Mr. Keynes and the 'Classics' a Century Later: Reviewing the IS-LM model

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Abstract

The IS-LM model, formulated by Hicks in 1937, has been a cornerstone in macroeconomic pedagogy and policy analysis. Influential economists and textbooks – including Blanchard (2021), Mankiw (2016), and Samuelson and Nordhaus (1998) – have extensively relied on its stylised but clear representation of the key macroeconomic relations of a capitalist economy. Despite its popularity, the IS-LM model faces criticism for its static nature and incomplete accounting structure. This paper aims to address fundamental questions about the continued relevance of the IS-LM model. Specifically, it explores whether the model, when enriched with dynamics and stock-flow completeness, still exhibits the same qualitative behaviour. The findings of this paper suggest that the answer is negative. When assessing the implications of economic policy shocks, the original formulation of the IS-LM model may lead to misleading conclusions, mainly due to flow leakages and missing stock-flow links.

Keywords: IS-LM Model, Economic Dynamics, Macroeconomics, Monetary Policy, Stock-Flow Consistency

JEL Classification: E12, E52, E44, C61

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1 Introduction

The IS-LM model is by far the most popular pedagogical and policy tool in macroeconomics since its first formulation by Hicks (Hicks, 1937 [4]; and Modigliani, 1944[8]). The most influential economics textbooks all rely on that model for providing both an analytical and geometrical representation of the (short-run) macroeconomic equilibrium condition for a closed economy (e.g., Blanchard, 2021[1]; Mankiw, 2016[7]; Samuelson and Nordhaus, 1998[12]). World-leading macroeconomists still use it to support their analyses in their blogs and tweets (e.g., Krugman, Simon Wren-Lewis). The fact is that the IS-LM model seems a quite useful and agile tool to study the most likely implications of policy shocks in the short run.[1]

As is well known, the original IS-LM model is made up of two curves. The IS curve defines the equilibrium condition in the goods market. More precisely, it represents all the combinations of income levels and (real) interest rates for which investment (I) matches saving (S), hence aggregate demand equals total output. Conversely, the LM curve defines the equilibrium condition in the financial market. More precisely, it shows all the combinations of income levels and interest rates that make private demand for liquidity (L) match money supply, as set by the central bank. Clearly, the intersection of the IS and LM curves delivers the simultaneous equilibrium in both the goods market and the money market. Changes in monetary policy shift the LM curve, whereas changes in fiscal policy shift the IS curve. An increase in money supply has a symmetrical effect on output and interest rate but becomes ineffective in the horizontal segments of the LM curve (liquidity trap). Higher government expenditures or lower taxes are usually associated with a trade-off, as they support total output but also increase the interest rate, thus partially crowding out private demand. The magnitude of this crowding-out effect depends on the slope of the LM curve and tends to disappear as LM becomes flatter – we refer to the continuous lines in Figure 1 for a geometrical representation.

Despite its popularity, the IS-LM model appears to have some shortcomings and remains controversial as a basis for policy design. Firstly, the model only facilitates comparative statics exercises, allowing the identification of the new equilibrium position following a shock but not the trajectory followed by the economy (traverse). In other words, the model lacks dynamics. Secondly, the IS-LM model aims to derive the general equilibrium condition for the economy by intersecting a flow curve (the IS) with a stock curve (the LM). The problem arises from the fact that the accounting structure of the model is, at best, incomplete (e.g., Godley and Shaikh, 2002[3]; Wray, 2019[14]), as flows impact on stocks and stocks, in turn, produce flows – an issue that Hicks himself was aware of (Hicks, 1981[5]). This paper aims to address the following research questions: Is the IS-LM model still a decent, though stylised, representation of the way a capitalist economy works? What happens when its two major flaws (lack of dynamics and accounting incompleteness) are fixed? In other words, is it possible to develop a stock-flow consistent dynamic IS-LM model? And how does this affect alternative policy scenarios?

By revisiting the IS-LM framework through a stock-flow consistent and dynamic lens, this paper contributes to the broader debate on the suitability of conventional macroeconomic tools in informing monetary and fiscal policy. The analysis has direct implications for how central banks choose their operating targets, and for the robustness of fiscal policy evaluation in macroeconomic models.

The rest of this contribution is organised as follows. The second section discusses the model's

[1]Prices are assumed to be fixed (or at least exogenously set) in the short run. The model is complemented by a price-setting mechanism (the Phillips curve) to derive implications for the medium run in standard macroeconomics textbooks. This paper focuses on short-run effects, specifically employing the pure IS-LM model. However, section 3.6 demonstrates that the findings remain valid, and are indeed amplified, when a production function, market-clearing prices, and private firm security issuance are incorporated into the basic model.

accounting structure and present the behavioural equations and identities it comprises. The third section summarises the basic features of the model and derives the analytical solutions. We demonstrate that the steady-state value of national income depends on the interest rate level. However, the sign of the impact of the interest rate, in turn, depends on the values taken by the model's coefficients. This result is visualised by simulating the model. Lastly, it is shown that, although in principle the central bank can choose its policy instrument, controlling the stock of money is likely to have a destabilising impact on the economy, independently of the relative stability of the goods and money markets. We further discuss our results in section four.

