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The IS-LM-BB: A Model For Unconventional Monetary Policy

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Executive Summary

The Monetary policy of the United States has not been the same since the 2008-2009 international crisis. Following the crisis, given that the federal funds interest rate - the conventional monetary policy instrument - fell to almost zero, the Federal Reserve (FED) had to resort to two unconventional instruments: Firstly, an announcement on the future trajectory of the short-term interest rate. Secondly, direct intervention in the long-term bond market.

The objective of this article is to extend the IS-LM model devised by Hicks (1937), to incorporate American monetary policy innovations. This updated model, unlike IS-LM, takes into account that the FED administers the short-term interest rate, not monetary supply, which is endogenous. On the other hand, so as to address *quantitative easing*, a long-term bond market is added to the IS-LM - in which there only exists a short-term bond market - by resorting to Tobin (1981).

This article shows that the old models and the old methods remain very useful in dealing with contemporary macroeconomic problems

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Key words: unconventional monetary policy, liquidity trap, IS-LM model.

"The monetary authority often tends in practice to concentrate upon short-term debts and to leave the price of long-term debts to be influenced by belated and imperfect reactions from the price of short-term debts;—though here again there is no reason why they need do so." (Keynes 2008: 206).

> "Open-market purchases of long term securities might have helped to depress their rates and to push banks and other financial institutions into more private lending." (Tobin 1965: 472).

INTRODUCTION

The Monetary policy in the center of the world economy, the United States, has not been the same since the 2008-2009 international crisis.

Following the crisis, the principal monetary policy instrument of the USA's central bank, the Federal Reserve (FED), stood as the interest rate of reference for federal funds markets.

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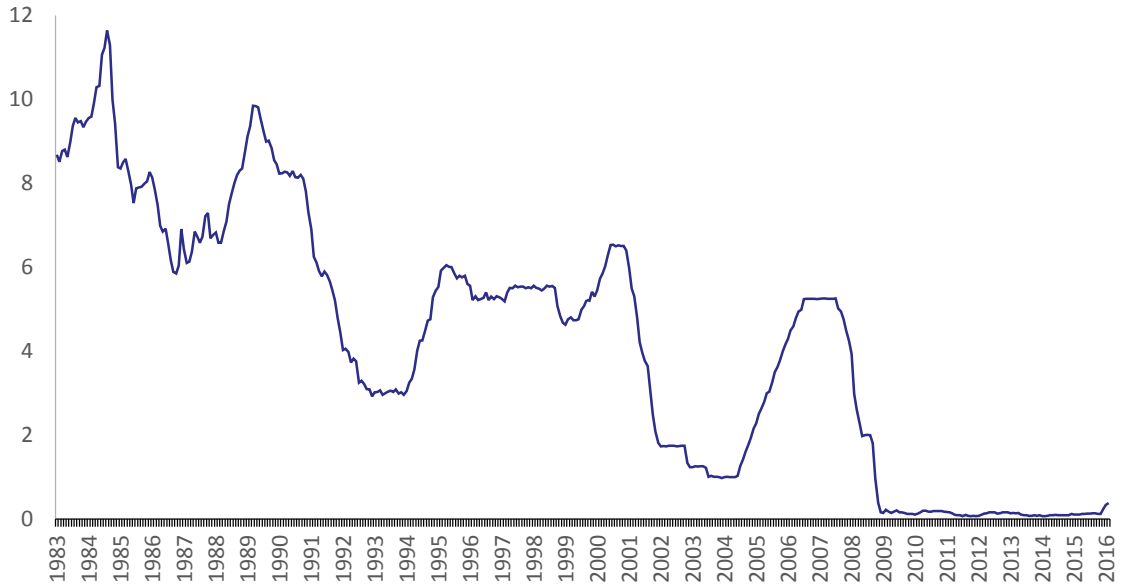
Following the crisis, given that the interest rate fell to almost zero, the United States monetary authority had to resort to two unconventional instruments: firstly, an announcement on the future trajectory of the short term interest rate; secondly, direct intervention (buying) in the long-term bond market (an essential component of *quantitative easing*).

The sequence and timing of FED policies, as well as the evidence that these policies were not effective, are described comprehensively in Bernanke (2012a) and in IMF (2013).

As can be seen in Graph 1, with the onset of the crisis in 2007, the FED embarked upon a swift series of interest rate reductions, which saw it drop from 5.25% in September, 2007 to almost zero at the close of 2008. At present, the reference rate is represented by a band, between 0 and 0.25%.

Graph 1
Federal funds rate
(Percentages)



Source: Federal Reserve Bank of St. Louis.

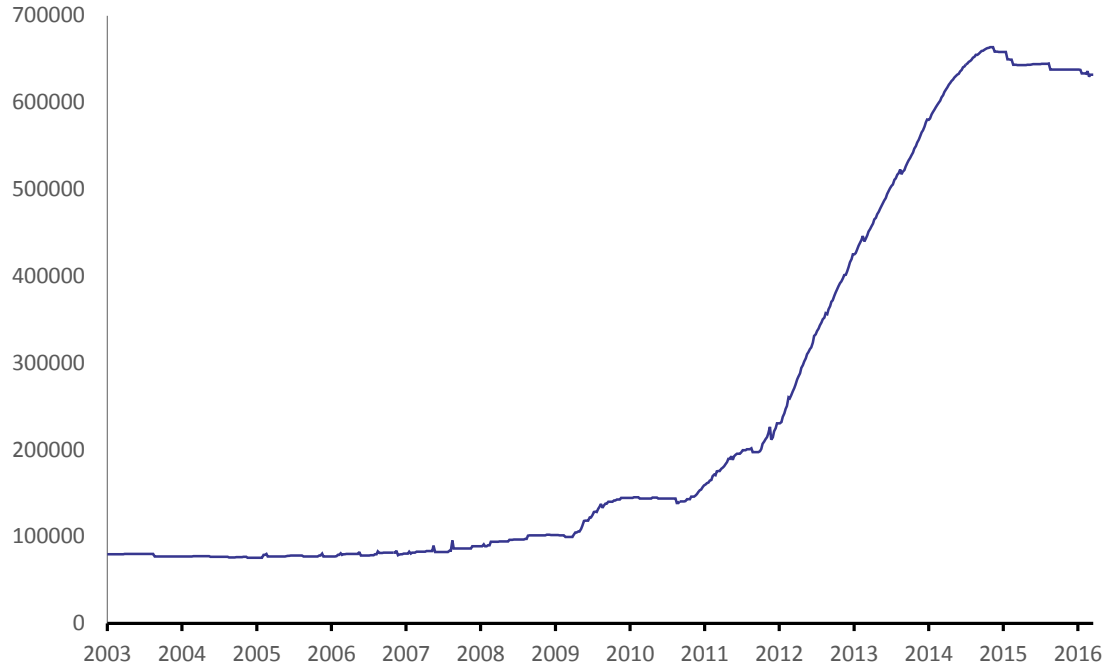
As the short-term rate was already at zero, and the recession was ongoing, the FED announced that this exceptionally-low interest rate would continue for "some time" initially, then for a "prolonged period", followed by "until mid-2015". Finally, in December 2012, it declared that the rate would stay close to zero at least until unemployment had dropped below 6.5%, on condition that long-term inflation expectations remained well-anchored. The aim of the announcement was to make an impact on long-term interest rates.

