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Unconventional monetary policy and credit market activity

Juan Carlos Medina Guirado

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Resumen

Desde la recesión financiera del 2007-2009 y hasta el día de hoy, los principales bancos centrales han utilizado a instrumentos de política no tradicionales para estimular la actividad económica. Un ejemplo muy característico fue la expansión de sus hojas de balance a través de la compra de títulos de deuda gubernamental de largo plazo. En este artículo analizo el efecto de esta herramienta “no convencional” en los mercados de crédito y lo comparo con aquel de instrumentos convencionales tales como las operaciones de mercado abierto. Nuestros resultados sugieren que las compras de títulos de deuda gubernamental de largo plazo estimulan la actividad en los mercados de crédito y reducen los costos de financiamiento tanto privado como público sólo cuando existe un régimen con tasas de interés bajas y deuda fiscal limitada. De otra manera, esta política incrementa el costo del servicio a la deuda, lo que resulta en una contracción del crédito. Por otro lado, las operaciones de mercado abierto facilitan la disponibilidad de crédito pero afectan negativamente la compartición del riesgo en la economía.

Palabras Clave: Banca Central, política monetaria no convencional, intermediación financiera, mercados de crédito.

Abstract

Since the 2007-2009 financial recession and up until the present day, the main central banks have resorted to nontraditional policy tools to stimulate economic activity. A distinctive example was the expansion of the size of their balance sheets through the purchase of long-term government securities. In this paper I analyze the effect on credit markets of this “unconventional” monetary policy tool and compare it with that of conventional instruments such as open market operations. Our findings suggest that central bank purchases of long-term government securities stimulate credit market activity and reduce the cost of public and private borrowing only under a low interest rate and reduced fiscal debt regime. Otherwise, this policy increases the cost of servicing debt resulting in a contraction of lending. In contrast, open market operations aid credit availability but negatively affect the amount of risk-sharing in the economy.

Keywords: Central Banking, unconventional monetary policy, financial intermediation, credit markets.

JEL: E31, E44, E52, E58.

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➤ 1. Introduction.

One of the major developments in monetary policy has been the use of the size of central bank's balance sheets as an instrument to stimulate economic activity. The use of this “unconventional” tool has come about after traditional policy instruments have been exhausted during periods of considerable economic stress. For instance, amid the global recession in December 2008, the Federal Reserve decreased the target for its short-term policy rate, the Fed Funds Rate, to be between zero and 25 basis points. In contrast, the total amount of assets held by the Fed has increased from \$0.93 trillion in September 2008 to \$7.1 trillion in May 2020.¹ Although in a differing magnitude, the Bank of England (BOE) has followed a similar expansionary trend with the Bank of Japan (BOJ) and the European Central Bank (ECB) increasing the aggressiveness of their expansionary balance sheet policies.

The success of the Fed's balance sheet, or “quantitative easing” (QE) measures in terms of lowering long-term interest rates on treasury securities is backed by a substantial body of empirical research.² Similarly, but for the BOE's asset purchases, econometric findings like that in Joyce et al. (2011) find a reduction in medium to long-term government bond yields by about 100 basis points. In the case of Japan, Ueda (2012) and Takeda and Yajima (2014) find that the BOJ's QE program -initiated in March 2001- depressed long-term rates of Japanese government securities as well as of several privately-issued assets.

All of this empirical research supports the effectiveness of balance sheet programs mostly in financial markets. However, studies on the impact of these programs on bank lending are scant or relatively new.³ The need for a deeper insight in this “banking channel” of monetary policy is brought up by Boivin, Kiley and Mishkin (2011), who correlate the reduced amount of theoretical studies in the area with the difficulty of finding and specifying the relevant mechanisms necessary to perform empirical analysis.

In this paper I contribute to this gap in the literature by providing a framework that illustrates how the size of a Central Bank's (CB) balance sheet impacts lending by banks in the credit market. Specifically, I offer a structure in which an independent monetary authority controls the rate of money growth and engages in the purchase of short-term and long-term bonds issued by a fiscal authority. In turn, these policies affect the investment decisions of financial intermediaries.

¹ <https://fred.stlouisfed.org/series/WALCL>.

² See Meyer and Bonfim (2012), Li and Wei (2012) and Pandl (2012) for the cumulative effects of the Fed's QE programs including the Maturity Extension Program.

³ See Bowman et al. (2011) who find a positive effect of the BOJ's QE policies on Japanese bank's lending and Joyce and Spaltro (2014) who find similar effects of balance sheet policies in the UK.

Given that the impact of monetary policy decisions on credit markets depends on the actions of financial intermediaries, our modeling approach seriously takes into account this feature by having an explicit role for these institutions. Namely, and as shown by Diamond and Dybvig (1983), intermediaries provide crucial risk-sharing services that insure agents against liquidity risk. Additionally, intermediaries provide intertemporal consumption-smoothing services by issuing loans in credit markets. Financial intermediation is also relevant for monetary policy since it avoids socially undesirable levels of short-term, liquid-asset investments and thus favoring longer-term investment allocations in the spirit of Bencivenga and Smith (1991). These features allow us to model in an explicit manner how monetary policy affects the incentives of banks to issue long-term private debt and hold long-term government securities. I also offer a well-defined role for money as means of exchange in order to rigorously analyze the rate of money growth as a policy instrument.