2 Adding stock-flow consistency and dynamics

2.1 Accounting tables

The first step to ensure the accounting water-tightness of a macroeconomic model is to create the related balance sheet and transactions-flow matrix (Godley and Lavoie, 2006 [2]).

The analysis begins with the balance sheet. In the stylised economy considered by the IS-LM model, there are only two financial assets: money (or cash) and government bills. Money is issued by the central bank. It is assumed that neither private firms nor the government wish to hold idle balances. As a result, money is entirely held by households at the end of the period. By definition, the amount of bills not purchased by households is held by the central bank. For the sake of simplicity, only investment in circulating capital is considered. Consequently, there is no stock of fixed capital in the economy. The resulting balance-sheet matrix is represented in Table 1.

Table 1: Balance-sheet matrix of the basic IS-LM model

	Households	Firms	Central bank	Government	Σ
Money (liquidity)	$+L$		$-M$		0
Bills	$+B_h$		$+B_{cb}$	$-B_s$	0
Wealth	$-V$			$+V$	0
Σ	0	0	0	0	0

Notes: A '+' before a magnitude denotes an asset, whereas '-' denotes a liability.

Table 2: Transactions-flow matrix of the basic IS-LM model

	Households	Firms		Central bank	Government	Σ
		Current	*Capital*			
Consumption	$-C$	$+C$				0
Investment		$+I$	$-I$			0
Gov. spending		$+G$			$-G$	0
Income	$+W$	$-Y$	$+A$			0
Taxes	$-T$				$+T$	0
Interest paym.	$+r_{-1} \cdot B_{-1}$			$+r_{-1} \cdot B_{cb,-1}$	$-r_{-1} \cdot B_{s,-1}$	0
Seign. income				$-r_{-1} \cdot B_{cb,-1}$	$+r_{-1} \cdot B_{cb,-1}$	0
Δ in money	$-\Delta L$			$+\Delta M$		0
Δ in bills	$-\Delta B_h$			$-\Delta B_{cb}$	$+\Delta B_s$	0
Σ	0	0	0	0	0	0

Notes: A '+' before a magnitude denotes a receipt or a source of funds, whereas '-' denotes a payment or a use of funds.

The transactions-flow matrix is now examined. Households are the final recipients of production firms' incomes net of investment funding. For the sake of simplicity, it is assumed that taxes are only levied on households' gross income. The latter includes interest payments received on their holdings of government bills in addition to labor incomes paid by the firms. It is important to note that saving, calculated as the algebraic sum of incomes and expenditures, must match the total changes in net wealth components. As mentioned, since there is no banking sector, firms entirely fund their investment using internal funds or retained incomes. The resulting set of transactions and changes in stocks is displayed in Table 2.

The accounting structure of the model is now fully outlined. In the next section, it is used to derive (or verify) the key identities of the model. Behavioral equations are inspired by the typical assumptions underlying the IS-LM model: investment is a growing function of output (taken as a proxy for expected demand) and a decreasing function of the interest rate; saving is a growing function of both income and the interest rate; liquidity demand is a growing function of (disposable) income and a decreasing function of the interest rate. For the sake of simplicity, each component of the two curves is expressed as a linear function. Prices are set exogenously. The original static IS-LM framework is turned into a dynamic model by simply adding lags to the regressors of behavioral equations.[2]

2.2 The system of equations

Investment (in circulating capital) and saving flows are defined, respectively, as:

$$I = \iota_0 - \iota_1 \cdot r_{-1} + \iota_2 \cdot Y_{-1} \tag{1}$$

$$S = YD - C \tag{2}$$

where ι_1 is (the absolute value of) the interest rate elasticity of investment, r is is the (real) interest rate, ι_2 is the elasticity of investment to expected demand, Y is national income, YD is households' disposable income, and C is consumption.

The last two variables are defined, respectively, as:

$$YD = W + r_{-1} \cdot B_{h,-1} - T \tag{3}$$

$$C = \alpha_1 \cdot YD + \alpha_2 \cdot V_{-1} \tag{4}$$

where W is total labour income (including both workers' wages and managers' salaries) distributed by the firms to the households, B_h is the stock of bills held by the households, T is total taxes, α_1 is the marginal propensity to consume out of income, and α_2 is the marginal propensity to consume out of wealth, V.[3]

Note that, since there are no banks, it is implicitly assumed that investment is funded out of firms' internal funds. This is the reason the income households receive from firms, W, is calculated net of internal funds, A:

$$W = Y - A \tag{5}$$

$$A = I \tag{6}$$

Plugging equation (3), (4) and (5) into (2), we can re-define the equation of private saving as a growing function of national disposable income and interest rate:

$$S = (Y - A + r_{-1} \cdot B_{h,-1} - T) \cdot (1 - \alpha_1) - \alpha_2 \cdot V_{-1} \tag{2B}$$

[2]The final structure of the model resembles that proposed by Oreiro et al., 2018[10], although there are a few differences concerning behavioural equations, particularly the investment function.