Almost simultaneously, *quantitative easing* - the purchase of long-term securities, especially US treasury bonds - was unveiled, as can be seen in Graph 2.

The purchase of long-term bonds necessarily lowers long-term interest rates, by way of three channels (IMF 2013). Firstly, that of signaling, which has the same effect as the announcement on future short-term rates as a guide to future monetary policy. Secondly, the channel of scarcity, as the FED is a major buyer, which reduces the bond inventory available for the private sector, resulting in price increases and yield decreases. Finally, the

channel of duration, which applies because purchases of long-term bonds held by the FED are so vast that private sector asset portfolios become less risky, thus pushing up demand for long-term bonds.

Graph 2
US treasury bonds held by the FED for more than 10 years



Source: Federal Reserve Bank of St. Louis.

In short, the FED went beyond its traditional role as lender of last resort and came to be a "market maker of last resort" (IMF 2013).

Numerous authors have modeled the FED's unconventional model. Most have done so using Dynamic Stochastic General Equilibrium (DSGE) models: the must-use instrument of contemporary macroeconomists. For an example of this, see Gertler y Karadi (2011), who model unconventional monetary policy as a case in which, given the crisis, financial intermediation faces balance restrictions, and central bank lending helps to loosen these restrictions.

This article adopts a more traditional theoretical option: that of Keynes (1936), and the old Keynsianism of Hicks (1937) and Tobin (1965, 1981).

Keynes, in his *General Theory*, had already considered the possibility that a monetary authority might use "unconventional" instruments, especially that of intervention in long-term debt markets. In his opinion, the monetary authority must not restrict its action to intervention in short-term debt markets.

> "The monetary authority often tends in practice to concentrate upon short-term debts and to leave the price of long-term debts to be influenced by belated and imperfect reactions from the price of short-term debts;—though here again there is no reason why they need do so." (Keynes 2008: 206).

Keynes also considered the need for the monetary authority to intervene in long-term debt markets in the event of an economy entering a *liquidity trap*: a situation in which the interest rate drops to the point where almost everyone prefers cash to acquiring debt with such low yields.

> "In this event the monetary authority would have lost effective control over the rate of interest (…) Indeed, owing to the unwillingness of most monetary authorities to deal boldly in debts of long term, there has not been much opportunity for a test." (Keynes 2008:207).

Likewise, almost fifty years ago, the 1981 Nobel Prize winner James Tobin contended during a discussion about the Great Depression that if the FED had intervened in long-term debt markets, the depression would have been overcome much more quickly.

> "Open-market purchases of long term securities might have helped to depress their rates and to push banks and other financial institutions into more private lending." (Tobin 1965: 472).

The model presented below is in keeping with the tradition of the old Keynesianism of the 1960s. We hold that the old models and old methods are still useful in tackling many contemporary economic problems. Ours is an extension of the old and immortal IS-LM model (1937), enriched with models in which financial assets are imperfect substitutes for one another, such as those of Tobin and Brainard (1963), Branson (1977) and Tobin (1981), which allow US monetary policy innovations to be incorporated in plain and, we believe, convincing terms.

The two extensions are as follows: Firstly, unlike IS-LM models, where the monetary policy instrument is money supply, it is kept in mind that the FED administers the short-term interest rate, not monetary supply, which is endogenous. Secondly, to address *quantitative easing,* the purchase of long-term securities held by the FED, a long-term bond market is added to the IS-LM, in which only a short-term bond market exists.

Via this apparatus, we can discuss the effects on the economic activity level of conventional monetary policy: that of adjusting the short-term interest rate, as well as the effects of unconventional monetary policies, such as the announcement of the short-term interest rate's stability and the purchase of long-term bonds.

1. THE MODEL'S FINANCIAL STRUCTURE

The financial structure of this economy shows a marked Anglo-Saxon bias, as with Hicks' IS-LM (1937). The financial system is dominated by bond markets, and bank credits and deposits do not exist.

In this economy, on the supply side, the nominal financial wealth of the private sector (Q) takes the form of short-term bonds (B^{bp0}), long-term bonds (B^{bp1}) and money or monetary base (M^s).

$$Q = B^{bp0} + B^{bp1} + M^s$$

On the other hand, demand for financial wealth in nominal terms (Q^d) is made up of demand for nominal short-term bonds, (B^{bp0d}), demand for long-term bonds (B^{bp1d}) , and demand for money (M^d).

$$Q^d = B^{bp0d} + B^{bp1d} + M^d$$

In equilibrium, financial wealth has to be equal to demand for financial wealth. That is,

$$B^{bp0} + B^{bp1} + M^s = B^{bp0d} + B^{bp1d} + M^d \quad (1)$$

This financial restriction allows us, on the one hand, to appeal to Walras' Law, which we can dispense with the analysis of one of the markets. On the other hand, it allows us to stabilize the determinants of demand for a financial asset, on the basis of defining demand for other financial assets.

To apply Walras' Law, we can rearrange the equation (10.1) as follows:

$$(B^{bp0} - B^{bp0d}) + (B^{bp1} - B^{bp1d}) + (M^s - M^d) = 0 \quad (2)$$

The equation (2) clearly shows that equilibrium exists in two markets; say, in the money markets $(M^s - M^d = 0)$ and the long-term bond markets $(B^{bp1} - B^{bp1d} = 0)$, so the equilibrium in the short-term bond market $(B^{bp0} - B^{bp0d} = 0)$ is fully guaranteed. Based on this argument, we can dispense with analysis of the short-term bond market.

On the other hand, if we suppose that in the short term financial wealth is a given, and is constant, and we define, for example, the equation with the determinants of nominal demand for money, the long and short-term demand for bond equations must necessarily be restricted by the determinants of the demand for money.

These are the old teachings of the Nobel laureate James Tobin, expressed fifty years ago in Tobin and Brainard (1963), and masterfully presented in his *Nobel Lecture* (Tobin 1981). For our purposes, however, the Tobinian presentation of Branson (1977) is more apt, for its simplicity.

In Branson's presentation, demands for financial assets may be represented as fractions of financial wealth. These fractions, in turn, depend on the yield of the asset under study, as well as that of other assets, and other parameters that reflect the peculiarities of those assets, which are imperfect substitutes for one another.

The dependence of demands for assets on wealth can be represented as follows:

$$M^d = \delta_0 Q \quad (3)$$

$$B^{bp1d} = \delta_1 Q \quad (4)$$

$$B^{bp0d} = (1 - \delta_0 - \delta_1) Q \quad (5)$$

It is evident that $M_Q^d + B_Q^{bp1d} + B_Q^{bp0d} = 1$

Where the generic term X_Y expresses the partial derivative of the variable X with respect to the variable Y.

