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Macroeconomics without the LM: A Post-Keynesian Perspective

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Abstract

Romer (2000) provides an alternative model to the AS/AD and IS/LM models that abandons the LM schedule by having the short-term interest rate set by the central bank. His framework acknowledges the critical role of the central bank in determining short-term interest rates, which moves mainstream macroeconomics closer to Post Keynesian monetary theory.

The current paper presents a Post Keynesian construction of macroeconomics without an LM schedule. Rather than describing the financial sector in terms of an exogenously determined interest rate set by the central bank, the model unpacks financial markets by fully specifying a banking sector. The key analytic feature of the Post Keynesian approach is to replace the money market with the loan market. That makes transparent the macroeconomic significance of the loan market and bank behavior, and generates an endogenous money supply driven by bank lending. If banks become more optimistic over the cycle and lower their interest rate mark-up, that increases the likelihood of instability.

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I Introduction

Romer (2000) provides an alternative model to the AS/AD and IS/LM models that abandons the LM schedule and recognizes that the short-term interest rate is set by central banks. Such a framework acknowledges the critical role of the central bank in determining short-term interest rates, moving mainstream macroeconomics closer to Post Keynesian monetary theory. However, Romer's framework leaves the role of the financial sector and bank lending invisible, and these are features Post Keynesians have long argued are central to monetary macroeconomics.

The current paper presents an alternative Post Keynesian construction of macroeconomics without an LM schedule, the key analytic feature of which is to replace the money market with the loan market. This sharply distinguishes the Post Keynesian approach from the neo-Keynesian ISLM approach. It is not an exogenous interest rate that is the defining difference: it is the role of banks and bank lending.

The model makes transparently clear the macroeconomic significance of the loan market and bank behavior, and has an endogenous money supply that is driven by bank lending. If banks become more optimistic over the cycle and lower their interest rate mark-up, that increases the likelihood of instability.

A second difference from Romer is that rather than having a natural level of output and a vertical Phillips curve, the model allows equilibrium output to vary and there is an inflation – output trade-off. That makes the model explicitly Keynesian.

Finally, like Romer, the model is a closed economy model. That constitutes the starting point, and expanding it to an open economy context to take account of globalization is a future step. However, whether there are significant novel theoretical (as opposed to policy) implications from globalization for Post Keynesian macroeconomics remains unclear and awaits further theoretical articulation.

II The basic model

One challenge in analyzing the financial sector and monetary policy is to avoid conflating financial sector issues with real sector issues. The economy consists of a financial and real sector, and they interact as shown in Figure 1. Thus, price and quantity developments in the financial sector affect outcomes in the real sector, and vice-versa. This interaction makes it important to distinguish effects caused by the specification of the financial sector from effects due to the specification of the real sector.

The focus of the current paper is on the operation of the financial sector, and to avoid conflating financial and real sector effects the paper adopts a simple textbook Keynesian description of the real sector. In particular, this means excluding income distribution effects arising from changes in worker bargaining power, which have been a major focus of Post Keynesian research regarding the real sector.

The basic model consists of a goods market and a financial sector. The goods market is governed by a standard Keynesian closure in which output adjusts to equal aggregate demand, as follows:

(1) $y = E$

(2) $E = E(y, i_L, B, L_{-1}, D_{-1}, A_1, A_2, .\ )$ $\quad E_y > 0, E_{iL} < 0, E_B > 0, E_L < 0, E_D > 0,$

$E_{A1} > 0, E_{A2} > 0$

Where y = output, E = aggregate demand (AD), i_L = loan interest rate, B = new borrowing, L_{-1} = last period's stock of debt, D_{-1} = last period's stock of bank deposits, A_1 = pure shock to animal spirits, and A_2 = joint shock to animal spirits and liquidity preference. For the time being the assumption is that inflation is zero. Income, borrowing, and the stock of debt are in real terms and are deflated by the price level (which can be thought of as normalized at unity). The assumed signs of the partial derivatives of the arguments of the AD function are as indicated.

Equation (1) is the goods market clearing condition, while equation (2) specifies the AD function. The level of AD depends positively on the flow of new borrowing. New borrowing finances spending: loan repayments lower spending. New borrowing adds to outstanding debt, which has a negative impact on next period spending. However, new borrowing also creates bank deposits through the lending activities of banks, and that adds to wealth and increases AD.

The financial sector is described by the following set of equations

(3) $B = L - L_{-1}$

(4) $L = L(i_L, y, A_1, A_2)$ $\qquad L_{iL} < 0,\ L_y > 0,\ L_{A1} > 0,\ L_{A2} > 0$

(5) $i_L = i_F + m(A_3, A_4, \ldots)$ $\qquad i_F \geq 0, m(.) \geq 0,\ m_{A3} > 0,\ m_{A4} > 0$

(6) $A_3 = \alpha A_2$ $\qquad \alpha < 0$

Where L = loan demand, i_L = bank loan market interest rate, i_F = money market interest rate, m = interest rate spread between money market rate and loan rate, A_3 = joint animal spirits – liquidity preference shock, and A_4 = pure financial sector liquidity preference shock.

Equation (3) defines new borrowing. Equation (4) specifies loan demand, which depends negatively on the loan interest rate and positively on the level of income. The two animal spirits shocks positively impact loan demand. Equation (5) determines the market interest rate in terms of a spread over the money market rate. It can be thought of as the bank mark-up, and this spread depends on the liquidity preference of financial institutions. This liquidity preference captures the state of financial market confidence and assessments of risk. The money market interest rate is exogenously set by the central bank. Equation (6) specifies the joint liquidity preference – animal spirits shock.

There are three types of shock. A_1 is a pure "animal spirits" goods market shock that only affects spending. Its impact is positive. A_4 is a pure financial sector liquidity preference shock that only affects credit market spreads. Its impact is to raise the spread.