Our modeling framework presents an overlapping generations structure that rests on Schreft & Smith (1997) in which financial intermediaries provide risk-pooling services to depositors that are prone to random liquidity draws. Also, informational asymmetries generate a well-defined transactions role for money. These liquidity shocks represent consumption preference shocks as in Diamond and Dybvig (1983).

Our setup differs from Schreft & Smith (1997) and (1998), as I have an independent monetary authority that is separate from its fiscal counterpart. Additionally, I also depart from Schreft & Smith (2002) in that the monetary authority keeps part of its income such that any purchase of government debt originates an outstanding liability on the fiscal authority's balance sheet. That is, our setup analyzes true open market operations. I also build on the findings by Ghossoub, Laosuthi and Reed (2006) as well as Laosuthi and Reed (2012) in which they analyze the effects of conventional monetary policy on the availability of credit in the presence of government debt and with differing degrees of banking market concentration. However, our setup differs from theirs in important ways. Aside from our crucial feature of a separate and independent CB, I also deliver a richer maturity structure of government debt. Thus, I am able to incorporate and analyze “unconventional” tools like CB long-term government security purchases while also contrasting its effects relative to those of “conventional” monetary policy instruments such as purchases of short-term government securities.

Our results indicate that short-term bond purchases decrease the level of risk-sharing for depositors. Nonetheless, they are effective in reducing short and long-term yields of treasury securities as well as in promoting lending by intermediaries while at the same time reducing the cost of private credit. In contrast, when the CB purchases long-term treasuries, the impact on the overall cost of borrowing and lending activity is contingent on the level of short-term interest rates. Namely, long-term bond purchases promote loan supply and reduce the cost of raising funds for private and public agents only under a “low” short-term interest rate regime. Otherwise, if the CB implements a long-term bond purchase program, a contractionary

effect on the credit market can take place due to either a crowding out effect of government debt or through a reduction in the ability of the fiscal authority to subsidize credit market activity.

Finally, the paper is organized as follows. Section 2 introduces a benchmark, two-period model meant to analyze a general expansionary balance sheet policy. Section 3 introduces an extended, three-period model in which the CB can expand its balance sheet through short-term and long-term bonds. Section 4 analyzes the economy in the steady state. Section 5 presents the implications for monetary policy and section 6 concludes.

➤ 2. A benchmark two-period model.

I begin the analysis by studying a benchmark, two-period model in which the monetary authority follows a money growth rule and manipulates the size of its balance sheet by purchasing bonds, all of the same maturity. The analysis of this simple structure allows us to describe the different roles of the fiscal and monetary authorities. Further, and since several features of this simple model remain in the extended version, this exposition will allow for a better grasp of the implications of unconventional monetary policy when I introduce the extended model in the following section.

Our modeling structure has a separate and independent CB. This fact sets us apart from Schreft & Smith (1997) and (1998) in which monetary and fiscal policy is conducted by the same entity. The same difference is also true when comparing our framework with Ghossoub, Laosuthi and Reed (2006) as well as that of Laosuthi and Reed (2012). Even though Schreft & Smith (2002) do have a separate monetary authority, it rebates all of its returns from government securities back to the fiscal authority. In our case, the monetary authority keeps a fraction of its net revenues and can thus reinvest proceeds from government debt returns. This also implies that in our setup, bond purchases reflect true market operations as these transactions imply a net fiscal liability.

Finally, once I illustrate the structure of this model, I proceed to the next section by extending the life-cycle of agents to three-periods and including purchases of long-term bonds among the instruments of the monetary authority.

2.1. The environment.

Time is discrete, infinite and indexed by $t = 0, 1, 2, \dots \infty$. There are two symmetrical but separate locations, each populated by a unit-mass continuum of agents. These individuals live for two periods and can be either “depositors” or “borrowers”. At the start of time t , young depositors are endowed with $y_0 > 0$ units of a homogeneous consumption good and realize consumption c_{t+1} when old with preferences

$u(c_{t+1}) = \ln(c_{t+1})$. Every period, young depositors have a probability $\pi \in (0, 1)$ of geographically moving from their original location to the alternate location that creates a subpopulation of “movers” and “nonmovers”. In turn, borrowers are endowed with $y_1 > 0$ units of the consumption good when old but value consumption when young and when old according to $u(c_t, c_{t+1}) = \ln(c_t) + \beta \ln(c_{t+1})$, where $\beta \in (0, 1)$ is the discount factor. Unlike depositors, borrowers are not subject to relocation risk. A perfectly competitive banking sector is represented by financial intermediaries that simultaneously provide services in two different markets. First, in a deposit market, intermediaries offer rates of return taking competing bank's actions as given. Moreover, returns on deposits are contingent on the relocation status of its clients, offering r_t^m per unit deposited if a mover and r_t^n if a *nonmover*. Second, in the credit market, intermediaries offer riskless loans l_t at an interest rate of R_t per unit of the consumption good borrowed. Limited communication among banks between locations exclude the possibility of trading privately-issued liabilities. In contrast, fiat money is the only globally accepted asset which is dominated in rate of return by all other assets in the economy. These constraints generate a transactions role for money that relieves a trading friction for relocated agents as they must prematurely liquidate asset holdings to obtain cash and be able to consume in their new location. In this sense, relocation risk triggers a sudden demand for money balances or liquidity risk that is analogous to a preference shock as in Diamond and Dybvig (1983). Financial intermediaries offer returns to movers that depend on the size of the overall moving population as well as the return to money holdings. In doing so, they are effectively pooling income resources to insure against liquidity risk. Moreover, intermediaries participate in the credit market by supplying loans to borrowers that allow them to smooth their lifetime consumption. In this manner, banks act as financial intermediaries that provide risk insurance and consumption smoothing services in the economy.