As wealth is given, the definition of the determinants of demands for assets entails the search for factors that influence the coefficients δ_0 y δ_1. Of the three demands for assets, it is the first, the demand for money, which has been studied most. We will therefore start by defining it.

Nominal demand for money, because of the transactions motive, is positively associated with prices (P) and production (Y). On the other hand, demand for money depends positively on its own yield, which is null [1], and negatively on the yield of alternative assets, and short and long-term bonds. The short-term bond yield is r_0, and its indicated yield is r_{0e}[2], while the long-term bond yield is r_1.

Consequently, nominal demand for money is given by,

$$M^d = \delta_0(P, Y, r_0, r_{0e}, r_1)Q \qquad (6)$$

$$M_P^d > 0, M_Y^d > 0, M_{r_0}^d < 0, M_{r_{0e}}^d < 0, M_{r_1}^d < 0$$

On the other hand, given the wealth constraints, nominal demand for long-term bonds depends inversely on price level and the economic activity level, as the nominal demand for money depends directly on these variables. Likewise, the demand for long-term bonds depends inversely on the yield of substitute assets, current and expected short-term interest rates, and, directly from its own yield, the long-term interest rate. That is,

$$B^{bp1d} = \delta_1\big(P, Y, r_{0,}, r_{0e}, r_1\big)Q \qquad (7)$$

$$B_P^{bp1d} < 0, B_Y^{bp1d} < 0, B_{r_0}^{bp1d} < 0, B_{r_{0e}}^{bp1d} < 0, B_{r_1}^{bp1d} > 0$$

Finally, nominal demand for short-term bonds depends inversely on price level, and economic activity level depends directly on current and expected short-term interest rates, and inversely on the long-term interest rate. That is,

$$B^{bp0d} = (1 - \delta_0 - \delta_1)\big(P, Y, r_{0,}, r_{0e}, r_1\big)Q \qquad (8)$$

[1] In the context of this model, where there are no banks, money is only in circulation, and has no yield.
[2] The need to include this term will be justified when we reach the section on unconventional monetary policy.

$$B_P^{bp0d} < 0, B_Y^{bp0d} < 0, B_{r_0}^{bp0d} > 0, B_{r_{0e}}^{bp0d} > 0, B_{r_1}^{bp0d} < 0$$

As financial wealth is given, the following restrictions must necessarily be complied with:

$$M_P^d + B_P^{bp1d} + B_P^{bp0d} = 0 \quad (9)$$

$$M_Y^d + B_Y^{bp1d} + B_Y^{bp0d} = 0 \quad (10)$$

$$M_{r_0}^d + B_{r_0}^{bp1d} + B_{r_0}^{bp0d} = 0 \quad (11)$$

$$M_{r_{0e}}^d + B_{r_{0e}}^{bp1d} + B_{r_{0e}}^{bp0d} = 0 \quad (12)$$

$$M_{r_1}^d + B_{r_1}^{bp1d} + B_{r_1}^{bp0d} = 0 \quad (13)$$

When we redefine demand for money and for long-term bonds later on, we will discover the merits of having these restrictions.

2. THE IS-LM-BB MODEL

This is an *old fashioned* short-term model in the tradition of Hicks (1937), Brainard and Tobin (1963), Branson (1977) and Tobin (1981).

Short-term implies that the price level is given and is exogenous,[3] for which we concentrate our attention on the effects of monetary policy on demand and economic activity level. In consequence, we can also ignore expected inflation, for which making the distinction between real and nominal interest rates would not go amiss. Short-term also implies that financial wealth is given.

The model features four markets: goods, money, short-term bonds and long-term bonds. Because of Walras' Law, we put the short-term bond market to one side.

The goods market is Keynesian, in Hicks' (1937) extreme version of fixed prices. This market is adjusted for quantities; the excess in demand in this market translates as an increase in the economic activity level.

The financial system implied by this model is dominated by a very organized public debt market (bonds), and deposits or bank credits do not exist. Three financial markets exist: money, long-term bonds and short-term bonds, which we dispense with due to Walras' Law. These three shares are imperfect substitutes for one another. That is, their yields may differ; they are not necessarily identical. The assumption of imperfect substitution is very useful in incorporating the long-term bond market into the traditional IS-LM, and enables simulation of what the FED is currently doing, just as Bernanke describes.

[3] An equation of standard aggregate demand can be incorporated without major complications, in which the price level depends on the expected price level and the output gap. This output gap combines with the aggregate demand curve, which is obtained from the IS-LM-BB model presented here, giving us a system that determines production, price levels, long-term interest rate and the quantity of money. Nonetheless, this option, which can be readily developed by the keen reader, takes away the clarity and simplicity that we believe is inherent to this presentation with given prices.

> "Imperfect substitutability of assets implies that changes in the supplies of various assets available to private investors may affect the prices and yields of those assets. Thus, Federal Reserve purchases of mortgage-backed securities (MBS), for example, should raise the prices and lower the yields of those securities; moreover, as investors rebalance their portfolios by replacing the MBS sold to the Federal Reserve with other assets, the prices of the assets they buy should rise and their yields decline as well. Declining yields and rising asset prices ease overall financial conditions and stimulate economic activity through channels similar to those for conventional monetary policy." (Bernanke 2012b:1).

In the relevant asset markets, the adjustment mechanisms for achieving the equilibriums are as follows: In the monetary market, the adjustment is also by quantities. As the short-term interest rate is fixed, the demand excess in this marked is tackled by the FED by creating more money (purchase of short-term bonds). The long-term bond market is adjusted for price; when excess demand occurs, the increase in the price of bonds, that is, the reduction in the long-term interest rate, is the adjustment mechanism that balances this market.

In this institutional framework, the FED has three policy instruments at hand: The first of these, the conventional, is the short-term interest rate. The second, which is unconventional, is the announcement of the short-term interest rate's future trajectory. Finally, the third, also unconventional, is intervention in the long-term bond market.

In the interests of simplicity, all the model's equations are presented in strictly linear terms.

We go on to describe each of the markets below.

2.1 Goods market equilibrium: the IS

The goods market in this closed economy is Keynsian, in the sense that production (Y) is adjusted to demand (D). Demand is made up of consumption (C), private consumption (I) and public spending (G), with the typical textbook performance functions. The only novelty in this market is that private investment depends, as is proper, on long-term bond interest rates (r_1). In the textbook treatment of IS-LM models, no distinction is made between short-term and long-term interest rates, as there is only a single interest rate.

$$Y = D = C + I + G = C_0 + c(1-t)Y + I_0 - br_1 + G_0 \qquad (14)$$

From the equation (14) we can obtain the known IS line, which in this case represents the combinations of long-term interest rates and productions, which maintain the equilibrium in the goods market.

