Heterodox Central Banking*

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1 Introduction

In response to the current global crisis, the U.S. Federal Reserve and other central banks around the world have implemented a number of diverse policy measures, including purchasing of a wide array of securities, lending to financial institutions, exchange rate interventions, and paying interest on reserves. Some central banks have also reduced monetary policy interest rates to minimum levels (lower bound) and have announced an explicit commitment to keep interest rates at that level for a prolonged period of time. This array of instruments contrasts with a conventional view, embedded in dominant models of monetary policy, under which a central bank only controls a short term interest rate, such as the Federal Funds rate.

Some of the previous actions may be classified as responses to increasing demand for liquidity in the context of high financial uncertainty. An example of this liquidity provision by central banks is repo operations to provide US dollar liquidity in many economies in the period around the bankruptcy of Lehman Brothers. Other actions may be classified as actions implemented to deal with malfunctioning of financial markets (insufficient lending to non financial firms or high lending spreads), and actions implemented to deal with the need to enhance the monetary policy stimulus under the lower bound constraint.

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This paper discusses theoretical and practical aspects of heterodox policies. In terms of theory, the paper focuses on the two alternative arguments that have been offered to rationalize such policies: the desirability of further monetary stimulus when interest rates are already at zero, and the need to unlock financially intermediated credit when it freezes in a crisis. On the first argument, we provide a framework to analyze the theoretical mechanisms through which quantitative easing may be effective to deal with the lower bound constraint. We then show that the effectiveness of such unconventional policies depends crucially on the ability of the central bank to commit to future policy, in line with Krugman (1998). Regarding the second argument, we present a model that helps us to introduce a role for unconventional monetary policy in the context of non trivial financial intermediation. We then argue that the introduction of financial intermediaries in a standard models lead to results that challenge conventional wisdom regarding the effects of non conventional policies.

In terms of recent practice, we provide evidence regarding recent experience of central banks that have implemented inflation targets in the conduct of monetary policy. We associate the different monetary policy actions with different phases of the recent financial crisis and with different objectives. We concentrate our analysis in evaluating actions aimed at increasing the monetary policy stimulus and dealing with disrupted financial markets.

The rest of the paper is organized as follows. Section 2 presents a theoretical discussion of two relevant issues that have been at center stage in both policy and academic discussions about unconventional policies during the current crisis: the role of credibility and the importance of financial frictions and bank capital. Section 3, on the other hand, provides a more empirically oriented account of recent events. We first discuss the timing and the type of unconventional policies that have been implemented. We then compare several alternative measures that can be used to assess the stance of monetary policy, particularly when the policy rate has reached its lower bound. Finally, we provide descriptive evidence on the effects of these policies on the shape of the yield curve and the lending-deposit spreads. Section 4 concludes.

2 Rationalizing Hetedorox Monetary Policy

2.1 Monetary Policy at the Edge: The Role of Credibility

One often mentioned justification for unconventional monetary policy is that the usual monetary instrument, the control of an overnight interest rate in the interbank market, may have reached a limit. In particular, this is the case when a monetary stimulus is deemed to be desirable but the policy rate is a nominal one that cannot be pushed below zero (or a value slightly greater than zero). If the policy rate is already at or close to the lower bound, the central bank is forced to look for alternative ways to provide the monetary stimulus.

Clearly, the current crisis has brought several countries to a situation in which policy interest rates are close to zero but expansionary policy appears warranted. Much less clear, however, is whether that fact is sufficient to justify the kind of unconventional policies that we have observed *in practice*. Can one appeal to the zero lower bound problem to rationalize, for example, the striking expansion in the size of the Federal Reserve's balance sheet as well as the changes in its composition? Here we argue that the answer can be positive or negative, depending on the policy environment and, especially, on the central bank's ability to commit to future policy.

The starting point of our argument is the observation that currently accepted macroeconomic theory implies that the zero bound on interest rates will rarely, if ever, be a truly binding constraint for a central bank that can perfectly commit in advance to future policy. Current theories emphasize that a central bank can affect current economic decisions not only through the current setting of its policy instrument (e.g. today's interest rate) but also, and perhaps much more effectively, through its impact on the public's expectations of the future settings of the instrument. The corollary is that the central bank can always provide some stimulus to the economy, even if the policy rate is at the zero bound, by committing to reducing future policy rates below levels previously expected (which is itself feasible if the policy rate was expected to be positive at some point in the future).