There is a fiscal authority and an independent central bank (CB) in the economy. The fiscal authority generates income by issuing risk-free bonds in nominal amount B_t , with real value $b_t \equiv B_t/P_t$, where P_t is the unit price of the consumption good. The gross real return to government debt per unit of the consumption good borrowed at time t is R_t^b .

The CB conducts monetary policy using instruments. First, it regulates the nominal money supply M_t by controlling the rate of money growth $\sigma > 1$ following the rule $M_t = \sigma M_{t-1}$. In this manner, the CB can affect the return on real money balances $m_t \equiv M_t/P_t$, that depends on the relative price level P_t/P_{t+1} .

The second instrument allows the CB to directly make use of its balance sheet by engaging in a bond purchase program. Specifically, the CB purchases bonds from the fiscal authority in amount b_t^{CB} every period. Finally, the CB transfers a fraction $\lambda \in (0, 1)$ of its net income to the fiscal authority.

2.2. Timing of actions.

I now describe the sequence of actions of depositors and borrowers. At the beginning of period t , young depositors receive an endowment of $y_0 > 0$, which they deposit in the bank. In turn, intermediaries (banks) invest these funds in bonds, money balances and offer loans in a credit market. Next, young borrowers take out loans in order to consume during their middle age. Then, the relocation shock is realized and due to the limited communication between banks and restrictions on asset portability, moving agents must cash out their deposit from the bank. At the end of this period, depositors who have to relocate do so and carry money balances. Now, in their old stage, borrowers receive an endowment of $y_1 > 0$ which they use to payoff loan debt and afterwards, *nonmovers* claim their realized return on deposits. Finally, movers exchange their cash holdings for the homogeneous good with banks and all old agents consume.

2.3. Financial Intermediation.

a. The deposit market.

The market for financial intermediation is perfectly competitive and banks are identical across locations. Thus, a representative bank invests deposits into a portfolio of assets and announces returns of r_t^m for movers and of r_t^n for nonmovers. Hence, financial intermediation allows agents to have consumption levels of $c_t^m = r_t^m y_0$ if a mover, and $c_t^n = r_t^n y_0$ otherwise. Interest rates on deposits depend on the bank's returns to investments in cash m_t , government bonds b_t^p , and loans l_t . Therefore, to guarantee that returns on deposits are feasible, the bank sets its cash holdings for movers such that:

$$\pi r_t^m y_0 \leq m_t \frac{P_t}{P_{t+1}} \quad (1)$$

and similarly, but for the *nonmovers*, the bank will invest in bonds and loans offering returns that follow:

$$(1 - \pi) r_t^n y_0 \leq R_t^b b_t^p + R_t l_t \quad (2)$$

Furthermore, the bank's investment allocations are restricted by the amount of deposits in a balance sheet constraint:

$$y_0 \geq m_t + l_t + b_t^p \quad (3)$$

It follows that in equilibrium, banks offer rates of return $\{r_t^m, r_t^n\}$ that maximize depositor's expected utility:

$$\max\{\pi \ln(r_t^m y_0) + (1 - \pi) \ln(r_t^n y_0)\} \quad (4)$$

subject to (1)-(3).

The solution to the representative bank's problem implies that intermediaries hold money balances in an amount that is increasing in depositors' income and the degree of liquidity risk. This constitutes the optimal risk-sharing condition that permits banks to provide insurance against a random demand for liquidity in the form of cash:

$$m_t = \pi y_0. \quad (5)$$

Also from the bank's first order conditions, a no-arbitrage relationship holds:

$$R_t = R_t^b \quad (6)$$

which establishes that the cost of private debt has to equal that of public debt as banks exploit all profit opportunities in order to attract depositors.

b. The credit market.

Borrowers are only endowed when old with y_1 units of the consumption good. The fact that they value consumption when young makes these individuals seek any consumption smoothing opportunities. Hence, these individuals will finance their consumption when young by taking out default-free loans in amount l_t^d (at a given interest rate of R_t) in the credit market that maximizes:

$$\max\{\ln(l_t^d) + \beta \ln(y_1 - R_t l_t^d)\} \quad (7)$$

which gives a standard loan demand function that is increasing in income and decreasing in the cost of borrowing:

$$l_t^d = \frac{y_1}{(1 + \beta)R_t} \quad (8)$$

Finally, the market for loans clears so that:

$$l_t^s = l_t^d \quad (9)$$

for all $t \geq 0$.