$$r_1 = \frac{A_0}{b} - \frac{Y}{kb} \qquad (14)$$

Where,

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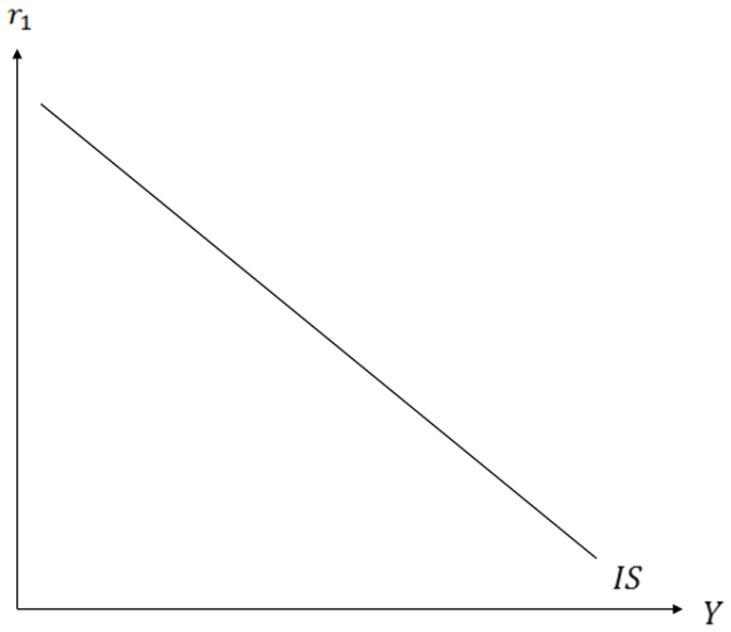
$A_0 = C_0 + I_0 + G_0$; $k = \frac{1}{1-c(1-t)}$ is the Keynesian multiplier; c is the marginal propensity to consume and t is the tax rate.

The slope of the IS is negative, and is given by,

$$\left.\frac{dr_1}{dY}\right|_{IS} = -\frac{1}{kb} < 0$$

Figure 1
The IS curve



2.2 Equilibrium in the money market: the LM

In the money market, the FED can create money through open market operations, which consists of the purchase or sale of short-term bonds (B^{b0}). In this model, it is implied that the FED can also create money based on an unconventional instrument, the purchase of long-term bonds (B^{b1}). Consequentially, nominal money supply is given by,

$$M^s = B^{b0} + B^{b1} \qquad (16)$$

The FED fixes the short-term interest rate (r_0), through the purchase and sale of short-term bonds. Nominal monetary supply, because of the short-term bonds component, is endogenous.

We have already specified nominal demand for money in the equation (6). This demand directly depends on the price level (P), production (Y) and wealth (Q), and inversely, on the short-term bond interest rate (r_0), the announced short-term interest rate(r_{0e}) and the long-term bond interest rate (r_1).

However, for the sake of simplicity, we are going to make two major simplifications that apply to both monetary policy and to the short-term bond market. Firstly, as in the case of the goods market, we are going to present the equations in strictly limited terms. Secondly, since we are not going to deal with wealth, we can disregard it as an argument for asset demands.[4].

Given these warnings, the equation (6) for nominal demand for money in linear terms, and by abstracting wealth, can be proposed as,

$$M^d = P + \alpha Y - \alpha_0 r_0 - \alpha_{0e} r_{0e} - \alpha_1 r_1 \quad (17)$$

Note that we are assuming that the ratio between price level and nominal demand for money is one to one, in keeping with the tradition of Friedman (1987).

In equilibrium, the money supply (M^s) must be equal to the nominal demand for money (M^d). Based on the equations (16) and (17), we find that,

$$B^{b0} + B^{b1} = P + \alpha Y - \alpha_0 r_0 - \alpha_{0e} r_{0e} - \alpha_1 r_1 \quad (18)$$

From the equation (18) we obtain the line for money market equilibrium, known as LM.

$$r_1 = \frac{-\left[\left(B^{b0} + B^{b1} - P\right) + \alpha_0 r_0 + \alpha_{0e} r_{0e}\right]}{\alpha_1} + \frac{\alpha}{\alpha_1} Y \quad (19)$$

The slope of the LM is positive, and is given by,

$$\left.\frac{dr_1}{dY}\right|_{LM} = \frac{\alpha}{\alpha_1} > 0$$

[4] The endogenization of wealth extends far beyond the scope of this article. When wealth is endogenous, as in Tobin (1981), there must exist a connection between flows and stocks (investment and capital stock, saving and wealth) and, furthermore, the prices of financial assets of interest rates affect financial wealth, as this is valued in nominal terms. In our model, wealth is exogenous, and for simplicity, we will disregard it.

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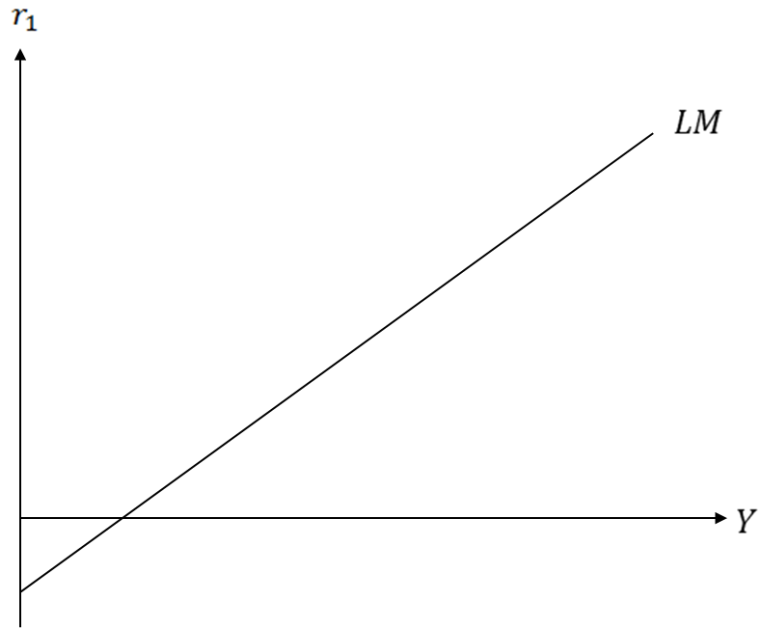
Figure 2
The LM curve



2.3 Equilibrium in the long-term bond market: the BB

In the long-term bond market, nominal supply of private-sector bonds (B^{bp1s}) must be equal to nominal demand for bonds (B^{b1d}). The nominal supply of long-term private sector bonds is equal to the total inventory of long-term bonds existing in the economy $(\bar{B})$, less long-term bonds held by the FED (B^{b1}). That is,

$$B^{bp1s} = \bar{B} - B^{b1} \qquad (20)$$

Nominal demand for long-term bonds is given by the equation (10.7). As in the case of nominal demand for money, in linear terms and by abstracting financial wealth, nominal demand for long-term bonds is given by[5],

$$B^{bp1d} = -P - \beta Y - \beta_0 r_0 - \beta_{0e} r_{0e} + \beta_1 r_1 \qquad (21)$$

In equilibrium, nominal supply and demand for long-term bonds must be equal. That is,

[5] In this case we are assuming that the elasticity of nominal demand for bonds with respect to the price level is -1. This implies, given the equation (9), that the elasticity of nominal demand for short-term bonds with respect to price level is 0. This is a simplification that has no important implications for this model.