Thus, for example, Bernanke and Reinhart (2004, page 85) argue that one of the available strategies for "stimulating the economy that do not involve changing the current value of the policy rate...[is] providing assurance to financial investors that short rates will be lower in the future

than they currently expect". The same argument has been embraced recently by the European Central Bank (Bini Smaghi 2009), the Bank of Canada (Murray 2009), and others. In fact, even Krugman's (1998) pioneering discussion of Japan implied that the Bank of Japan could have escaped the liquidity trap there by promising to keep interest rates sufficiently low for some period even after inflation had become positive (see also Svensson 2003).

In short, the zero lower bound on interest rates is unlikely to be a serious constraint on a central bank that can precommit policy. One could conjecture, however, that unconventional policies such as "quantitative easing" or "credit easing" may be still be useful to complement conventional policy. Somewhat surprising, however, is to realize that that conjecture is quite unlikely to hold.

This key point has been developed most convincingly by Eggertsson and Woodford (2003). They show that, once a strategy for setting current and future policy rates is in place (for example, by a rule of the Taylor type), real allocations and asset prices are independent of what the central bank does with the composition or size of its balance sheet in periods in which the policy rate is zero.

It may be worth expanding on the intuition behind this important result, if only to stress its generality. Eggertsson and Woodford's model is a variant of the canonical New Keynesian sticky price model developed by Woodford (2003) and others. In that model, as well as many others, all asset prices are determined once the equilibrium pricing kernel or stochastic discount factor is given. Likewise, the stochastic discount factor determines the relevant budget constraint of the household, and the pricing decisions of producers.

In such a context, an interest rate rule can affect aggregate outcomes by establishing a relation between the stochastic discount factor and other variables such as inflation or the output gap. In equilibrium, that relation will be given by an equation of the following sort:

$$\begin{aligned} \left[E_t \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{P_t}{P_{t+1}}\right]^{-1} &= 1 + i_t \\ &= \phi(Z_t) \end{aligned}$$

where β is the average household's discount factor λ_t is the marginal utility of consumption, P_t the

price of consumption, i_t the nominal interest rate for loans between periods t and $t+1$, and ϕ is a function of a vector of variables Z_t, typically inflation and output. The first equality reflects the household's optimal portfolio decisions; here, the stochastic discount factor is given by the random variable $\beta\lambda_{t+1}/\lambda_t$. The second equality says that the central bank sets the interest rate i_t as a function ϕ of the vector of variables Z_t. So, in equilibrium, interest rate policy (e.g. a choice of the function ϕ as well as the vector Z_t) implies a relation between the stochastic discount factor, inflation, and the vector Z_t. Indeed, this is the main (and often the only) way in which interest rate policy affects aggregate outcomes.

If the zero bound on the policy rate i_t were not a binding constraint, a choice of an interest rate rule $\phi(Z_t)$ would leave no room for "quantitative easing", that is, independent control of the monetary base. The quantity of money would be determined by its demand, with the central bank adjusting the base as necessary to clear the market (this is indeed what an interest rate rule would mean). In addition, under usual assumptions on fiscal policy, changes in the composition of the central bank's balance sheet (and, more generally, of the consolidated government) are irrelevant for aggregate outcomes. This is because the latter can be shown to depend only on the present value budget constraint of the government, which is given by its initial debt plus the appropriately discounted value of (possibly state contingent) fiscal deficits.

Eggertsson and Woodford (2003) extend this logic to situations in which the interest rate policy $\phi(Z_t)$ may prescribe a zero interest rate under some circumstances (i.e. for some values of the vector Z_t). In those cases, they assume that the demand for money is indeterminate (the real demand for money being only bounded below by some satiation level). This allows the central bank to determine the quantity of money independently, in other words, to engage in "quantitative easing". They show, however, that aggregate allocations are independent of the details of such quantitative easing. The logic is simple: as we just discussed, quantitative easing might affect aggregate outcomes if it had some impact on the stochastic discount factor. But the latter is pinned down by the function ϕ, as in the absence of the lower bound problem.