2.4. The Central Bank.

A monetary authority is represented by a CB that is responsible for the conduct of monetary policy. The CB has two instruments at its disposal. First, it controls the supply of money in the economy by altering the rate of money growth σ . This instrument provides the monetary authority with inflation tax proceeds or seigniorage revenue in amount $\left(\frac{\sigma-1}{\sigma}\right)m_t$ every period. Second, the CB engages in a government security purchase program by acquiring bonds in amount b_t^{CB} and collecting returns on previously issued bonds in amount $R_{t-1}^b b_{t-1}^{CB}$. Thus, the CB resource constraint is depicted by:

$$R_{t-1}^b b_{t-1}^{CB} + \left(\frac{\sigma-1}{\sigma}\right)m_t - b_t^{CB} > 0 \quad (10)$$

where net income is strictly positive as the CB controls seigniorage revenue in order to avoid any losses. Finally, every period, the CB transfers a fraction $\lambda \in (0,1)$ of its net resources to the fiscal authority. These transfers allow monetary policy to influence the impact of public debt in the economy.

2.5. The fiscal authority.

A fiscal authority issues debt in the form of bonds b_t every period, hence, government revenue comes from the sale of bonds to the CB and to private investors such that the bond market clears in every period:

$$b_t = b_t^{CB} + b_t^P \quad (11)$$

for all $t \geq 0$.

Debt payments constitute the expense side of the fiscal authority's budget constraint in the LHS of (12). Additionally, its income is complemented every period by a fraction λ of the CB's net revenues so that under a balanced budget constraint:

$$R_{t-1}^b b_{t-1} = b_t + \lambda \left[R_{t-1}^b b_{t-1}^{CB} + \left(\frac{\sigma - 1}{\sigma} \right) m_t - b_t^{CB} \right] \quad (12)$$

2.6. Steady state analysis.

The steady state properties of the economy follow. First, by (6) and (8) I construct the no arbitrage locus:

$$l = \frac{y_1}{(1 + \beta)R^b} \quad (13)$$

which relates borrower's loan demand with the return on government debt.

Next, I obtain a second steady state relationship. Note that in a steady state equilibrium $P_{t+1}/P_t = \sigma$ so that using (5) and (11) into (12) yields:

$$b^P = \lambda \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{\pi y_0}{R^b - 1} \right) - (1 - \lambda)b^{CB} \quad (14)$$

This expression shows how private bond holdings are affected through monetary policy by way of open market operations given the net lending position of the fiscal authority. For instance, when $R^b - 1 > 0$, net real interest rates are positive which implies that the fiscal authority is a net borrower: $b^p > 0$. In this case, CB bond purchases can reduce the amount of public debt in intermediaries portfolios and free up resources that can now be invested in other assets such as loans. Similarly, when $R^b - 1 < 0$, there are negative net real interest rates and the fiscal authority is a net lender: $b^p < 0$. This fact implies that the fiscal authority is in fact lending low cost resources to intermediaries which constitute a subsidy. Under this scenario, CB purchases of government bonds facilitate fiscal subsidies which increase investment resources to intermediaries. Note that in both cases, the effectiveness of monetary policy increases as CB transfers λ decrease. This highlights the relevance of the CB's fiscal independence and thus the importance of a CB expansionary balance sheet policy to affect lending activity. To gain a deeper insight, I substitute the value of b^p in (14) into the bank's balance sheet constraint described by (3), and obtain an expression for the steady state loan supply level:

$$l = y_0 - \pi y_0 \left[1 + \frac{\lambda \left(\frac{\sigma - 1}{\sigma} \right)}{R^b - 1} \right] + (1 - \lambda) b^{CB} \quad (15)$$

This expression denotes important aspects of credit intermediation. For instance, increases in cash reserves due to higher liquidity shocks reduce the supply of credit. Also, higher borrowing costs reflected by R^b , positively impact loan supply. Furthermore, CB bond purchases can effectively increase loan supply by reducing the supply of government debt available so that intermediaries destine more resources to loan investment. Next, I offer conditions for a steady-state to exist.

Proposition 1. *(Existence of multiple steady states).*

Assume (10) holds and let $\hat{l} = [1 - \pi(1 - \lambda)]y_0 + (1 - \lambda)b^{CB}$. Further, assume that borrower's endowments when old are such that: $y_1 > [y_0 + (1 - \lambda)(b^{CB} - \pi y_0)] \left(\frac{1 + \beta}{\sigma} \right)$.

Under these conditions, multiple steady states exist in which the net lending position of the fiscal authority as well as credit market activity differ. In one economy there is low credit market activity and the fiscal authority is a net borrower; in the other, higher credit market activity coexists with a fiscal authority that is a net lender.

In other words, we have one economy in which the fiscal authority is a net borrower, the existing levels of public debt result in a highly distorted credit market. This condition implies low levels of lending activity along with high borrowing costs. In contrast, the other economy in which the fiscal authority is a net lender, there exist more efficient credit markets with comparatively low interest rates and higher lending volume.