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$$\bar{B} - B^{b1} = -P - \beta Y - \beta_0 r_0 - \beta_{0e} r_{0e} + \beta_1 r_1 \quad (22)$$

La equation (22), charted on the plan for long-term interest rate and production, represents equilibrium in the long-term interest rate market, the BB line.

$$r_1 = \frac{[\bar{B} - B^{b1} + P + \beta_0 r_0 + \beta_{0e} r_{0e}]}{\beta_1} + \frac{\beta}{\beta_1} Y \quad (23)$$

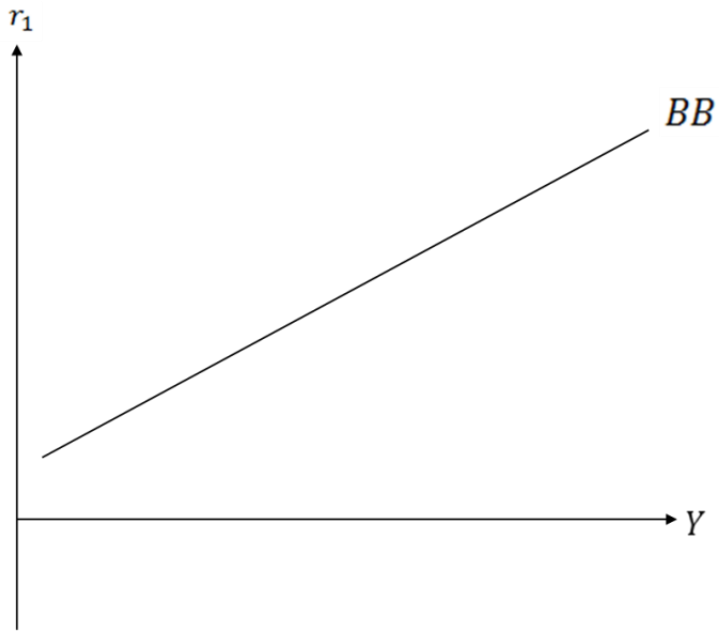
Where:

$\bar{B} = B^{b1} + B^{bp1s}$, $\bar{B}$ is given in the short-term.

The BB slope is positive, and is given by,

$$\left.\frac{dr_1}{dY}\right|_{BB} = \frac{\beta}{\beta_1} > 0$$

Figure 3
The BB curve



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2.4 General equilibrium: the IS-LM-BB

General equilibrium is reached when there is simultaneous equilibrium in the goods, money and long-term bonds markets. Because of Walras' Law, the short-term bond market must also be in equilibrium.

The model is therefore given by the following system of equations,

$$r_1 = \frac{A_0}{b} - \frac{Y}{kb} \tag{15}$$

$$r_1 = \frac{-[(B^{b0}+B^{b1}-P)+\alpha_0 r_0+\alpha_{0e} r_{0e}]}{\alpha_1} + \frac{\alpha}{\alpha_1} Y \tag{19}$$

$$r_1 = \frac{[\bar{B}-B^{b1}+P+\beta_0 r_0+\beta_{0e} r_{0e}]}{\beta_1} + \frac{\beta}{\beta_1} Y \tag{23}$$

The endogenous variables for this model are production, short-term bond stock (thus, money supply) and the long-term interest rate. Production is determined in the goods market, the short-term bond inventory in the money market, and the long-term interest rate in the long-term bond market.

From the equations (15), (19) and (23), we arrive at the IS-LM-BB in its reduced form, where the values for production equilibrium (Y), trends for short-term central bank bonds (B^{b0}) and the long-term bond interest rates (r_1) are found, based on all exogenous variables .

$$Y^{eq} = \left[\frac{\beta_1 k}{kb\beta+\beta_1}\right] A_0 - \left[\frac{kb}{kb\beta+\beta_1}\right] \bar{B} + \left[\frac{kb}{kb\beta+\beta_1}\right] B^{b1} - \left[\frac{kb}{kb\beta+\beta_1}\right] P - \left[\frac{kb\beta_0}{kb\beta+\beta_1}\right] r_0 - \left[\frac{kb\beta_{0e}}{kb\beta+\beta_1}\right] r_{0e} \tag{24}$$

$$B^{b0eq} = \left[\frac{k(\alpha\beta_1-\alpha_1\beta)}{kb\beta+\beta_1}\right] A_0 - \left[\frac{\alpha kb+\alpha_1}{kb\beta+\beta_1}\right] \bar{B} + \left[\frac{\alpha_1-\beta_1+kb(\alpha-\beta)}{kb\beta+\beta_1}\right] B^{b1} + \left[\frac{\beta_1+kb\beta-\alpha kb-\alpha_1}{kb\beta+\beta_1}\right] P - \left[\frac{kb(\beta\alpha_0+\alpha\beta_0)+\alpha_0\beta_1+\alpha_1\beta_0}{kb\beta+\beta_1}\right] r_0 - \left[\frac{kb(\beta\alpha_{0e}+\alpha\beta_{0e})+\alpha_{0e}\beta_1+\alpha_1\beta_{0e}}{kb\beta+\beta_1}\right] r_{0e} \tag{25}$$

$$r_1^{eq} = \left[\frac{k\beta}{kb\beta+\beta_1}\right] A_0 + \left[\frac{1}{kb\beta+\beta_1}\right] \bar{B} - \left[\frac{1}{kb\beta+\beta_1}\right] B^{b1} + \left[\frac{1}{kb\beta+\beta_1}\right] P + \left[\frac{\beta_0}{kb\beta+\beta_1}\right] r_0 + \left[\frac{\beta_{0e}}{kb\beta+\beta_1}\right] r_{0e} \tag{26}$$

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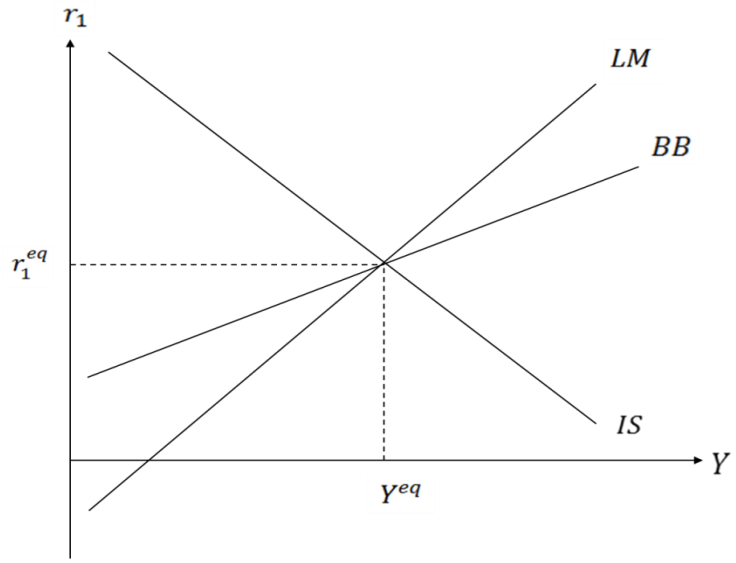
In Figure 1, we present the general equilibrium for the model. The LM slope is greater than that of the BB, as a consequence of the restrictions to the value of the parameters imposed on strict use of equations (10) and (13). From (10), it can be seen that $\alpha > \beta$, and from (13) that $\beta_1 > \alpha_1$. Consequentially, the slope of the LM is greater than that of the BB.