A_2 and A_3 are joint animal spirits – liquidity preference shocks that affect both the goods market and the financial sector. The animal spirits shock raises confidence and AD and it simultaneously reduces liquidity preference (i.e. increases the confidence of banks), which lowers interest spreads. This pattern is a structural co-movement and not statistical covariance, and it reflects how changes in confidence that affect real spending can be mirrored in financial sector behavior.

The structural connection between liquidity preference and animal spirits has been emphasized by Kregel (1984/5) who sees them as two sides of the same coin. There is also a parallel with Davidson's (1965) treatment of Keynes' finance motive as increases in animal spirits increase the finance demand for money. Consequently, positive shocks to effective demand are structurally linked to positive shocks in the financial sector. The neo-Keynesian ISLM model's failure to capture these structural connections and its representation of them as statistical co-variances was a major failing of the model.

Figure 2 illustrates the determination of the short run level of output. Combining equations (1) and (2) yields the familiar IS schedule.[1] The financial sector, represented by equation (5), determines the loan rate. The loan rate then affects the level of AD, thereby influencing the level of output.

The comparative statics of the basic model are given by

$dy/di_F < 0$ $\quad$ $di_L/di_F > 0$

$dy/dA_1 > 0$ $\quad$ $di_L/dA_1 = 0$

$dy/dA_2 > 0$ $\quad$ $di_L/dA_2 < 0$

$dy/dA_4 < 0$ $\quad$ $di_L/dA_4 > 0$

Increases in the policy interest rate lower income and raise the loan rate. Pure animal spirits shocks (A_1) raise income and have no affect on the loan rate. Pure liquidity preference shocks (A_4) raise the interest rate and lower income. Joint animal spirits - liquidity preference shocks (A_2) raise income and lower rates, a pattern that is hard to generate and explain within the conventional neo-Keynesian ISLM model. This illustrates the importance of such shocks.

III Endogenizing bank mark-ups and credit spreads

In the previous section the bank mark-up/credit spread was unaffected by the level of economic activity and lending. However, bank mark-ups may respond endogenously to real and financial sector developments. In this case the loan rate can be re-specified as

(5') $i_L = i_F + m(L(i_L, y, A_1, A_2), y, A_3, A_4, \ldots)$ $\qquad$ $m_L > 0, m_Y < 0$

[1] For most Post Keynesians the major failing of the ISLM model is its treatment of the financial sector in terms of an LM schedule that lacks reference to bank lending and endogenous money. A smaller group of Post Keynesians associated with the Cambridge U.K. school also question the IS schedule, believing it may be upward sloping due to capital re-switching effects. However, empirical estimates of aggregate effective demand find a negative relation with real interest rates, and that is the assumption built into equation (2).

Equation (5') has the credit spread responding positively to the level of lending and negatively to the level of income.

The positive response to lending is consistent with both the structuralist (Palley, 1987/88; Pollin, 1991) and horizontalist (Wray, 1991; Lavoie, 1996) views of endogenous money. According to structuralists, credit markets can become congested owing to financing limitations of individual firms and limited portfolio demands on part of banks and others to hold loans. According to horizontalists, spreads may also increase due to the worsening credit quality of marginal borrowers as the loan pool grows – an argument that is also supported by structuralists.

The interest rate spread or mark-up can also fall in response to expansions of income. This reflects a Minskyian psychological channel whereby economic expansions improve the "confidence" of lenders and investors, leading them to lower required risk premiums. Such an outcome might be associated with the transition from hedge to speculative finance (Minsky, 1975, 1986).

The reduced form of equation (5') yields a mark-up given by

(5'') $i_L = i_F + m(y, A_1, A_2, A_3, A_4) \quad m_Y \gtrless 0$

The interesting and novel feature is that the bank mark-up may therefore rise or fall with income. It rises if the loan volume effect dominates and falls if the Minskyian confidence effect dominates. The loan volume effect refers to the impact of credit market congestion and/or deteriorating borrower quality.

The bank loan rate schedule given by equation (5'') constitutes an effective loan supply schedule as it determines the terms on which credit is made available. In a Post Keynesian monetary framework loan demand and the bank loan rate schedule are the critical determinants of interest rates. This contrasts with the neo-Keynesian ISLM model that emphasizes the role of money supply and money demand. From a Post Keynesian perspective the LM schedule (liquidity – money) is replaced by an LL schedule (liquidity – loans).

Figures 3.a, 3.b, and 3.c show three different LL schedules derived under different assumptions about the behavior of bank mark-ups and credit spreads. Figure 3.a assumes that credit spreads are exogenously fixed, generating a horizontal LL schedule. Figure 3.b assumes that credit spreads rise with income, generating a positively sloped LL schedule. Figure 3.c assumes that credit spreads fall with increases in income, generating a negatively sloped LL schedule.

The short run equilibrium level of output is then determined by combining the IS and LL schedules, which are given respectively by

(6.a) $y = E(i_L, L_{-1}, D_{-1}, A_1, A_2)$

(6.b) $i_L = i_F + m(y, A_1, \alpha A_2, A_4)$

Graphically, the short run equilibrium output and interest rate are determined by the intersection of the IS and LL schedules drawn in loan rate – output space. Figure 4 shows the determination of equilibrium for the case where the IS schedule is negatively sloped and the LL schedule is positively sloped.

If the Minskyian confidence effect on the loan mark-up dominates the loan volume effect, the LL schedule is negatively sloped. If the LL schedule is more negatively sloped than the IS schedule, it is easy to intuit that the economy might be unstable. This is because increases in AD cause expansions in income that in turn raise financial market confidence, which lowers the loan interest rate. That in turn causes a further expansion in AD and output. This pattern fits with Minsky's (1992) description of his financial instability hypothesis.

IV Monetary aggregates in the Post Keynesian model

Whereas the ISLM model has the money supply determined by the money multiplier, Post Keynesian endogenous money theory emphasizes the loan multiplier (Coghlan, 1978). This reflects a reversal of causation whereby it is loans that create deposits rather than deposits creating loans.