The justification for the last assertion is illuminating. The assertion would be immediate if the marginal utility of consumption, λ_t, were independent of real money balances. Eggertsson and

Woodford assume, however, that utility may depend on real balances in a nonseparable way, so λ_t may depend on M_t/P_t. However, if the interest rate is driven to zero, real balances must exceed the satiation level, which in turn means that the quantity of money has no longer any effect on utility and, *a fortiriori,* on λ_t. (It is in this exact sense that money and bonds becoming perfect substitutes at zero interest rates matters.)

Having established that quantitative easing is irrelevant at zero interest rates, the irrelevance of altering the composition of the central bank's balance sheet follows in the same way as before.

Our discussion (hopefully) stresses that the logic behind the Eggertsson-Woodford irrelevance result is quite general and, hence, extends to a very wide class of models, including most currently in fashion. The result, in particular, does not hinge on the absence of imperfectly substitutable assets, which may have led some to suspect that changes in the size and composition of the central bank balance sheets would have "portfolio balance" effects. Indeed, the absence of portfolio balance effects could be taken to be a significant flaw, and one could conjecture that models featuring such effects may overturn the irrelevance argument. But a compelling portfolio balance model of the effects of policies regarding the balance sheet of the central bank is yet to be developed. In addition, the empirical evidence about portfolio balance effects provides little support for them, as stressed by Bernanke and Reinhart (2004): "the limited empirical evidence suggests that, withing broad classes, assets are close substitutes, so that changes in relative supplies of the scale observed in U.S. experience are unlikely to have a major impact on risk premiums or even term premiums (Reinhart and Brian Sack, 2000)".

Summarizing, we have argued that a central bank that can commit in advance to a conventional interest rate policy will generally not find that the zero bound on interest rates is a binding restriction and, in particular, can provide a monetary stimulus even in a liquidity trap by promising that future settings of the policy rate will be lower than they would have been otherwise. In addition, such a central bank will find that quantitative easing, portfolio management maneuvers, and other strategies for altering the size and composition of its balance sheet at times of zero interest rates are irrelevant.

This given, why is then the case that, often, central banks have been unable to come out of

deflationary liquidity traps by just promising expansionary policy in the future? The key conjecture is that such promises may not be credible. Credibility as a crucial constraint in this situation has, of course, been emphasized by several authors, starting with Krugman in his (1998) analysis of the Japanese recession.

One implication of this observation is that the literature is full of warnings and admonitions about the need for central banks to ensure that announcements of future policy are believable, suggesting even that central banks can "manage expectations" independently of interest rate policy. For example, the Banque of France recently stated that one unconventional policy is "influencing the yield curve by guiding expectations" (Banque of France 2009, page 5). There is little guidance in these statements, however, as to how precisely the central bank can independently manage expectations. Bernanke and Reinhart (2004, p.86) acknowledged this fact, stating: "Ultimately, however, the central bank's best strategy for building credibility is to build trust by ensuring that its deeds match its words...the shaping of expectations is not an independent policy instrument in the long run. "

Others have responded to the credibility issue by emphasizing the need for improving "transparency" and "clear communication " of central bank policy intentions. Of course, it is hard to argue with the view that transparency and clear communication are desirable aspects of central bank policy. But, aside from the fact that it is not clear why the need for them is greater when interest rates are close to zero than at other times, there is no generally accepted theory of how more or less transparency affects monetary transmission channels.

A related claim, of particular relevance to our discussion, is that changes in the size and composition of the central bank balance sheet can help the credibility of the central bank's announcements about future policy. And, in fact, some authors have claimed that this is the main role of unconventional policies. For example, Bernanke and Reinhart (2004, p. 88) argue that a central bank policy of setting a high target for bank reserves "...is more visible, and hence may be more credible, than a purely verbal promise about future short term interest rates. " Likewise, Eggertsson and Woodford (2003) conjectured that "shifts in the portfolio of the central bank could be of some value in making credible to the private sector the central bank's own commitment to a particular kind of

future policy... 'Signalling ' effects of this kind...might well provide a justification for open market policy when the zero bound binds. "

To date, however, attempts to make these claims more precise are lacking. But a long standing theory of monetary policy under imperfect credibility suggests several ways to develop this view. To illustrate, let us examine the implications of a simple model of monetary policy.