$$\frac{\alpha}{\alpha_1} > \frac{\beta}{\beta_1}$$

Figure4 General equilibrium: the IS-LM-BB model



3. THE IS-LM-BB, AGGREGATE DEMAND AND AGGREGATE SUPPLY

From the equation (24), we can derive the demand curve, which is given by,

$$P = \frac{\beta_1}{b} A_0 - \bar{B} + B^{b1} - \beta_0 r_0 - \beta_{0e} r_{0e} - \frac{kb\beta + \beta_1}{kb} Y \qquad (27)$$

The slope of the aggregate demand curve is negative. The reason for this is that a price level increase reduces the nominal demand for long-term bonds, which pushes up the long-term interest rate and causes investment, demand and the economic activity level to fall. The slope is given by,

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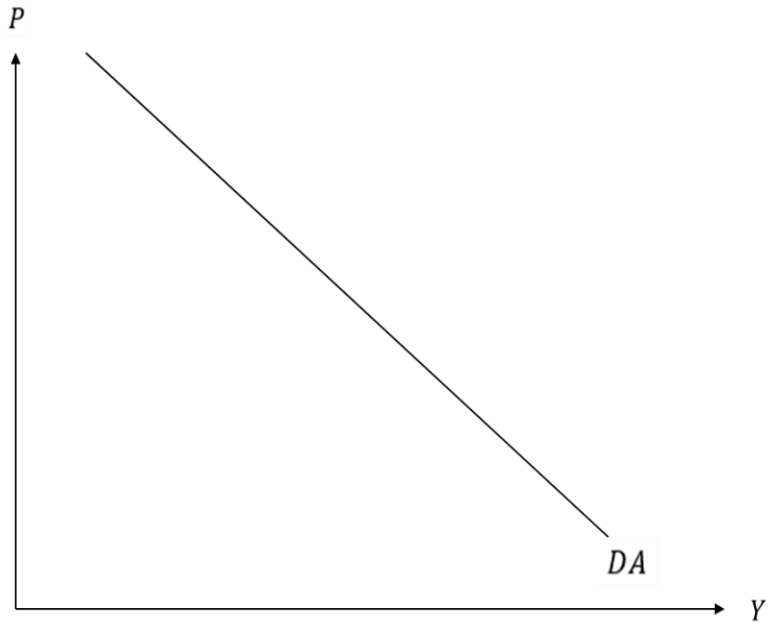
$$\left.\frac{dP}{dY}\right|_{DA} = -\frac{kb\beta + \beta_1}{kb} < 0$$

Figure 5
Aggregate demand



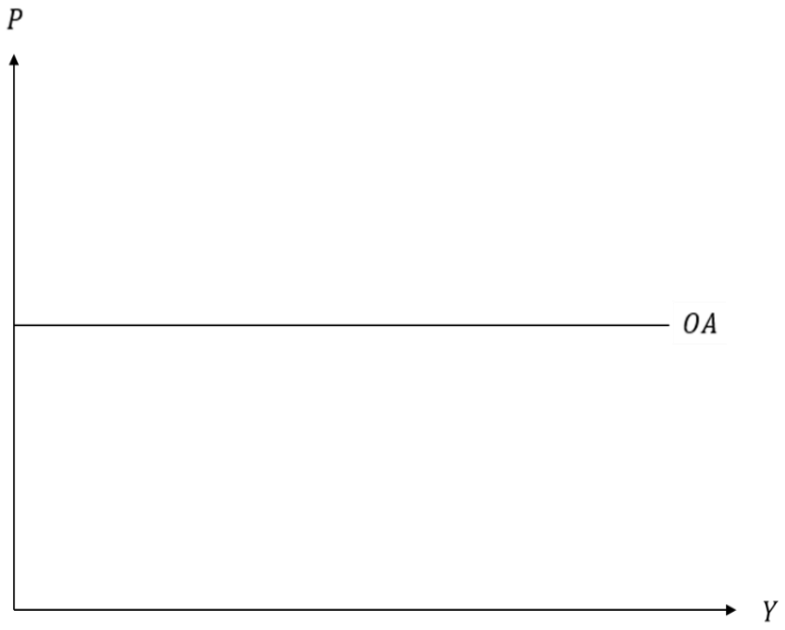
In this model, aggregate supply is completely elastic at price and quantity level, and is as Hicks (1937) assumed.

$$P = P_0 \qquad (28)$$

Figure 6

Aggregate supply

DOI: 10.18535/ijsrm/v4i11.02



In summary, this short-term model enables the values of production equilibrium, the short-term bond inventory held by the FED (money supply) and long-term interest rate. The fiscal policy instruments are the tax rate and public spending. The monetary policy instruments are the short-term interest rate, the announced short-term interest rate, and the purchase of long-term bonds.

The complete model is represented in Figure 1. The IS-LM-BB model is presented in the upper part, while aggregate supply and demand is shown in the lower part.

Figure 7
IS-LM-BB, aggregate supply and demand

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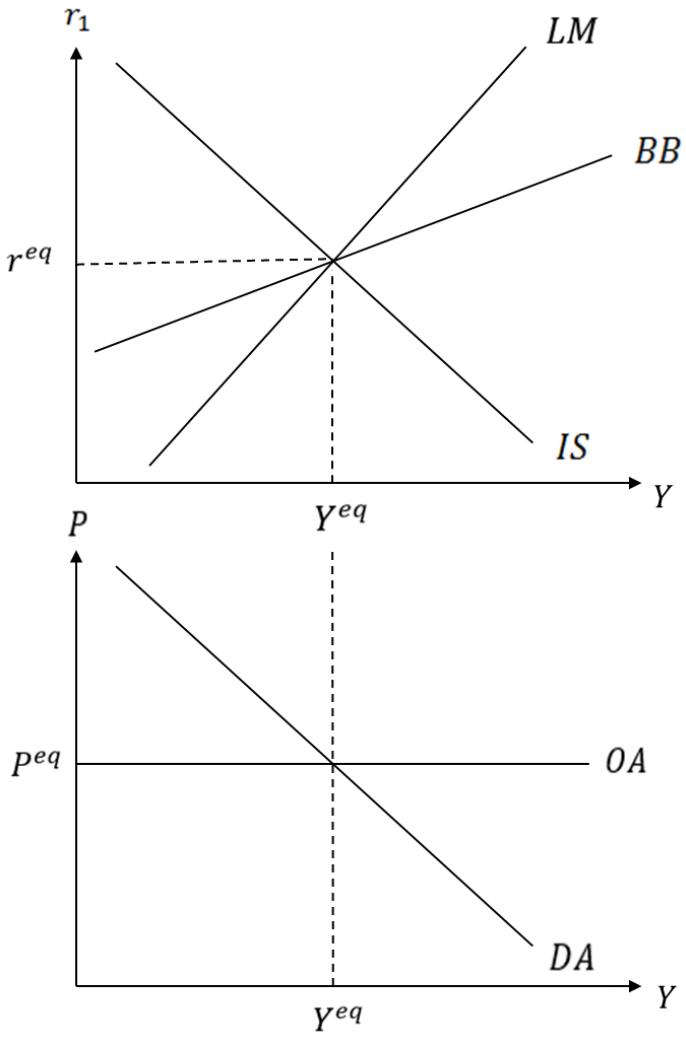

It should be noted that since our figures consider the long-term rather than the short-term interest rate, charting the model is not a problem, even when there is a *liquidity trap*[6]. In the graphic representations of the liquidity trap offered by Krugman (1998) and Romer (2013), on the level of short-term interest rate and product, the aggregate demand curve may have a section with the habitual slope, and another with a positive slope (Romer 2013). Our aggregate demand curve has the normal negative slope, even when the short-term interest rate is zero.