The operation of the loan multiplier and the determination of the money supply can be described by adding the following equations describing the banking sector.

(7) $L + R = D$

(8) $R = kD$ $\qquad 0 \leq k \leq 1$

(9) $L = L(i_L, y, ..)$

(10) $D = D(i_D, y, q)$ $\qquad D_{iD} > 0, D_y > 0, D_q > 0$

(11) $i_F = [1 + k]\beta i_D$ $\qquad \beta > 1$

Where R = required reserves, D = demand deposits, k = required reserve ratio for deposits, q = equity prices, and i_D = interest rate on deposits.

Equation (7) is the banking sector's balance sheet constraint. Equation (8) determines required reserve holdings. Equation (9) is the aggregate loan demand function. Equation (10) is the demand for bank deposits (i.e. money demand). It is a positive function of the deposit interest rate and income. It is also a positive function of stock prices, reflecting that when stock prices are higher stock dividend yields are lower, making bank deposits relatively more attractive. Finally, equation (11) links the deposit rate to the money market rate. Deposits and money market borrowing are both sources of funds to individual banks, and they therefore equalize the marginal costs of these funding sources (Palley, 1987/88). The cost of deposits includes the reserve requirement that must be held on each dollar of deposits (k) plus administrative costs (β). Hence the true cost of deposits is the interest rate (i_D) scaled up to incorporate reserve requirement and administration costs.

Combining equations (7) and (8) and rearranging yields

(12) $L = [1-k]D$

Where [1-k] is the loan multiplier. Loans create deposits that are then loaned out by banks. The amount that can be re-loaned depends on the reserve requirement ratio that determines how much of each deposit the banks must retain. A higher reserve requirement ratio (k) therefore lowers the multiplier as banks must hold on to more of each deposit.

First differencing equation (12) provides the relation between loan creation, new borrowing, and deposit creation, which is as follows

(13) $L - L_{-1} = B = [1-k][D - D_{-1}]$

Figure 4 shows the determination of the money supply and stock prices for a given level of income. The northeast quadrant describes the loan market in which banks satisfy all loan demand at the loan interest rate that is a mark-up over the money market rate. The southeast panel shows the loan multiplier, and it determines the money supply.

The northwest panel constitutes the money market, which works as follows. The banking system determines the money supply via the volume of lending, and the money (deposits) that is created must be willingly held (Goodhart, 1989; Palley, 1991; Howells, 1995). Money demand is therefore brought into alignment with money supply through equity price adjustment. If agents have excess money balances, they buy equities. This drives up equity prices until they are content to hold the existing stock of deposits. This equilibrating process results in a positive relationship between the money supply and equity prices. Thus, increases in bank lending that increase the money supply (stock of deposits) generate an increase in equity prices.

Note, as currently specified, the money market, money demand and equity prices are separable from rest of model, given by the IS and LL equations that summarize the real sector and the banking sector. This simplifies presentation of the model by keeping it to a two dimensional space. However, if equity prices are added as arguments of the AD and loan demand functions, the model becomes a simultaneous Post Keynesian short run general equilibrium model determining outcomes in the goods market, the loan market, and the money market.[2] That makes it difficult to represent graphically as there are three endogenous variables: income (y), the loan rate (i_L), and stock prices (q).

Analytically, the significance of making AD depend positively on stock prices is to make the effects of endogenous money more expansionary. This is because increased lending expands the money supply, causing stock prices to rise, which in turn further increases AD and output.

V Adding inflation

Inflation is an important part of the economic environment, and the model can be expanded to include its effects. Introducing inflation introduces a distinction between nominal and real interest rates. The financial sector determines the nominal interest rate

[2] The rationale for AD depending on equity prices would be a stock market wealth effect, which would make AD a positive function of q. The rationale for loan demand depending on equity prices is that firms might shift to equity financing when equity prices are high and the cost of equity capital low, thereby

while goods market decisions depend on the real rate.

This pattern can be captured by adding an equation for the real interest rate and re-specifying AD as follows

(2') $E = E(y, r_L, \pi, B, L_{-1}, D_{-1}, A_1, A_2, \dots)$ $\qquad E_\pi > 0$

(14) $r_L = i_L - \pi$

where r_L = real interest rate and π = inflation rate. Inflation has two expansionary effects on AD. First, it lowers the real interest rate via equation (14). Second, it causes agents to bring forward spending plans in anticipation of higher prices, which raises AD via equation (2').

Figure 5 shows the basic model of the goods market amended to include the effect of inflation. There are now two interest rates – the nominal and the real – to be determined, along with the level of output. Banks set a nominal interest rate that is a mark-up over the nominal money market rate that is set by the monetary authority. Given the rate of inflation, this bank nominal loan rate then determines a real interest rate that determines AD, which in turn determines output in the goods market.

The money market and stock market will also be affected by inflation because inflation affects money demand. This can be captured by re-specifying the demand for deposits to include inflation as an argument, as follows:

(10') $D = D(i_D, \pi. y, q)$ $\qquad D_{iD} > 0, D_\pi < 0. D_y > 0, D_q > 0$

According to this specification inflation reduces the demand for deposits as it is akin to a tax on money. Holders of deposits therefore try to switch out of them by buying equity, which drives up equity prices. However, the stock of deposits is determined by bank

making loan demand a negative function of q.

lending so that trying to switch out of deposits by buying equity does not reduce the money supply. Instead, equity prices must increase so that the dividend yield falls until agents are willing to hold the money balances created by the banking system's lending activity.