2.7. Comparative statics.

a. Rate of money growth rule.

Next, I study the effects of monetary policy in the steady state. Starting with money supply in the economy, the impact of an increase in the rate of money growth is summarized by the following proposition:

Proposition 2. (Increase in the Rate of Money Growth).

i. When the overall stance of the fiscal authority is of a net debtor: $\frac{dl}{d\sigma} < 0$, $\frac{dR^b}{d\sigma} > 0$ and

$$\frac{dR}{d\sigma} > 0.$$

ii. When the overall stance of the fiscal authority is of a net lender: $\frac{dl}{d\sigma} > 0$, $\frac{dR^b}{d\sigma} < 0$ and

$$\frac{dR}{d\sigma} < 0.$$

That is, higher rates of money growth increase resources transferred to the fiscal authority. In the economy with low levels of credit market activity, the fiscal authority utilizes these additional resources to issue more debt. However, in order for the bond market to clear according to (11), the return to bonds has to increase. The final outcome is a reduction in credit activity as higher returns for public debt crowd out loan investment from intermediaries' portfolios. In contrast, in the economy with comparatively larger credit market activity, higher seigniorage transfers allow the fiscal authority to enhance resource subsidies to the private sector. In turn, these intermediaries allocate more resources to loan investment that by (9) reduces the cost of private borrowing increasing lending volume.

b. Bond purchase program.

In contrast with a money growth policy, the impact of an expansionary balance sheet policy through purchases of government securities differs as illustrated by the following proposition:

Proposition 3. (Treasury Purchases). Irrespective of the fiscal authority's net lending position, $\frac{dl}{db^{CB}} > 0$,

$$\frac{dR^b}{db^{CB}} < 0 \text{ and } \frac{dR}{db^{CB}} < 0.$$

This implies that in both economies, expansionary balance sheet policy increases the asset side of the fiscal authority via transfers. At the same time, because the central bank keeps a fraction $1 - \lambda$ of bond purchases, fiscal liabilities also increase. However, when the fiscal authority is a net borrower, bond purchases by the monetary authority also reduce intermediaries' investment opportunities in public debt. In this case, the ultimate outcome is a decline in bond supply which shifts intermediaries resources toward loan investment. For the loan market to clear, the cost of private and public borrowing must go down by condition (9).

If the fiscal authority is a net lender, through this policy, the monetary authority is effectively lending low cost resources to the fiscal authority. In turn, this enhances subsidies to the private sector which allows these intermediaries to allocate greater resources into loan investments. As a result the cost of borrowing declines by loan market clearing.

➔ 3. A three-period model.

I now build on the previous benchmark model by extending the life-cycle of agents as well as the maturity structure of assets in the economy. The objective of this setup is to enrich the set of monetary policy instruments by including purchases of long-term government securities. In this manner, the monetary authority can now implement an expansionary balance sheet policy by purchasing bond securities of short and long-term maturities in order to affect credit market activity.

3.1. The environment.

In the population of size one, individuals live for three periods denoted by “young”, “middle aged” and “old”. When young, depositors are endowed with $y_0 > 0$ units of the homogeneous consumption good and the relocation shock occurs during their middle age. These agents value consumption only when old. Borrowers are endowed with $y_1 > 0$ units of the consumption good when old and value consumption opportunities when middle aged and when old.

The fiscal authority issues debt obligations with different maturity structures. For instance, it issues short-term (one-period) bonds whose real value I denote by $b_{1,t}$. A holder of a unit of this security at time t has the right to a claim of $R_{1,t}^b$ units of the consumption good borrowed at time $t - 1$. The fiscal authority also issues long-term bonds $b_{2,t}$, which give a return of $R_{2,t}^b$ for every unit of the consumption good borrowed two periods before, or at $t - 2$.

Therefore, along with controlling the rate of money growth and short-term bond purchases $b_{1,t}^{CB}$ the CB now uses its balance sheet as a third instrument by engaging in long-term bond purchases in amount $b_{2,t}^{CB}$ every period.

3.2. Timing of actions.

I now describe the sequence of actions of depositors and borrowers in the economy. At their young stage, depositors receive an endowment which they deposit in the bank. With these resources, intermediaries conform investment portfolios on behalf of their depositors. Afterwards, borrowers take out loans to finance middle age consumption. When the middle stage arrives, the relocation shock is realized and a fraction π of young depositors will terminate their investments early. These middle aged movers exchange their investment returns for cash held by old movers that arrived from the opposite location and are in need to consume in this stage. Once middle-aged movers relocate, they become old and exchange their cash holdings for the consumption good with the middle-aged movers from their new location. At the same time, borrowers receive their endowment which they consume after honoring loan payments.

3.3. Financial intermediation.

a. The deposit market.