4. CONVENTIONAL AND UNCONVENTIONAL MONETARY POLICY

Below, we will employ this basic model to undertake some comparative statistical exercises that will allow us to evaluate its usefulness in discussing monetary policy, both conventional and unconventional.

The effects of conventional monetary policy: reduction of the short-term interest rate

The short-term interest rate is the FED's typical conventional instrument of monetary policy.

[6] Understood here in Krugman's terms (1998) as a situation in which the short-term interest rate is zero.

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A reduction in the short-term interest rate in the money market leads to an upturn in the demand for money and, consequentially, to an increased nominal money supply, as the FED is moved to purchase short-term bonds to keep the money market in equilibrium.

In the long-term bond market, the lower short-term bond interest rate drives up demand for long-term bonds, which brings about a demand excess in this market, triggering a downturn in the long-term interest rate (long-term bond price rise). The low long-term interest rate pushes up investment, and thus economic reactivation occurs. The low long-term interest rate and the economic reactivation elevate the demand for money further still, hastening the expansion of primary issuance.

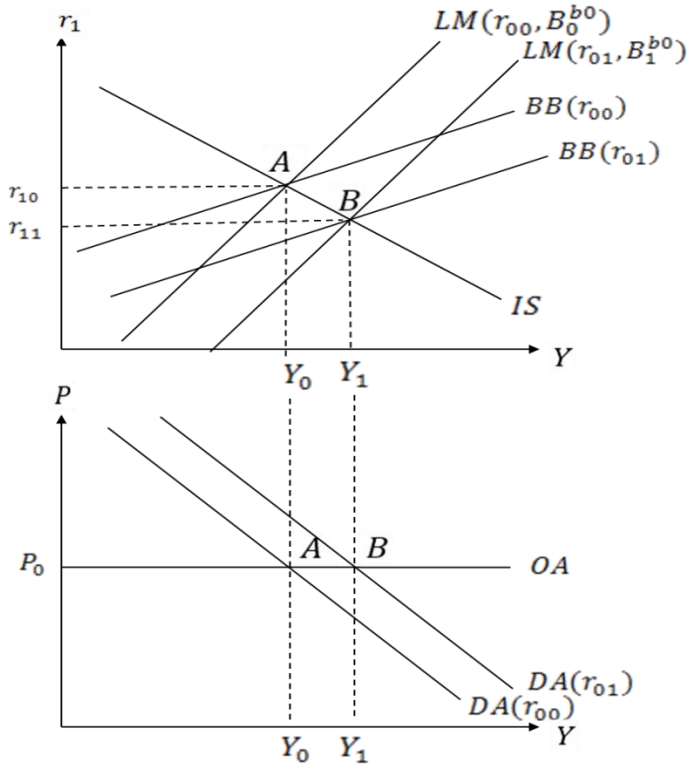
In summary, the reduction in the short-term interest rate causes the long-term interest rate to fall, reactivates the economy, and puts up short-term FED bond holdings.

In the upper part of Figure 8, we can see that the BB line shifts to the right, due to the reduction of the short-term interest rate. The LM also shifts toward the right, but as a result of two movements in opposing directions. On the one hand, the reduction in the interest rate shifts the LM to the left, while, on the other hand, the consequent rise in the money supply (short-term bonds held by the FED) shifts it to the right, which is the effect that prevails.

In the lower part of the figure, the low short-term interest rate shifts the aggregate demand curve to the right.

In the new general equilibrium, point B, production is greater, the long-term interest rate is lower, and the money supply (due to the greater short-term bond inventory held by the FED) is greater.

Figure 8
Conventional monetary policy



The mathematical response is given by,

DOI: 10.18535/ijsrm/v4i11.02

$$dY = -\left[\frac{kb\beta_0}{kb\beta + \beta_1}\right] dr_0 > 0$$

$$dB^{b0} = -\left[\frac{kb(\beta\alpha_0 + \alpha\beta_0) + \alpha_0\beta_1 + \alpha_1\beta_0}{kb\beta + \beta_1}\right] dr_0 > 0$$

$$dr_1 = \left[\frac{\beta_0}{kb\beta + \beta_1}\right] dr_0 < 0$$

The effects of unconventional monetary policy: announcement that the short-term interest rate remains low

The short-term interest rate instrument can have limits, whether because it is already close to zero or because, under certain conditions, the *transfer effect* of this rate on the long-term interest rate, which is what affects private spending, is very weak. Under these conditions, the FED may, in addition to reducing the short-term interest rate, *announce* that this low interest rate will remain for a long time.

If the announcement is credible, as well as bringing about all the effects described in the previous exercise, it further propels the increase in the actual demand for money and the reduction in the actual demand for bonds. The reason for this is that the low expected short-term interest rate also increases the demand for money, prompting the FED to create more; it also pushes up demand for long-term bonds, leading to an interest rate drop in this market. Therefore, the money supply increases more and the long-term interest rate falls more, with reference to the case in which the policy interest rate is put down. Consequentially, reactivation in this case is also greater than when only the short-term interest rate is reduced.

In summary, a reduction in the short-term interest rate, accompanied by a promise to maintain that low rate in the future, serves to increase production and short-term FED bond holdings, while reducing the long-term interest rate, with greater intensity than in the previous case.

In the upper part of Figure 9, we can see that the LM line shifts more emphatically to the right than in the previous case, expressed in figure 8. In the final equilibrium, point B, production and money supply are greater, and higher than in the previous exercise, while the long-term interest rate is less, and lower than in the previous exercise.

In the lower part of the figure, aggregate demand shifts to the right with more emphasis than in the previous case.