VI Adding monetary policy

Monetary policy operates through the money market rate that the central bank controls. In the U.S. this rate is the federal funds rate. Policy can be conceptualized as the monetary authority setting a nominal money market interest rate with the goal of hitting output target, y^*. This implies a target money market rate of

(15) $i_F^* = E^{-1}(y^*, m(L(.), y, A_3, A_4,) - \pi, B, L_{-1}, D_{-1}, A_1, A_2, \ldots)$

The economic logic behind the target selection rests on the monetary authority working backward from its output target to an interest rate setting consistent with hitting that target.

Thus, a given output target implies a needed level of AD. Given the parameters of AD that implies a needed real loan rate. Given the inflation rate, that implies a needed nominal loan rate. Given the parameters of the banking sector's mark-up, that nominal loan rate implies a needed nominal money market rate, which is the target interest rate.

The target money market rate is a negative function of the output target (y^*), a negative function of banks' mark-up (m), and a positive function of inflation (π). It is also a positive function of factors that increase AD, and a negative function of factors that decrease AD.

VII Endogenizing inflation

So far inflation has been taken as given. However, inflation can be endogenized by adding a Phillips curve, which can be either a demand-pull or a conflict inflation Phillips curve.

A simple linear version of the Phillips curve is given by

(15) $\pi = a_0 + a_1 y$

Equation (15) implies that inflation is a positive function of the level of output. A straightforward implication of such a Phillips curve is that targeting the level of output is equivalent to targeting a particular rate of inflation.

Given the above Phillips curve, the nominal interest rate target becomes

(15') $i_F^* = E^{-1}(y^*, m(L(.), y, A_3, A_4,) - \pi, B, L_{-1}, D_{-1}, A_1, A_2,\dots)$

$= E^{-1}(y^*, m(L(.), y, A_3, A_4,) - a_0 - a_1 y^*, B, L_{-1}, D_{-1}, A_1, A_2,\dots)$

where y^*= the target output level. Alternatively, the target interest rate can be expressed in terms of a target inflation rate as follows

(15") $i_F^* = E^{-1}(y, m(L(.), y, A_3, A_4,) - \pi^*, B, L_{-1}, D_{-1}, A_1, A_2,\dots)$

$= E^{-1}([\pi^* - a_0]/a_1, m(L(.), y, A_3, A_4,) - \pi^*, B, L_{-1}, D_{-1}, A_1, A_2,\dots)$

where $\pi^* = a_0 + a_1 y^*$. Endogenizing inflation therefore results in a nominal interest rate policy rule that can be expressed as a function of either an output target or an inflation target.

From a Post Keynesian perspective inflation targeting is equivalent to output targeting. The problem is that inflation targeting obscures that reality, and by obscuring that reality can result in sub-optimal policy choices. Thus, because inflation is a bad, policy makers may lean toward a sub-optimally low inflation target with significant output losses if they are unaware of the fact that an inflation target is also implicitly an output target. That is why inflation targeting is an undesirable public policy frame

(Palley, 2007).

The interest rate policy functions given by equations (15') and (15") can be represented in both output – interest rate space and inflation - interest rate space, and the reaction functions trace out the nominal money market interest rate required to hit a target level of output or inflation. The nominal money market interest rate then implies a nominal loan market rate and a real interest rate.

These interest rate functions are conditional on the state of AD and the Phillips curve, and changes in variables affecting AD or the parameters of the Phillips curve shift these functions. For instance, an increase in goods market animal spirits (A_1) will shift the interest rate functions up. The economic logic is that the higher animal spirits increase AD, calling for a lower target interest rate to hit any level of output.

An increase in bank liquidity preference (A_4) will shift the interest rate functions down. The logic is that increased bank liquidity preference raises credit market spreads and the market real interest rate. To hit a given output target policy must therefore lower the real rate, which calls for a downward shift of the nominal interest rate policy function.

Lastly, an adverse shift in the Phillips curve will shift up the nominal interest rate policy function. The logic is that each output level is now associated with a higher rate of inflation. To maintain the real interest rate consistent with any given output target, the nominal policy rate must rise. Consequently the policy interest rate function shifts up along its entirety.

The slope of the nominal interest rate policy function is ambiguous, and it can be positively or negatively sloped with respect to output. This ambiguity is because the required nominal interest rate is subject to conflicting forces. On one hand, an increase in the output target needs a lower real interest rate that calls for a lower nominal rate. On the other hand, an increase in the output target raises inflation which calls for a higher nominal rate to prevent excessive reduction in the real rate.

There are three factors affecting the slope of the policy interest rate function: 1) the interest sensitivity of AD; 2) the slope of the Phillips curve; and 3) the behavior of the bank mark-up.

The policy interest rate function will tend to be positively sloped in output – interest rate space if 1) AD is sensitive to the real interest rate, 2) the Phillips curve is steep so that inflation rises rapidly with output, and 3) the credit spread is insensitive to output or even narrows with output. In this case, the central bank will need to raise nominal interest rates with output to stop the real rate from falling too far.

The nominal interest rate policy function will tend to be negatively sloped in output – interest rate space if 1) AD is in sensitive to the real interest rate, 2) the Phillips curve is relatively flat, and 3) the credit spread is increases with output. In this case, the central bank will need to lower nominal interest rates with output in order to lower the real rate and sustain a level of AD consistent with a higher output target.

The slope of the nominal interest rate policy function can give rise to interesting dynamics of interest rate adjustment when the monetary authority changes its output target. Thus, suppose the authority raises its output target, and therefore lowers its nominal policy rate to stimulate demand. Given the initial inflation rate, this lowers the real interest rate, causing output and inflation to increase. As inflation increases, the monetary authority may then need to start raising the nominal rate to achieve the real rate consistent with the new output target.

VII Stability analysis

Thus far the analysis has focused on static equilibrium outcomes and comparative static effects. The appendix provides a simple linear version of the model with a Keynesian dynamic adjustment equation of the form

(16) $\Delta y = \psi[E_{-1} - y_{-1}]$ $0 < \psi < 1$

According to this adjustment mechanism output responds to last period's excess demand conditions, partially closing the gap in the current period. If ψ is large, then the output response to excess demand is large: if ψ is small, the reverse holds.