[3]Equation (4) is the so-called Modigliani consumption function (see Modigliani, 1954[9]; also Godley and Lavoie, 2006 [2]).

While government spending is taken as completely exogenous, taxes are calculated by using an average tax rate on gross total income:

$$T = \theta \cdot (W + r_{-1} \cdot B_{h,-1}) \quad (7)$$

Even though it is not strictly necessary, this choice allows stabilising the dynamics of the model, as it balances the government budget in the steady state.

Let us now turn to the demand component of the LM curve, which can be defined based on Tobin (1958[13])'s portfolio theory:

$$\frac{L}{V} = \lambda_0 + \lambda_1 \cdot \frac{YD}{V} - \lambda_2 \cdot r$$

from which:

$$L = \lambda_0 \cdot V + \lambda_1 \cdot YD - \lambda_2 \cdot r \cdot V \quad (8)$$

Equation (8) implies that households' share of liquidity to total wealth is a growing function of disposable income (transactions motive) and a decreasing function of the interest rate (precautionary and speculative motives).

For the sake of consistency, since there are only two financial assets, the stock of bills held by the households must amount to:

$$B_h = V - L \quad (9)$$

Households' net wealth accumulates as households save:

$$V = V_{-1} + S \quad (10)$$

Looking at the supply side, new bills are issued as the government runs into budget deficits, therefore:

$$B_s = B_{s,-1} + G + r_{-1} \cdot (B_{s,-1} - B_{cb,-1}) - T \quad (11)$$

where G is government spending, and B_{cb} is the stock of bills held by the central bank. The latter returns to the government the interest payments received on the bills that are not held by the households.

Accounting consistency requires that the amount of central bank's holdings of bills be:

$$B_{cb} = B_s - B_h \quad (12)$$

National income – for a closed economy – is defined as:

$$Y = C + I + G \quad (13)$$

In principle, the central bank can either set the interest rate, and let money supply (M) adjust to demand (L), or set money supply, and allow the interest rate (r) to adjust accordingly. These can be regarded as alternative closures for the model. The former implies a flat LM curve. The latter is associated with the 'traditional' upward-sloping LM curve.

2.3 Exogenous money closure

This option, which is the one traditionally chosen by macroeconomics textbooks,[4] is tantamount to assuming that the interest rate adjusts in such a way to make the demand for

[4] Please refer again to Mankiw (2016)[7], and Samuelson and Nordhaus (1998)[12].

liquidity match the exogenous supply. The equilibrium value of the interest rate can be derived by replacing L with M in equation (8) and then solving for r:

$$r = \frac{\lambda_0 \cdot V + \lambda_1 \cdot YD - M}{\lambda_2 \cdot V} \tag{14A}$$

Since all the variables and parameters involved in equation (14A) are positive, the condition to ensure that the interest rate does not fall below zero is: $\lambda_0 \cdot V + \lambda_1 \cdot YD \geq M$. The higher the liquidity preference, captured by coefficients λ_0 (autonomous liquidity to wealth ratio) and λ_1 (transactions motive), the higher the interest rate required for households to forgo liquidity. Consequently, a lower disposable income and a lower wealth are sufficient to satisfy the non-negative interest rate condition.

As for the supply of money, it is exogenously set by the monetary authorities:

$$M = \bar{M} \tag{15A}$$

A problem with this formulation is that it overlooks the way money enters the system in the real world, in which central banks can hardly control monetary aggregates. Besides, we will show that this policy choice makes the interest rate (and the economy) quite volatile.

2.4 Endogenous money closure

The central bank pursues the conventional monetary policy by setting the level of the policy rate. The supply of money adjusts to the resulting demand for liquidity at that level of the interest rate. Since there are only two financial assets in this simplified model, this is tantamount to holding that money is created as long as the central bank subscribes the government bills that are not held by the private sector. Therefore, the interest rate is exogenous set:

$$r = \bar{r} \tag{14B}$$

whereas the stock of money supplied by the central bank is:

$$M = M_{-1} + \Delta B_{cb} \tag{15B}$$

As mentioned, this closure implies a flat LM curve, as money is created based on households' demand for liquidity. Given its replication of the approach employed by major central banks in the real world, this method has recently been adopted by some macroeconomics textbooks (e.g., Blanchard, 2021[1]).

2.5 Consistency requirements

Any complete and coherent model must contain an equation that is redundant, meaning that it is logically implied by all the others (Walras' Law). In this model, the redundant or hidden equation depends on the chosen closure.