In contrast to the benchmark model, banks do not invest in cash. The fact that the relocation shock takes place after a depositor's young period allows banks to invest in a higher-yield asset on their behalf - in this case a one period, or short-term bond- that matures before relocation takes place. Consequently, movers must obtain cash outside the banking system. They do so by exchanging their deposit returns for cash with now old movers that arrived from the opposite location. It follows that bank returns depend on the yield of short-term bond investments for movers $b_{1,t}^m$ and for *nonmovers* $b_{1,t}^n$, as well as of long-term bond purchases $b_{2,t}^n$. Additionally, bank returns are complemented by returns to private debt investment in the form of loans l_t . The rate of return to loans constitutes a sure claim of R_t per unit of the consumption good borrowed in $t - 2$ making private borrowing a long-term liability. Given returns on deposits of r_t^n and r_t^m , deposit market participants have access to consumption levels of $c_t^m = r_t^m y_0$ if a mover and $c_t^n = r_t^n y_0$ otherwise. Thus, on behalf of its moving depositors, the bank will invest in a short-term bond taking into account the return to money balances:

$$r_t^m y_0 \leq (R_{1,t+1}^b b_{1,t}^m) \frac{P_t}{P_{t+1}} \quad (16)$$

Similarly, feasibility of bank returns to *nonmovers* yields:

$$r_t^n y_0 \leq (R_{1,t+1}^b b_{1,t}^n) R_{2,t+2}^b + R_{2,t+2}^b b_{2,t}^n + R_{t+2} l_t \quad (17)$$

These constraints imply that the bank's balance sheet constraint is described by:

$$y_0 \geq b_{1,t}^m + b_{1,t}^n + b_{2,t}^n + l_t \quad (18)$$

In a perfectly competitive deposit market, a representative bank offers rates of return that solve:

$$\max\{\pi \ln(r_t^m y_0) + (1 - \pi) \ln(r_t^n y_0)\} \quad (19)$$

subject to (16)-(18).

The solution to the bank's problem determines the optimal risk-sharing condition reflected by the bank's purchases of short-term bonds for its moving clients:

$$b_{1,t}^m = \pi y_0 \quad (20)$$

which are proportional to the size of the deposit base as well as the magnitude of the relocation shock.

However, before changing locations, moving depositors will exchange their bank returns $R_{1,t+1}^b b_{1,t}^m$ for cash with the now old movers from the opposite location. Thus, and in line with (20), money demand is given by:

$$m_{t+1} = R_{1,t+1}^b (\pi y_0) \quad (21)$$

In addition, I obtain two no-arbitrage conditions between the rates of return of public versus private debt:

$$R_{1,t+1}^b R_{1,t+2}^b = R_{t+2} \quad (22)$$

$$R_{2,t+2}^b = R_{t+2} \quad (23)$$

Expression (22) imposes the representative bank to invest until the compounded return on short term debt equals the long term return on private investment. The following expression (23) indicates the same action forcing the equality of returns of existing long-term investment opportunities. These two expressions imply that

$$R_{1,t+1}^b R_{1,t+2}^b = R_{2,t+2}^b \quad (24)$$

which lays the term structure of interest rates in the economy.

b. The credit market.

Borrowers will take out default-free loans l_t^d in the credit market at an interest rate of R_{t+2} . At optimality, borrowers take out loans such that:

$$l_t^d = \frac{y_1}{(1 + \beta)R_{t+2}} \quad (25)$$

so that at a given income level and rate of time preference, demand for loans decreases with the cost of borrowing.

Also, the credit market clears:

$$l_t = l_t^d \quad (26)$$

for all $t \geq 0$.

3.4. The Central Bank.

The monetary authority conducts open market operations and obtains seigniorage revenue by controlling the rate of money growth. In this setup however, by purchasing long term bonds $b_{2,t}^{CB}$ the monetary authority has an additional mean to use its balance sheet and affect credit market activity. Thus, the CB's resource constraint is depicted by:

$$R_{1,t-1}^b b_{1,t-1}^{CB} + R_{2,t-2}^b b_{2,t-2}^{CB} + \left(\frac{\sigma-1}{\sigma}\right) m_t - b_{1,t}^{CB} - b_{2,t}^{CB} > 0 \quad (27)$$

3.5. The fiscal authority.

Every period the fiscal authority issues short and long term bonds to finance its previous debt payments. Both types of securities are purchased by intermediaries in their effort to provide risk-sharing and consumption-smoothing services, as well as by the central bank to conduct expansionary balance sheet policies. Short term bond securities mature within one period and at any point in time the market for these securities clears:

$$b_{1,t} = b_{1,t}^m + b_{1,t}^n + b_{1,t}^{CB} \quad (28)$$

for all $t \geq 0$.

Long-term bonds mature within two periods and similarly:

$$b_{2,t} = b_{2,t}^n + b_{2,t}^{CB} \quad (29)$$

for all $t \geq 0$.

Along with debt revenue, the fiscal authority makes use of income transfers from the monetary authority. These transfers consist of a fraction λ of net proceeds as depicted in (27) and it is another revenue source destined to honor debt obligations. Consequently, the fiscal authority's budget constraint is represented by:

$$R_{1,t-1}^b b_{1,t-1} + R_{2,t-2}^b b_{2,t-2} = b_{1,t} + b_{2,t} + \lambda \left[R_{1,t-1}^b b_{1,t-1}^{CB} + R_{2,t-2}^b b_{2,t-2}^{CB} + \left(\frac{\sigma-1}{\sigma}\right) m_t - b_{1,t}^{CB} - b_{2,t}^{CB} \right] \quad (30)$$

In this manner, the rate of money growth as well as government debt purchases by the monetary authority can influence the supply of public debt in the economy.