Given such an adjustment mechanism the linear system of equations reduces to a second order difference equation in output. As is well known, such an equation can generate convergent (stable) or divergent (unstable) outcomes, and the current model fits this pattern.

However, it is worth considering the case where (a) the Minsky confidence effect dominates the loan congestion effect ($m_y < 0$) so that the loan rate mark-up falls as output expands; (b) new borrowing has a large positive impact on AD (E_B is large); and (c) the absolute value of the AD wealth effect of bank deposits and bank loans is the same ($|E_L| = |E_D|$). In this event one of the necessary stability conditions may be violated so that the model is unstable.

The economic logic is simple. New borrowing strongly expands AD and output, causing the loan rate mark-up and the loan rate to fall, in turn generating further expansion of AD and output. Such a process is the hallmark of a Minskyian business cycle.

Lastly, if AD is strongly sensitive to inflation (E_π is large) this also increases the likelihood of instability. That is because of the Tobin –Mundell effect (Tobin 1965, 1975) whereby inflation causes agents to shift away from money and increase spending, thereby further increasing AD and inflation.

VIII Conclusion

This paper has presented a macro model of economy that incorporates a Post Keynesian construction of the financial sector. The key analytic feature of the model that distinguishes it from the neo-Keynesian ISLM model is replacement of the money market with the loan market. The model makes transparently clear the macroeconomic significance of the loan market and bank behavior, and has an endogenous money supply that is driven by bank lending. If banks become more optimistic over the cycle and lower their mark-up, that increases the likelihood of instability.

Appendix

This appendix explores the dynamic stability properties of a linear version of the model developed in the main body of the paper. The linear model is given by the following equations:

(A.1) $\Delta y = \psi[E_{-1} - y_{-1}]$ $\quad 0 < \psi < 1$

(A.2) $E = \varepsilon_0 + \varepsilon_1 y + \varepsilon_2[i_L - \pi] + \varepsilon_3\pi + \varepsilon_4 B + \varepsilon_5 L_{-1} + \varepsilon_6 D_{-1}$ $\quad \varepsilon_0, \varepsilon_1, \varepsilon_3, \varepsilon_4, \varepsilon_6 > 0; \varepsilon_2, \varepsilon_5, < 0$

(A.3) $\pi = \rho_0 + \rho_1 y$ $\quad \rho_0, \rho_1 > 0$

(A.4) $i_L = i_F + m$

(A.5) $m = m_0 + m_1 y$ $\quad m_0 > 0,\ m_1 \gtrless 0$

(A.6) $B = L - L_{-1}$

(A.7) $L = \lambda_0 + \lambda_1 i_L + \lambda_2 y$ $\quad \lambda_0, \lambda_2 > 0; \lambda_1 < 0$

(A.8) $D = \delta_0 + \delta_1 i_D + \delta_2 q + \delta_3 y$ $\quad \delta_0, \delta_1, \delta_3 > 0;\ \delta_2 < 0$

(A.9) $i_D = i_F/[1 + k]\beta$ $\quad k, \beta > 0$

(A.10) $L = [1 - k]D$

Equation (A.1) describes the output adjustment process, which is driven by a Keynesian excess demand mechanism. As discussed in the text, the equilibrium version of the model can be reduced to a two equation system consisting of an IS (goods market equilibrium) and LL (loan market equilibrium schedule).

Equation (A.1) – (A.3) describe the real economy and include the Phillips curve. Equations (A.4) – (A.10) describe the financial sector, including the banking sector.

The dynamics of the model have the loan and stock markets always being in equilibrium, but the goods market can be out of equilibrium and marked by excess demand. In effect, the dynamics of the model have desired borrowing equal to actual borrowing and desired portfolio holdings equal to actual portfolio holdings, but there can be excess demand in goods markets. That excess demand drives future output adjustment.

Equations (A.3) – (A.10) can be used to solve the current values of i_L, i_D, and q. These are given respectively by:

(A.11) $i_L = i_F + m_0 + m_1 y$

(A.12) $i_D = i_F/[1 + k]\beta = zi_F$ $\quad z = 1/[1 + k]\beta$

(A.13) $q = \{\lambda_0 + \lambda_1 m_0 - [1 - k]\delta_0 + [\lambda_1 - [1 - k]\delta_1 z]i_F + [\lambda_1 m_1 + \lambda_2 - [1 - k]\delta_3]y\}/[1 - k]\delta_2$

Substituting equations (A.11) – (A.13) into equations (A.7) and (A.8) yields

(A.14) $L = \lambda_0 + \lambda_1[m_0 + i_F] + [\lambda_1 m_1 + \lambda_2]y$

(A.15) $D = [\lambda_0 + \lambda_1 m_0]/[1-k] + \lambda_1 i_F/[1-k] + [\lambda_1 m_1 + \lambda_2]y/[1-k]$

Substituting (A.3), (A.6), (A.14), and (A.15), into equation (A.2) yields

(A.16) $E = \varepsilon_0 + \varepsilon_2[i_F + m_0 - \rho_0] + \varepsilon_3\rho_0 + \varepsilon_5[\lambda_0 + \lambda_1[m_0 + i_F]] + \varepsilon_6[\lambda_0 + \lambda_1 m_0 + \lambda_1 i_F]/[1-k]$

$+ \{\varepsilon_1 + \varepsilon_2[m_1 - \rho_1] + \varepsilon_3\rho_1 + \varepsilon_4[\lambda_1 m_1 + \lambda_2]\}y - \{\varepsilon_4 - \varepsilon_5 - \varepsilon_6\}[\lambda_1 m_1 + \lambda_2]y_{-1}$