In the exogenous money version of the model, the hidden equation is the one matching the supply of money with the amount of government bills held by the central bank. It can be derived from the fourth column of Table 1:

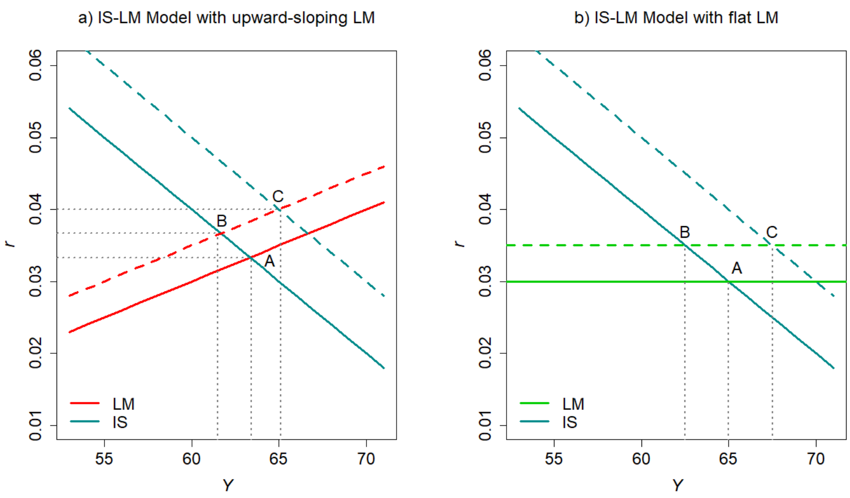
$$M = B_{cb}$$

The former is defined by equation (15A), whereas the latter is independently defined by equation (12).

In the endogenous money version, the hidden equation is the one matching the supply of money with the related demand. It can be derived from the second row of Table 1:

$$M = L$$

Figure 1: Equilibrium arising from intersecting the IS and the LM curves



The former is defined by equation (15B), whereas the latter is independently defined by the portfolio equation (8).

If the model is complete and consistent, then the equilibrium defined by the hidden equation is always fulfilled. Therefore, the related equation must be excluded from the model when calculating its solutions. In fact, it can be conveniently used to double-check its accounting coherence.

3 Findings

3.1 Summing up: basic structure of the IS-LM model

The model developed in section 2 is a dynamic and stock-flow consistent version of the standard IS-LM model, developed by Hicks and popularised by intermediate macroeconomics textbooks ever since. The key common behavioural equations of the model are:

$$I = \iota_0 - \iota_1 \cdot r_{-1} + \iota_2 \cdot Y_{-1} \tag{1}$$

$$S = (Y - A + r_{-1} \cdot B_{h,-1} - T) \cdot (1 - \alpha_1) - \alpha_2 \cdot V_{-1} \tag{2B}$$

$$L = \lambda_0 \cdot V + \lambda_1 \cdot YD - \lambda_2 \cdot r \cdot V \tag{8}$$

Additional key equations for the upward-sloping LM curve case are:

$$r = \frac{\lambda_0 \cdot V + \lambda_1 \cdot YD - M}{\lambda_2 \cdot V} \tag{14A}$$

$$M = \bar{M} \tag{15A}$$

Conversely, additional key equations for the flat LM curve case are:

$$r = \bar{r} \tag{14B}$$

$$M = M_{-1} + \Delta B_{cb} \tag{15B}$$

As shown in the previous sections, the model must be completed with assumptions about policy instruments, investment funding, and income distribution – equations (5), (6) and (7) in this simple rendition – and identities derived from a correct macroeconomic accounting.

3.2 Analytical solutions

Before simulating the model, its properties can be analysed by identifying its steady-state solutions. The steady-state value of national income can be calculated by noting that in the stationary state the government budget must be balanced (Godley and Lavoie, 2007, p. 112[2]). Remembering that total government expenditure includes interest payments to households, one obtains:

$$G + r_{-1} \cdot B_{h,-1} = \theta \cdot (W + r_{-1} \cdot B_{h,-1})$$

from which, using equations (1), (5) and (6) into equation (7), one gets:

$$G + r_{-1} \cdot B_{h,-1} = \theta \cdot [Y - (\iota_0 - \iota_1 \cdot r_{-1} + \iota_2 \cdot Y_{-1}) + r_{-1} \cdot B_{h,-1}]$$

Solving for the (quasi) steady-state value of national income, one gets:

$$Y^* = \left\{ \frac{G}{\theta} + r \cdot \left[\frac{B_h^* \cdot (1-\theta)}{\theta} - \iota_1 \right] + \iota_0 \right\} \cdot \frac{1}{1-\iota_2} \tag{13S}$$

where the asterisks show the steady-state values of the associated variables.

Equation (13S) shows us that the (quasi) steady state level of national income depends on the level of the interest rate.[5] More precisely:

a) if $B_h^* \cdot (1-\theta)/\theta > \iota_1$, a higher (positive) interest rate is associated with a higher level of national income in the steady state;

b) in contrast, if $B_h^* \cdot (1-\theta)/\theta < \iota_1$, a higher (positive) interest rate is associated with a lower level of national income in the steady state;

c) lastly, if $B_h^* \cdot (1-\theta)/\theta = \iota_1$, the steady-state level of national income is unaffected by the interest rate level.

Summing up, both the magnitude and the sign of the impact of the interest rate on the steady-state level of national income crucially depend on the interest rate elasticity of investment (ι_1) and the average tax rate (θ).

3.3 Identification and model baseline

Numerical simulations can now be used to display model dynamics over time. For this purpose, economically meaningful values are assigned to model parameters and exogenous variables, and then the cross-period behaviour of national income and other endogenous variables is observed under alternative monetary policy scenarios. The chosen coefficients are shown by Table 3.

