of money with respect to M1 money ($M1V1 \equiv PY$). This is permissible as the quantity equation of money, as an identity, always holds true anyway.

From those two adjustments, an adjusted IS-LM model results which includes both high-powered money and M1 money. For it, we can tell a more detailed IS-LM story.

Vis-à-vis the usual IS-LM textbook story, the more detailed IS-LM story has ten advantages.

1. There is no ambiguity about what is meant by “money”;
2. Monetary policy is described as it actually takes place (central bank sets a policy rate and adjusts high-powered money so that the policy rate is met);
3. Quantitative easing is brought into the picture;
4. The M1 money multiplier is integrated into the IS-LM story;
5. An intuition is given for why the LM curve might shift to the right by more or less than the increase in money;
6. A market diagram interpretation of the IS-LM model opens up;
7. There is no ambiguity about the IS-LM model's interest rate;
8. There is no ambiguity about what is meant by “velocity of money”;
9. It guards against the “Treasury view” fallacy;
10. Full-reserve banking is brought into the picture.

Each point means that the more detailed IS-LM story has greater explanatory power than the usual IS-LM textbook story.

At the same time, model complexity is unchanged, with equations (1') and (2') not noticeably more difficult than equations (1) and (2).

Combined, this means that the more detailed IS-LM story improves the IS-LM model's explanatory-power-to-model-complexity ratio – the metric against which we should judge any model.

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