3.5. Steady state analysis.

I start by studying the role of bond purchases by the monetary authority. Looking at the bank's balance sheet constraint in (18) and plugging in for the risk-sharing condition in (20), we have that:

$$l = y_0(1 - \pi) - (b_{1,t}^n + b_{2,t}^n) \quad (31)$$

This expression illustrates two important facts about loan intermediation. First, for a given depositor income level, an increase in the frequency of liquidity shocks compromises resources for long term loan investment. Secondly, increased borrowing by the fiscal authority can potentially reduce the amount of loans that intermediaries supply in the credit market. That is, public debt can “crowd out” private loan investment in detriment of the ability of intermediaries to provide consumption-smoothing services.

However, in this intermediation process there is a non-trivial role for monetary policy. To see this, first note that in the steady state, $(R_1^b)^2 = R_2^b$ by (24). Hence, I can rewrite (30) by making use of (20) along with (28) and (29) so that:

$$b_1^n + (R_1^b + 1)b_2^n = \pi y_0 \left[\lambda \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{R_1^b}{R_1^b - 1} \right) - 1 \right] - (1 - \lambda) [b_1^{CB} + (R_1^b + 1)b_2^{CB}] \quad (32)$$

This expression implies that bond purchases by the monetary authority have a direct impact on the amount of government securities available to private investors. I discuss the two possible cases based on the fiscal authority's net lending position.

In the case for which $R_1^b - 1 > 0$, the fiscal authority is a net borrower as long as $\lambda \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{R_1^b}{R_1^b - 1} \right) - 1 > 0$, or equivalently:

$$\lambda \left(\frac{\sigma - 1}{\sigma} \right) R_1^b > R_1^b - 1 \quad (33)$$

This inequality implies that the real value of seigniorage resource transfers must be greater than the net real debt obligations of the fiscal authority. I assume this restriction holds so that an increase in bond purchases by the monetary authority reduces the supply of bonds that otherwise would be allocated into intermediaries' portfolios. Looking back at (31) suggests that bond purchases reduce fiscal debt distortions in the credit markets by allowing intermediaries to invest a greater amount of deposits into loans. When $R_1^b - 1 < 0$, the fiscal authority is a net lender to the private sector. In this respect, bond purchases by the monetary authority increase the resource capacity of the fiscal authority. In turn, by (31), intermediaries can destine more resources into loan investment.

I now focus on the existence of steady state equilibrium in the economy. Using (3.31) and (3.32) I obtain the steady state loan supply in the economy:

$$l = y_0 \left\{ 1 - \pi \lambda \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{R_1^b}{R_1^b - 1} \right) \right\} + (1 - \lambda) b_1^{CB} + [1 - \lambda(R_1^b + 1)] b_2^{CB} + R_1^b b_2 \quad (34)$$

This expression indicates the partial marginal impact of bond purchases on credit availability. Specifically, short-term bond purchases always increase loan investment since $1 - \lambda > 0$ while the effect of long-term bond purchases $1 - \lambda(R_1^b + 1)$ also depends on the level of short-term interest rates.

Similarly, I derive the second steady-state condition which is the no-arbitrage locus between the returns to private and public borrowing. Taking (24), I use the fact that $(R_1^b)^2 = R$ holds by (22) so that:

$$l = \frac{y_1}{(1 + \beta)(R_1^b)^2} \quad (35)$$

Equations (35) and (36) capture the steady-state behavior of the economy.

Proposition 4 (*Existence of Multiple Steady States*):

Assume (27) holds and let $\hat{l} = [y_0(\lambda\pi + \sigma) + b_2 - \lambda b_2^{CB}]\sigma^{-1} + (1 - \lambda)(b_1^{CB} + b_2^{CB})$. Moreover, assume that borrower's endowments are such that: $y_1 > [y_0(\lambda\pi + \sigma) + b_2 - \lambda b_2^{CB} + (1 - \lambda)(b_1^{CB} + b_2^{CB})\sigma](1 + \beta)\sigma^{-3}$.

Then, under these conditions, two steady states exist. In one, the fiscal authority is a net borrower yielding low credit market activity, while in a second one, the fiscal authority is a net lender allowing for high levels of credit market activity.

I now turn to the analysis of the effects of monetary policy.

3.6. Comparative statics.

a. Rate of Money growth.

Proposition 5. (Increase in the Rate of Money Growth):

i. In economies in which the fiscal authority is a net borrower: $\frac{dl}{d\sigma} < 0$, $\frac{dR_1^b}{d\sigma} > 0$, $\frac{dR_2^b}{d\sigma} > 0$, and $\frac{dR}{d\sigma} > 0$.

ii. In economies in which the fiscal authority holds a net lending position: $\frac{dl}{d\sigma} > 0$, $\frac{dR_1^b}{d\sigma} < 0$, $\frac{dR_2^b}{d\sigma} < 0$, and $\frac{dR}{d\sigma} < 0$.