Lagging equation (A.16) yields

(A.17) $E_{-1} = \varepsilon_0 + \varepsilon_2[i_F + m_0 - \rho_0] + \varepsilon_3\rho_0 + \varepsilon_5[\lambda_0 + \lambda_1[m_0 + i_F]] + \varepsilon_6[\lambda_0 + \lambda_1 m_0 + \lambda_1 i_F]/[1-k]$

$+ \{\varepsilon_1 + \varepsilon_2[m_1 - \rho_1] + \varepsilon_3\rho_1 + \varepsilon_4[\lambda_1 m_1 + \lambda_2]\}y_{-1} - \{\varepsilon_4 - \varepsilon_5 - \varepsilon_6\}[\lambda_1 m_1 + \lambda_2]y_{-2}$

Rearranging equation (A.1) yields

(A.1’) $y = [1 - \psi]y_{-1} + \psi E_{-1}$

Substituting equation (A.17) into (A.1’) yields

(A.19) $y = \psi\{\varepsilon_0 + \varepsilon_2[i_F + m_0 - \rho_0] + \varepsilon_3\rho_0 + \varepsilon_5[\lambda_0 + \lambda_1[m_0 + i_F]] + \varepsilon_6[\lambda_0 + \lambda_1 m_0 + \lambda_1 i_F]/[1-k]\}$

$+ [1 - \psi + \psi\{\varepsilon_1 + \varepsilon_2[m_1 - \rho_1] + \varepsilon_3\rho_1 + \varepsilon_4[\lambda_1 m_1 + \lambda_2]\}]y_{-1}$

$- \psi\{\varepsilon_4 - \varepsilon_5 - \varepsilon_6\}[\lambda_1 m_1 + \lambda_2]y_{-2}$

Equation (A.19) can then be re-written as

(A.20) $y = a_0 + a_1 y_{-1} + a_2 y_{-2}$

where $a_0 = \psi\{\varepsilon_0 + \varepsilon_2[i_F + m_0 - \rho_0] + \varepsilon_3\rho_0 + \varepsilon_5[\lambda_0 + \lambda_1[m_0 + i_F]] + \varepsilon_6[\lambda_0 + \lambda_1 m_0 + \lambda_1 i_F]/[1-k]\}$

$a_1 = 1 - \psi + \psi\{\varepsilon_1 + \varepsilon_2[m_1 - \rho_1] + \varepsilon_3\rho_1 + \varepsilon_4[\lambda_1 m_1 + \lambda_2]\}$

$a_2 = - \psi\{\varepsilon_4 - \varepsilon_5 - \varepsilon_6\}[\lambda_1 m_1 + \lambda_2]$

The necessary and sufficient conditions for stability (Gandolfo, 1985, p.59) are

$1 + a_1 + a_2 > 0$

$1 - a_2 > 0$

$1 - a_1 + a_2 > 0$

Inspection of the stability condition reveals that the model can be stable or unstable, depending on the parameter values. However, it is worth considering the case where $m_1 < 0$, ε_4 is large, and $|\varepsilon_5| = |\varepsilon_6|$.

$m_1 < 0$ implies the Minsky confidence effect dominates the loan congestion effect, so that the loan rate mark-up falls as output expands. ε_4 is large says that new borrowing has a large positive impact on AD. $|\varepsilon_5| = |\varepsilon_6|$ implies the absolute value of the AD wealth effect of bank deposits and bank loons is the same.

These signings unambiguously imply $a_1 > 0$ and $a_2 < 0$. In this case if $|a_1|$ and $|a_2|$ are both large, the stability condition $1 - a_1 + a_2 > 0$ may be violated so that the model is unstable.

The economic logic is simple. New borrowing strongly expands AD and output, causing the loan rate mark-up and the loan rate to fall, in turn generating further expansion of AD and output. Such a process is the hallmark of a Minskyian business cycle.

Lastly, if AD is strongly sensitive to inflation (ε_3 large) this also increases the likelihood of instability by increasing the absolute value of a_1. This is because of the Tobin –Mundell effect whereby inflation causes agents to shift away from money and increase spending, thereby further increasing AD and inflation.