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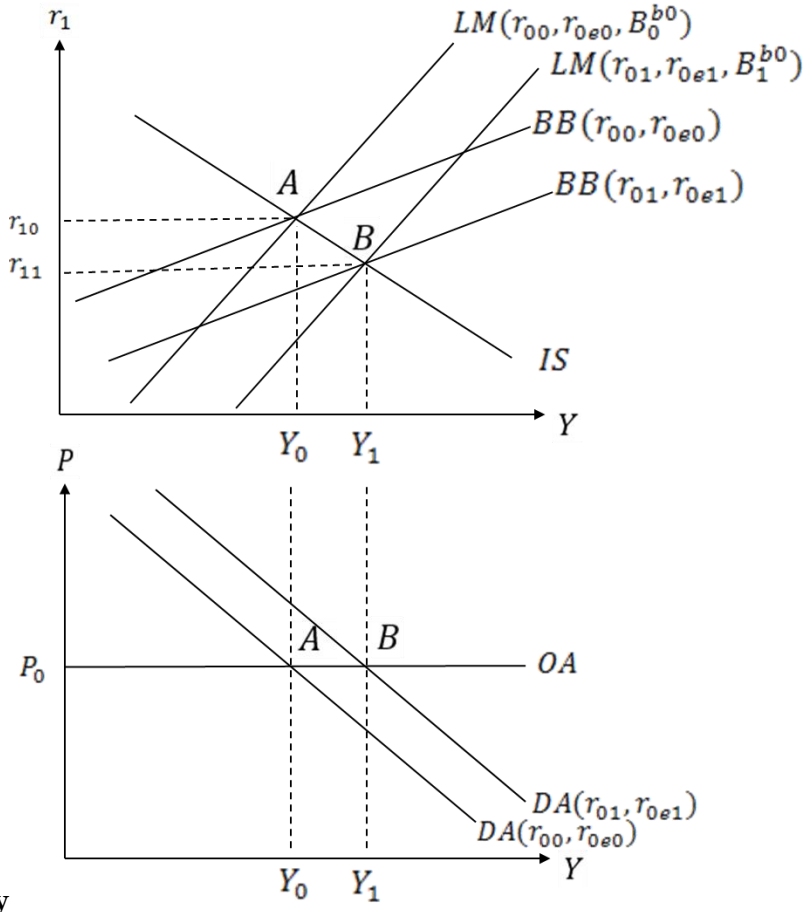
Figure9



Unconventional monetary policy

The mathematical response is given by,

$$dY = -\left[\frac{kb(\beta_0 + \beta_{0e})}{kb\beta + \beta_1}\right] dr_0 > 0$$

$$dB^{b0} = -\left[\frac{kb(\beta\alpha_0 + \alpha\beta_0 + \beta\alpha_{0e} + \alpha\beta_{0e}) + \alpha_0\beta_1 + \alpha_1\beta_0 + \alpha_{0e}\beta_1 + \alpha_1\beta_{0e}}{kb\beta + \beta_1}\right] dr_0 > 0$$

$$dr_1 = \left[\frac{\beta_0 + \beta_{0e}}{kb\beta + \beta_1}\right] dr_0 < 0$$

The effects of unconventional monetary policy: purchase of long-term bonds

This is the most visible expression of the unconventional monetary policy applied in the USA in the aftermath of the 2008-2009 crisis. This is *quantitative easing*, which is, essentially, the purchase of long-term bonds held by the FED. This is the first time in history that the FED has made this kind of policies.

The purchase of long-term bonds held by the FED simultaneously affects the money market and the long-term bond market.

In the money market, a purchase of long-term bonds pushes up the money offer and causes a supply excess in that market. Given that the FED fixes the short-term interest rate to keep it from falling, it has to sell short-term bonds, causing a reduction in the inventory of long-term bonds held by the FED.

On the other hand, in the long-term bond market, the intervention of the FED reduces the supply of long-term bonds available to the private sector, which brings about a demand excess in this market, thus reducing the interest rate of these bonds (and increasing their price). The lower long-term interest rate increases investment and, consequentially, production. The increased production pushes up demand for money and reduces the demand for bonds. The greater demand for money leads to a rise in the supply of money, as the FED has to tackle the demand excess in this market with further issuance through the purchase of short-term bonds. The lower demand for long-term bonds pushes up the long-term interest rate (lowering the price of these bonds), weakening, but not eliminating, the first effect on this rate.

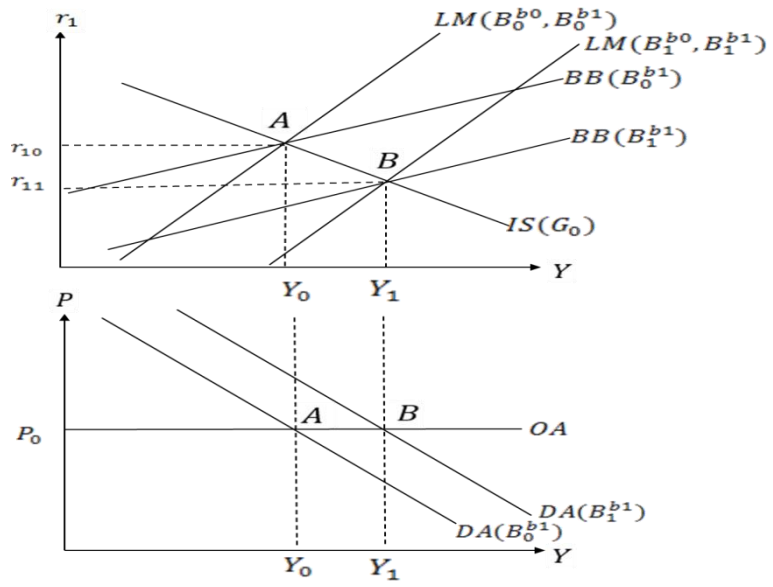
In summary, the purchase of long-term bonds through the FED reduces the long-term interest rate and reactivates the economy, while what happens to the short-term inventory stock held by the FED is not clear.

In the upper part of Figure 10, we can see that the BB line shifts to the right, due to the purchase of long-term bonds by the FED. Two effects occur on the LM. On the one hand, the purchase of long-term bonds, which increases money supply, shifts it to the right. On the other hand, following the initial shift, the LM starts to move again, either to the right or to the left, depending on whether the FED has to sell or buy short-term bonds, respectively.

In the lower part of the figure, aggregate demand shifts to the right.

In the final equilibrium, point B, production is greater, the long-term interest rate is lower, and the money supply is greater, though what occurs with the short-term bond inventory is not known.

Figure 10
Unconventional monetary policy



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The mathematical response is given by,

$$dY = \left[\frac{kb}{kb\beta + \beta_1}\right] dB^{b1} > 0$$

$$dB^{b0} = \left[\frac{\alpha_1 - \beta_1 + kb(\alpha - \beta)}{kb\beta + \beta_1}\right] dB^{b1} \lesseqgtr 0$$

$$dr_1 = -\left[\frac{1}{kb\beta + \beta_1}\right] dB^{b1} < 0$$

CONCLUSION

In this article, we have seen that the simple inclusion of a long-term bond market, a policy interest rate and FED-announced policy interest rate to the aged IS-LM model allows us to discuss the unconventional monetary policy issues set in motion by the FED following the 2009-2009 international crisis in simple, and we believe appropriate, terms.

The article is a small demonstration of how the old models and methods can still be of use in responding to contemporary macroeconomic questions. The models of Keynes, Hicks or Tobin and the old method of comparative statistics have become unfashionable for many, but, in many respects, they explain the complex events borne of the crisis better than modern models and methods.

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