In the simulations, the stock of money is allowed to grow at the same rate of output under the exogenous-money policy scenario.[6] Simulations were conducted using *R*. A time span of 100 periods was considered, with simultaneous solutions for the system of equations found by imposing 200 iterations per period.[7]

Model variables dynamics over time under the baseline scenario is displayed by Figure 2. More precisely, pane (*a*) shows the adjustment of national income to its steady-state value when the central bank uses either the interest rate (continuous line) or the quantity of money (dashed line) as its policy instrument. Pane (*a*) displays the related adjustment in the interest rate.

[5] The reason Y^* is not a fully developed steady-state solution for national income is that it still depends on the level of household holdings of bills.

[6] As a result, equation (15A) becomes: $M = M_{-1} \cdot (1 + g)$, where $g = (Y/Y_{-1}) - 1$. The qualitative findings of this paper are confirmed, and even strengthened, if a fully-exogenous growth rate for M is used.

[7] The *R* code is available upon request.

Table 3: Model parameters and exogenous variables

Symbol	Description	Value
ι_0	Autonomous investment	2
ι_1	Elasticity of investment to interest rate (absolute value)	20
ι_2	Elasticity of investment to expected demand	0.05
α_1	Marginal propensity to consume out of disposable income	0.6
α_2	Marginal propensity to consume out of net wealth	0.4
λ_0	Autonomous share of liquidity demand to disposable income	0.1
λ_1	Elasticity of liquidity demand to disposable income	0.1
λ_2	Elasticity of liquidity demand to interest rate (absolute value)	2
θ	Average tax rate on income	0.20
G_0	Government expenditure	10
M_0	Initial value of money supply	1
$\bar{r}$	Target policy rate	0.03

3.4 The paradox of the interest rate

Figure 3 shows that, for the set of parameters defined by Table 3, tight monetary policy – whether conducted through monetary restriction or a policy rate increase – implies a higher level of national income. This corresponds to case (*a*) in section 3.1. Intuitively, the reason is that a higher interest rate implies increased interest payments from the government to the private sector (households), thereby supporting consumption. If the decrease in investment expenditures is insufficient to offset the rise in consumption, the final effect on demand and output will be positive.

Note that the considerations above hold only as long as the interest rate is positive or there is a zero-lower bound (ZLB). Figure 4 shows the stabilising effect of the ZLB on national income dynamics. Conversely, if the interest rate is allowed to fall into negative territory, this might actually lead to an improvement in national income over time, given the chosen set of coefficient values. This evidence raises questions about quantitative policies, as it turns out that their effectiveness is neither automatic nor linear. Instead, it will depend on both the market level of the interest rate *and* the specific identification of the model.

A geometrical representation of the adjustment process is provided by Figure 1. Starting from the state described by point A, the reduction in the monetary base (pane (*a*)) or a direct increase in the interest rate (pane (*b*)) shift the LM curve upwards. The new LM curve (dashed red line) intersects the IS curve at point B, characterised by a higher interest rate and a lower national income. This is the story told by the standard macroeconomic textbooks. What the traditional story usually overlooks is that the higher interest rate, in turn, shifts upwards the IS curve (dashed blue line), because of the higher amount of interest payments from the government. The new equilibrium point, C, may or may not be still marked by a lower national income, depending on the specific values taken by the coefficients θ (tax rate) and ι_1 (elasticity of investment to interest rate) as well as the amount of bills held by the households.

This seemingly paradoxical finding (a higher national income associated with a higher interest rate, but only as long as the latter is positive) allows for a more general observation about the IS-LM model: the IS bloc of equations and the LM bloc are *not* independent.[8] Consequently, intersecting a supposedly independent IS curve with a supposedly independent LM curve to identify the equilibrium condition for the two markets and then performing the well-known standard comparative statics exercises is not even an approximate method for studying basic macroeconomic relations. Rather, it is a wrong method, which may lead to misleading conclusions.

[8]This argument recalls the well-known critique by Keynes (1936)[6] of neoclassical theory, highlighting that the saving curve is not independent of the investment curve.