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Figure 1. The Economy

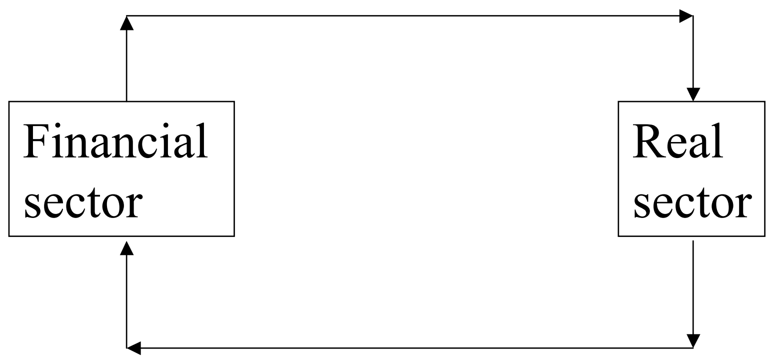

Figure 2. The Basic Model

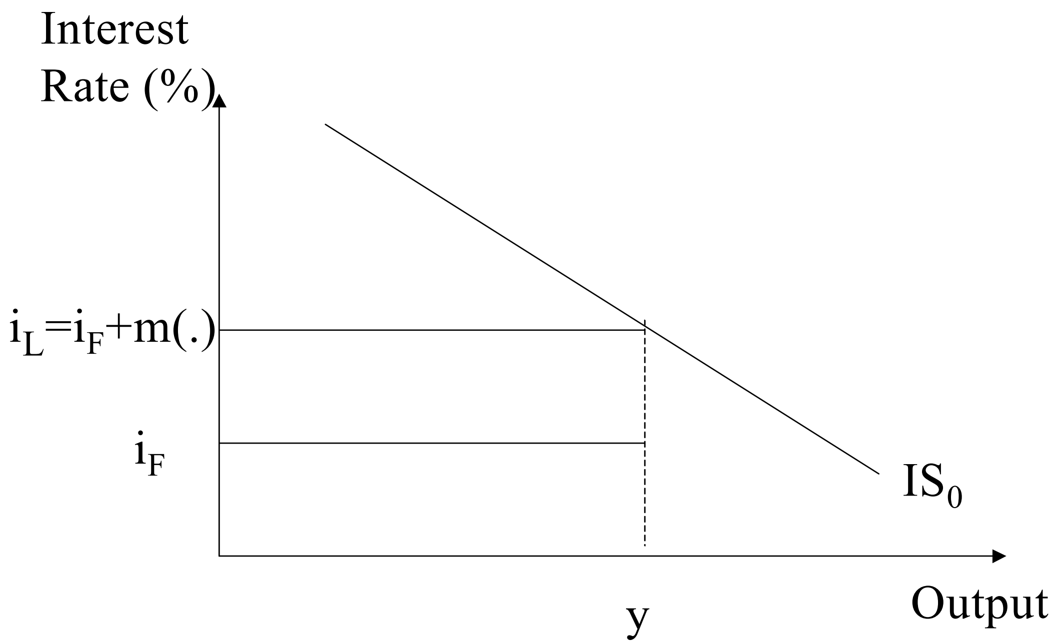

Figure 3.a. Horizontal LL ($y_0 < y_1$)

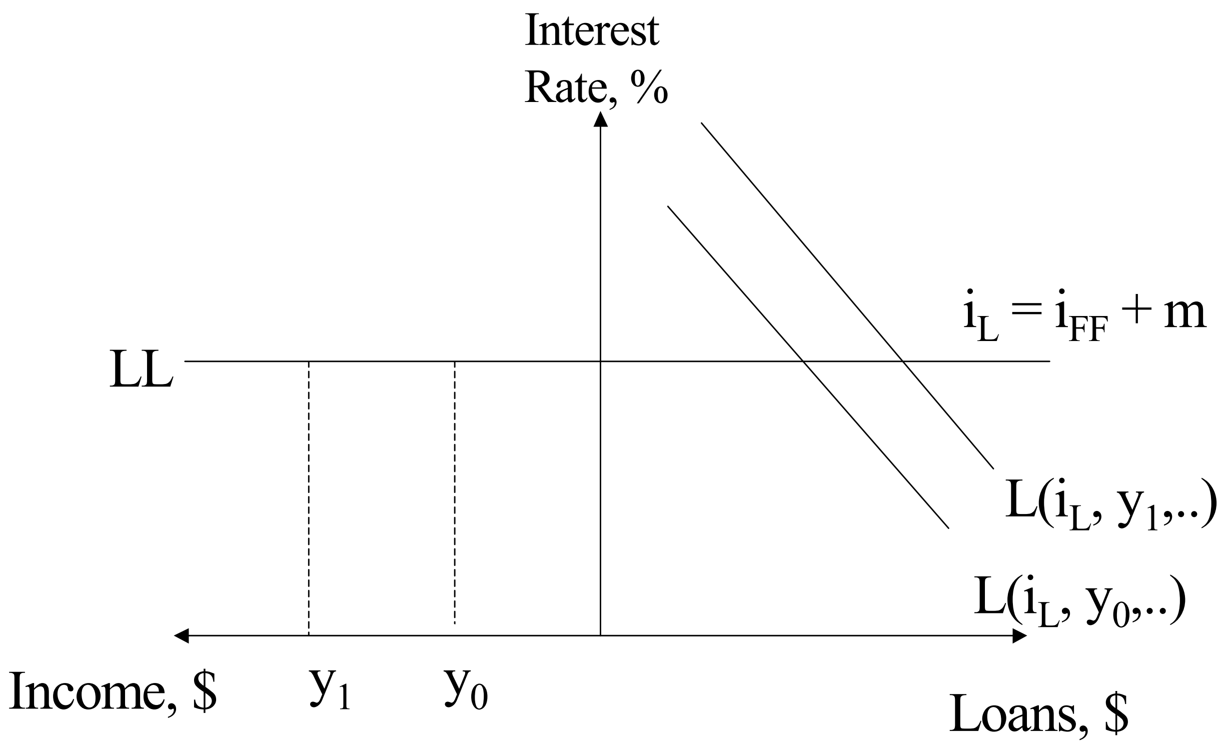

Figure 3.b. Positively sloped LL ($y_0 < y_1$)

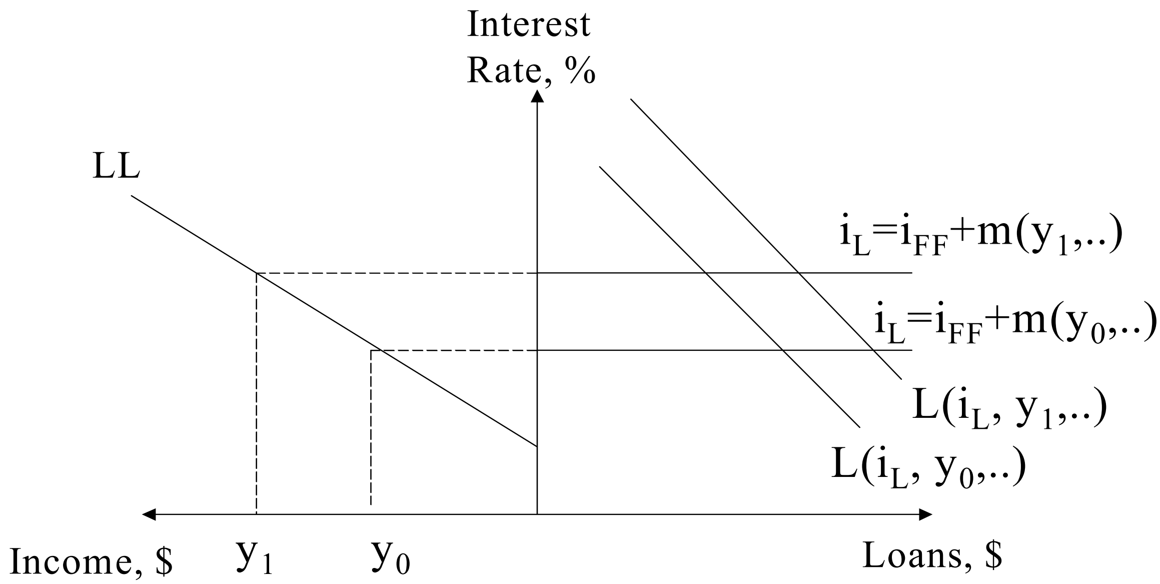

Figure 3.c. Negatively sloped LL ($y_0 < y_1$)