The intuition of this proposition is as follows. Higher rates of money growth increase seigniorage transfers to the fiscal authority. In the economy with low credit activity, this policy allows the fiscal authority to issue more debt. Due to (28) and (29) higher bond payouts take place. Moreover, higher returns on public debt crowd out loan investment from intermediaries portfolios. Through the no arbitrage conditions (22) and (23) there is an increase in the overall cost of borrowing which is ultimately reflected by a decline in lending volume. In the economy with high credit activity, this policy allows the fiscal authority to increase low-cost lending to the private sector. These additional resources boost loan investment by intermediaries thereby reducing the cost of private borrowing so that (26) holds. In turn, no arbitrage conditions from the bank's problem guarantee a reduction in the cost of public borrowing.

b. Open market operations.

Proposition 6. Irrespectively of the fiscal authority's net lending stance, $\frac{dl}{db_1^{CB}} > 0$, $\frac{dR^b}{db_1^{CB}} < 0$, $\frac{dR_2^b}{db_1^{CB}} < 0$, $\frac{dR}{db_1^{CB}} < 0$.

That is, purchases of short-term bonds by the monetary authority increase credit market activity and reduce borrowing costs irrespective of the fiscal authority's financial position. In the steady state with low credit market activity, short-term bond purchases reduce the availability of public-debt investment opportunities for intermediaries. Consequently, more resources are directed towards loan investments, which reduce the equilibrium interest rate on loans. In the steady state where the fiscal authority is a net lender, the monetary authority is transferring as well as effectively lending low cost resources to the fiscal authority. Open market operations then increase supplemental income to the fiscal authority that puts downward pressure on the cost of short-term public borrowing. At the same time, through increased loans from the monetary authority, the fiscal authority augments subsidies to the private sector causing an increase in resources directed at loan investment. Therefore, the private cost of borrowing must decline in equilibrium. Finally, through the no arbitrage conditions the overall cost of borrowing in the economy declines.

c. *Long-term bonds.*

When the monetary authority engages in a long-term bond purchase program, the impact on credit market activity differs relative to conventional open market operations. Namely, long-term bond purchases increase credit market activity and reduce the cost of public borrowing if:

$$R_1^b < \frac{1 - \lambda}{\lambda} \equiv R_1^{b*} \quad (36)$$

This condition implies that for long-term bond purchases to work, short-term interest rates must be “low”. Such condition holds irrespective of the net fiscal position of the government. In the economy with a highly distorted credit market, long-term bond purchases are successful in with drawing public debt from intermediaries' portfolios and stimulating loan investment. This effect dominates the increase in compounded resources -that translate into higher public debt levels- to the fiscal authority precisely because short-term interest rates are low in the sense of (36). Credit market clearing jointly with no-arbitrage conditions assure that overall interest rates across maturities decline. In the economy with high credit market activity, the monetary authority is effectively lending low cost resources to the fiscal authority. If again, interest rates are low enough, the compounded cost of servicing such debt is not high enough to compromise subsidies to the private sector. As a result, intermediaries have additional resources that increase loan supply and thus better serve the consumption-smoothing needs of borrowers.

Proposition 7. *Irrespective of the fiscal authority's net lending stance, $\frac{dl}{db_2^{CB}} > 0$, $\frac{dR^b}{db_2^{CB}} < 0$, $\frac{dR_2^b}{db_2^{CB}} < 0$, $\frac{dR}{db_2^{CB}} < 0$ if short-term interest rates are such that condition (36) holds.*

The above proposition implies that if the interest rate level of economy whose fiscal authority is in a net borrowing position, is higher relative to the threshold value of R_1^{b*} , then purchases of long term bonds by the CB ultimately crowd out loan investment while at the same time increasing the overall cost of borrowing public and private debt in the economy. Similarly, if the interest rate level of both economies is above such threshold value, then this policy is ineffective as both economies' interest rate levels violate condition (36).

3.7. Conclusions.

Recently, central banks around the world resorted to nontraditional policy tools to stimulate economic activity. A distinctive example was the expansion of the size of their balance sheets through the purchase of long-term government securities. In this paper I analyze the effect on credit markets of this "unconventional" monetary policy tool and compare it with that of conventional instruments such as open market operations. Our framework takes into account the role of financial intermediaries that provide risk-sharing and intertemporal consumption-smoothing services in the transmission mechanism of monetary policy. Our findings suggest that central bank purchases of long-term government securities stimulate credit market activity and reduce the cost of public and private borrowing only under a low interest rate and reduced fiscal debt regime. Otherwise, this policy increases the cost of servicing debt resulting in a contraction of lending. In contrast, open market operations aid credit availability but negatively affect the amount of risk-sharing in the economy.

Our analysis suggest the need for future research to explore more about how unconventional monetary policy affects credit markets and other aspects of economic activity. At the same time this analysis provides a rigorous framework from which one can further develop structures in order to explore other questions. For instance, the effect of monetary policy under a concentrated banking sector is of great importance. In an open-economy setting, the spillover effects of expansionary balance sheet policies are of interest for international central bank coordination as well as their impact on credit for emerging economies.

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