Figure 2: Traverse and steady states: baseline dynamics

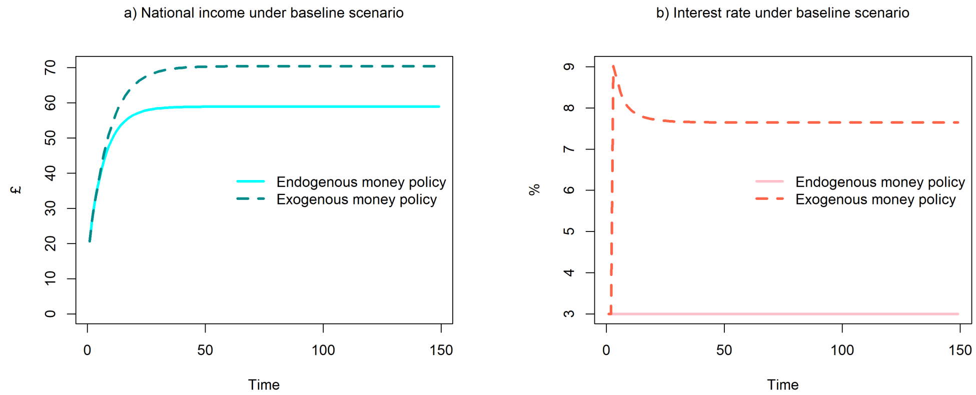
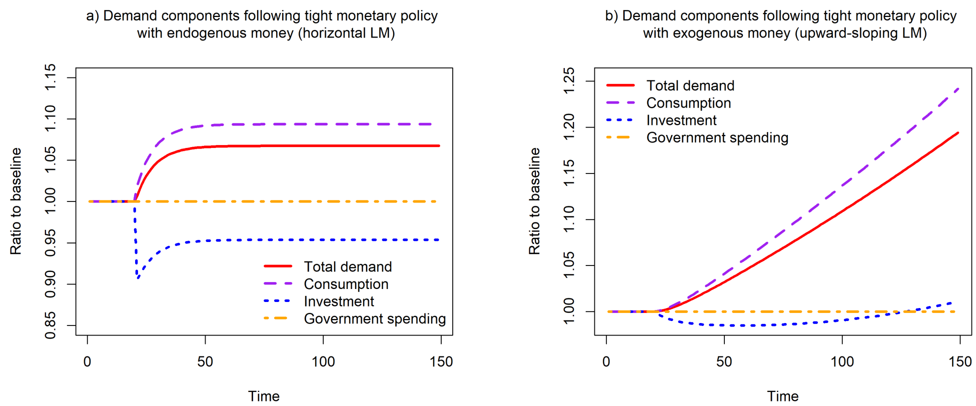


Figure 3: Tight monetary policy shocks



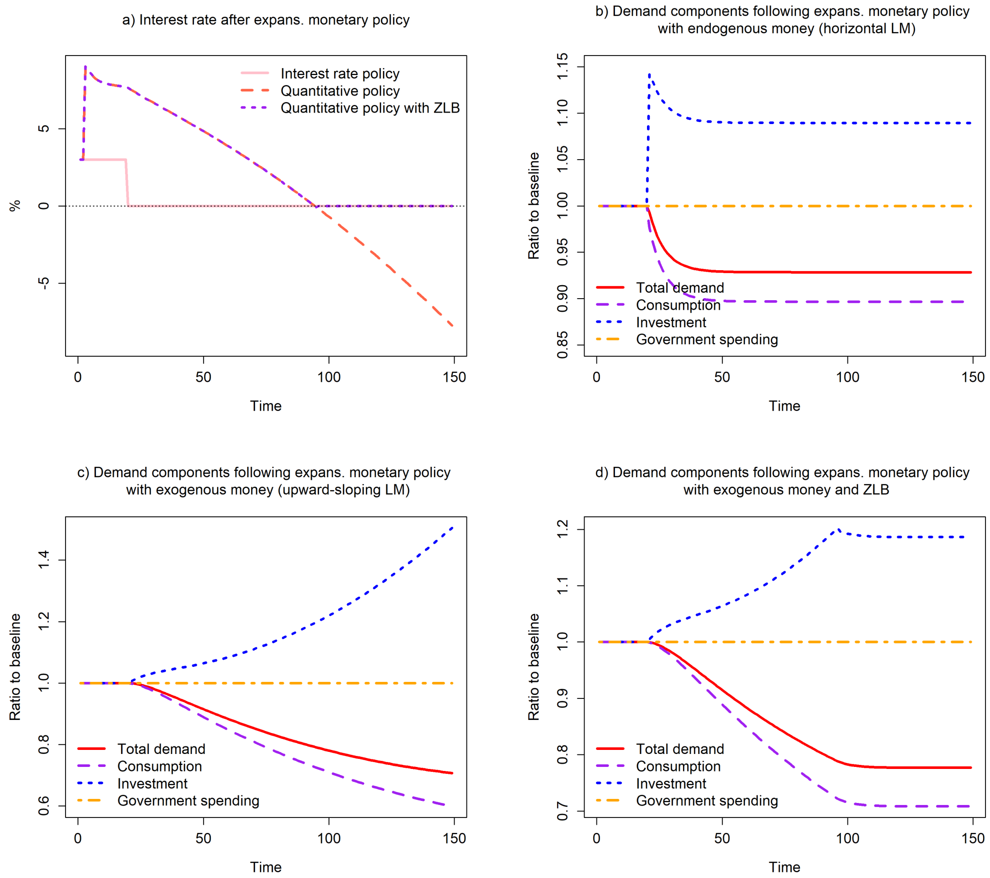
3.5 Controlling the money stock is destabilising

In a path-breaking article, Poole argues that the optimal choice of monetary policy instruments must be based on the relative degree of volatility of real versus financial variables and parameters. In short, if the goods market is more volatile than the money market, then the monetary authorities 'should set the money stock while letting the interest rate fluctuate as it will' (Poole, 1970, p. 199[11]). In the opposite situation, the authorities should set the policy rate, 'while the money supply is allowed to fluctuate as it will' (*ibidem*).