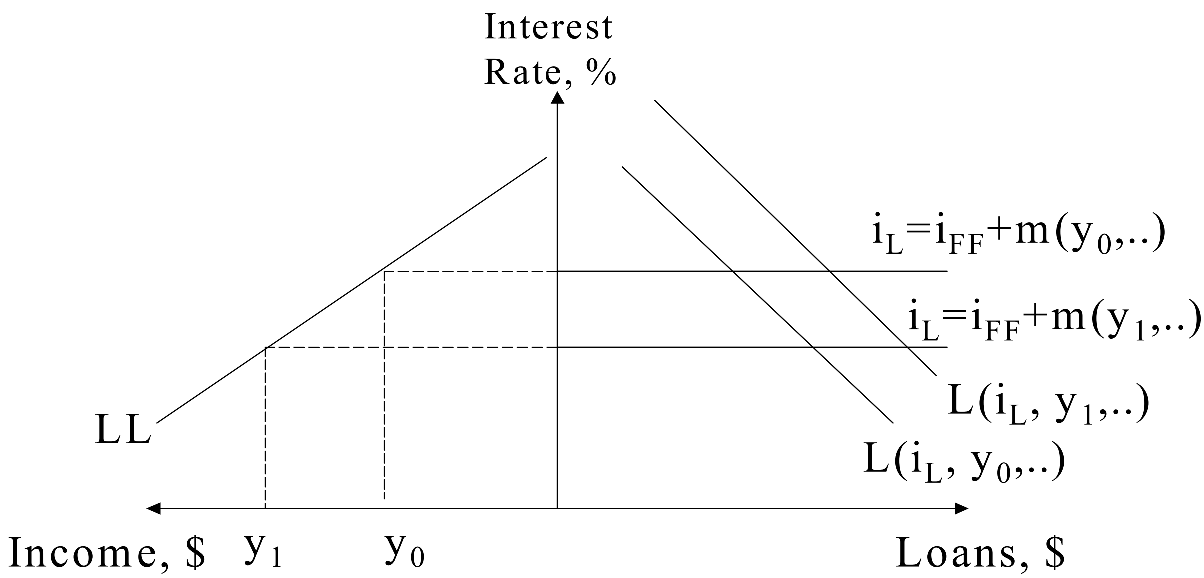

Figure 4: Determination of the money supply and stock prices

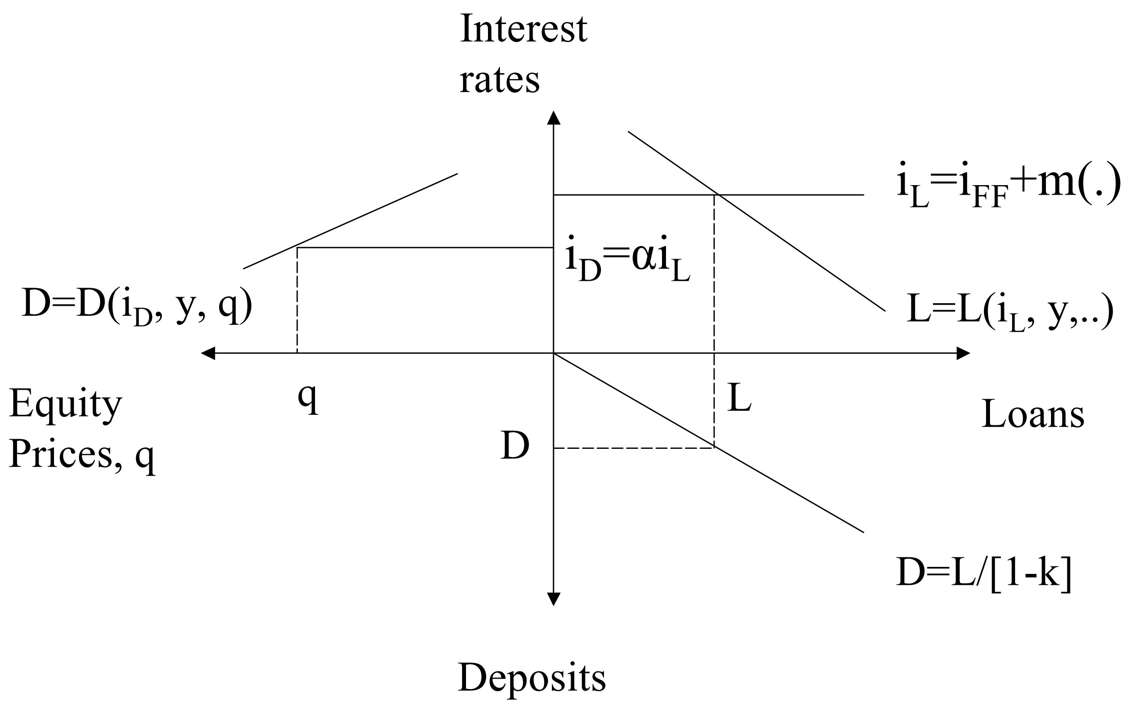

Figure 5. The Model with Inflation