The simulations above show that, even if it were feasible, controlling monetary aggregates while letting the interest rate fluctuate always makes the economy unstable, provided model's stock-flow consistency and completeness requirements are met.

To see this, it is enough to examine pane (*b*) in Figure 2 and/or compare pane (*a*) with pane (*b*) in the Figure 3. In order to adjust liquidity demand to the exogenous supply of money, the interest rate needs to change over time, continuously altering both households' portfolio choices and firms' investment plans. The destabilising effect of this policy option is apparent.

Figure 4: Expansionary monetary policies under different monetary rules



Most importantly, this instability does not depend on financial markets being more volatile than the real economy, but rather on the destabilising effect brought about by an unstable interest rate. Arguably, this is the true reason why, in the real world, central banks prefer announcing interest rate targets rather than monetary aggregate targets.

3.6 Production, prices and private security issuance

Before concluding, it should be noted that the model can be easily extended to incorporate medium-run features of neoclassical-Keynesian models – notably price flexibility and a production function – along with other common assumptions (e.g., private security issuance).

The first step is to use a neoclassical production function to define the natural or potential level of output.[9] A Cobb-Douglas function with constant returns of scale is used here:

$$Y_n = A_k \cdot K^{\alpha} \cdot N^{(1-\alpha)} \tag{14}$$

where, as usual, A_k is the Solow coefficient or total factor productivity and α is the output elasticity of capital.

[9] While the logical and empirical issues surrounding the neoclassical production function are well recognised, it is used here to remain consistent with the assumptions of the neoclassical-Keynesian model.

The level of employment is not completely exogenous. It adjusts to economic conditions:[10]

$$\Delta N = \gamma_n \cdot \Delta Y \tag{15}$$

where γ_n defines the speed of the adjustment of the employment level.

The unit price of output grows (falls) as current output exceeds (falls below) potential output:

$$P = P_{-1} \cdot \exp\big[\gamma_p \cdot (Y_{-1} - Y_{n,-1})\big] \tag{16}$$

where γ_p defines the speed of the adjustment of the unit price.

The real capital stock grows as investment is undertaken, net of depreciation:

$$K = K_{-1} + I - \delta_k \cdot K_{-1} \tag{17}$$

where δ_k is the depreciation rate.

A new investment function is used, according to which real investment adjusts to align the current fixed capital stock with the target level:[11]

$$I = \gamma_k \cdot (K^T_{-1} - K_{-1}) + \delta_k \cdot K_{-1} \tag{1M}$$

where γ_k is the speed of adjustment of current capital to the target stock.

The latter is defined as:

$$K^T = \kappa \cdot Y \tag{18}$$

where κ is the target capital to output ratio, which, in turn, negatively depends on the real interest rate on private securities:

$$\kappa = \kappa_0 - \kappa_1 \cdot (r_{e,-1} - \pi_{-1}) \tag{19}$$

where κ_0 and κ_1 are positive coefficients, $r_e = r_b = \bar{r}$, and π is the inflation rate ($\pi = \Delta P/P$).

The equation for saving is redefined to include the price level:

$$S = YD - C \cdot P \tag{2M}$$

Similarly, the equation for disposable income is redefined as:

$$Y = W + r_{b,-1} \cdot B_{h,-1} + r_{e,-1} \cdot E_{h,-1} - T \tag{3M}$$

Real consumption is a decreasing function of the price level:

$$C = \alpha_1 \cdot \frac{YD}{P} + \alpha_2 \cdot \frac{V_{-1}}{P} \tag{4M}$$

Labour incomes are:

$$W = Y \cdot P - A - r_{e,-1} \cdot E_{h,-1} \tag{5M}$$

Internal funds now cover capital depreciation:

$$A = \delta_k \cdot K_{-1} \cdot P \tag{6M}$$

Taxed incomes now include interest payments on private securities:

$$T = \theta \cdot (W + r_{b,-1} \cdot B_{h,-1} + r_{e,-1} \cdot E_{h,-1}) \tag{7M}$$

[10] This assumption is not strictly necessary. However, the higher the degree of exogeneity of the employment, the more exogenous money policies bring about instability.

[11] Once again, this assumption aims at stabilising the model.

Liquidity demand is redefined as:

$$L = \lambda_0 \cdot V + \lambda_1 \cdot YD - \lambda_2 \cdot r_b \cdot V - \lambda_3 \cdot r_e \cdot V \tag{8M}$$

Private securities are issued to fund firms' investment plans:

$$E_s = E_{s,-1} + \Delta(P \cdot K) \tag{20}$$

Since there are no banks, and households own the firms, real investment in fixed capital must be entirely funded through households' savings, hence:[12]

$$E_h = E_s \tag{21}$$

As a result, households' holdings of T-bills are redefined as:

$$B_h = V - L - E_h \tag{9M}$$

Lastly, the equation defining the supply of T-bills becomes:

$$B_s = B_{s,-1} + G \cdot P + r_{-1} \cdot (B_{s,-1} - B_{cb,-1}) - T \tag{11M}$$

The other equations of the model remain unchanged.

Figure 5: Tight monetary policy shocks in a complete model

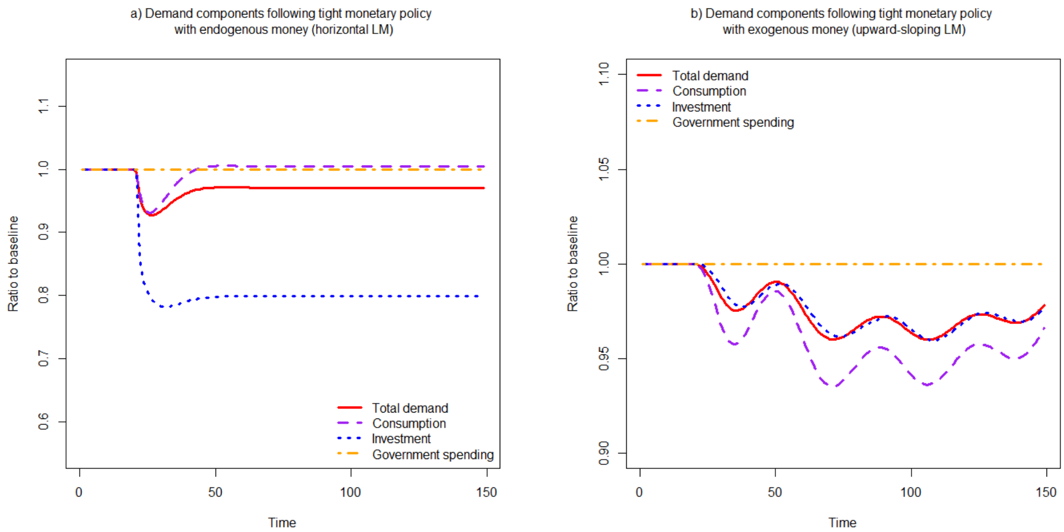


Figure 5 shows the effects of tight monetary policy under both horizontal and upward-sloping LM curves. This time, the coefficients are selected to ensure a decline in output following a contractionary monetary policy. However, once again, the instability induced by the exogenous money closure becomes evident when comparing the trends in the components of aggregate demand in quadrant (a) with those in quadrant (b). This corroborates the qualitative insights obtained from the simplified model discussed in the previous sections

[12]This is tantamount to assuming that banks are included in the household sector and always accommodate firms' demand for funding.

4 Final remarks

The purpose of this paper was to explore whether the IS-LM model, when enriched with dynamics and stock-flow completeness, still exhibits the same qualitative behavior as the original framework. Both analytical and numerical findings suggest that the answer is negative. When assessing the implications of economic policy shocks, the (original) IS-LM model is likely to lead to misleading conclusions, mainly due to the presence of flow leakages and missing stock-flow links. For instance, tight monetary policy may lead to an increase in output due to the higher flow of interest payments from the government to the private sector. In comparative statics terms, the increase in the LM curve is more than offset by an increase in the IS curve, which is triggered by the former.[13] The issue is that the two curves depend on one another. It is important to stress that these findings have been obtained using standard – that is, linear and 'well-behaved' – IS and LM curves in a closed economy. The coefficient-specific impact of monetary policy on national income is thus an inherent feature of any properly constructed IS-LM model. Unfortunately, this means that the original IS-LM model should be dismissed as both a pedagogical and a policy tool, including the most recent version of it featuring a flat LM curve. In particular, while the flat-LM version seems more in line with what central banks actually do and allows avoiding instability issues (which affect the upward-sloping version), it is still affected by the same incompleteness and staticity issues. Policy modelling requires tools that are not only analytically tractable but also institutionally realistic and internally coherent. In this respect, any version of the IS-LM model falls short, particularly when applied to simulate the effects of monetary or fiscal interventions in dynamic environments. For policymakers and institutions concerned with macro-financial stability, the results of this study are particularly salient. They suggest that targeting monetary aggregates – as occasionally advocated in policy circles – can be destabilising even under benign assumptions. Moreover, the finding that tight monetary policy may have expansionary effects under certain conditions highlights the need for careful model specification and calibration. These insights reinforce the importance of using macroeconomic models that incorporate explicit sectoral balances and behavioural dynamics when informing public policy. In place of IS-LM models, one or a set of stock-flow consistent and dynamic models should be used, capable of capturing the economic and financial complexity inherent in modern economies. Both economics students and policymakers would benefit greatly from this perhaps painful but long-overdue change in the teaching and dissemination of macroeconomics and policy modelling.

[13]In principle, the model might be expanded to account for the impact of functional income distribution. For instance, one could assume that the average propensity to consume out of income is a negative function of the interest rate (as suggested by Godley and Lavoie, 2007, section 4.6.3[2]). The rationale is the adverse effect on consumption of redistributing income from wage earners to rentiers. This change would imply a negative impact of a tight monetary policy in the short run – given the chosen set of coefficient values – although it would eventually increase the steady-state level of national income due to higher saving, hence greater wealth accumulation, and consequently, higher holdings of interest-bearing assets (government bills) by the private sector.

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