2.1.1 Unconventional Policy: An Illustrative Model

We shall extend the model of Jeanne and Svensson (2007, henceforth JS). Consider a small open economy with a representative agent that maximizes the discounted expected utility of money holdings and consumption of tradables and nontradables. The period utility of tradables is $\log C_t$, where C_t is a Cobb Douglass aggregate of home (h) nontradeables and foreign (f) tradables

$$C_t = C_{ht}^{1-\alpha} C_{ft}^{\alpha}$$

C_{ht} is, in turn, a conventional Dixit Stiglitz aggregate of domestic varieties. With the world price of foreign tradables normalized at one, the price of consumption is, therefore

$$P_t = P_{ht}^{1-\alpha} S_t^{\alpha}$$

where P_{ht} is the price of home nontradables and S_t the nominal exchange rate.

The representive agent chooses consumption and the holdings of money, a world noncontingent bond, and domestic bonds. His sources of income in each period are wages, profits of domestic firms, income from previous investments, and a transfer from the central bank (Z in JS). It turns out that these transfers are not needed for our argument, but let us keep them in for now to preserve the notation of JS.

There is a central bank that can print domestic currency freely to finance transfers and a portfolio of securities. A bond of maturity k is a promise to pay one unit of consumption at time $t + k$. For simplicity, assume that k can be either one or two, e.g. there are "short" (one period)

bonds and "long" (two period) bonds. [1]

Let Q_t^s denote the home currency price at t of a bond promising one unit of consumption at $t+s$, $s=1,2$. Letting B_t^s be the central bank holdings at the end of period t of the corresponding bond, the central bank's budget constraint is

$$Z_t + Q_t^1 B_t^1 + Q_t^2 B_t^2 = M_t - M_{t-1} + B_{t-1}^1 + Q_t^1 B_{t-1}^2$$

In contrast with JS, who examine the role of foreign exchange intervention, we assume that the central bank keeps zero foreign exchange reserves. Instead, it holds a portfolio of short and long bonds. This means that, in the central bank's budget constraint, the crucial term will be the last one in the RHS, which denotes the current value of long bonds purchased the previous period. Hence, changes in the price of long bonds can be a source of gains or losses for the central bank.

JS prove two results. The first one is that a central bank that minimizes a conventional expected discounted value of losses that depend only on inflation and the output gap may be unable to implement an optimal policy to escape from a liquidity trap, if it cannot commit to honor promises of future policy. The second result is that this commitment problem may be solved if the central bank cares enough about its capital position. The mechanism described by JS is for the central bank to initially acquire enough foreign exchange reserves, by either printing domestic currency or reducing transfers to the Treasury. This results in a currency mismatch and implies that, were the central bank subsequently deviate from a promise of high inflation, the concomitant currency appreciation would, via the fall in the value of the central bank's foreign reserves, result in a capital loss. This would deter the central bank from reneging on a promise of high inflation, if the central bank is assumed to care about its capital.

Here, we will describe a similar argument that relies on the management of the maturity of the assets in the central bank's portfolio. While the logic of the mechanism is essentially the same as in *JS,* we will see that there are some interesting differences as well.

First, note that the capital of the central bank is, by definition, the value of its assets minus

[1] Notice that we assume that bonds are real promises. This is a nontrivial assumption that is discussed at length in the working paper version of *JS*.

liabilities:

$$V_t = Q_t^1 B_t^1 + Q_t^2 B_t^2 - M_t$$

which, using the budget constraint above, can be rewritten as:

$$V_t = -M_{t-1} + B_{t-1}^1 + Q_t^1 B_{t-1}^2 - Z_t$$

This expresses, in particular, that the capital position of the central bank improves if Q_t^1, the price of short bonds, increases *and* the central bank had a long position in two period bonds at the end of the previous period. This will prove to be crucial.

Before elaborating on that point, let us discuss competitive equilibria. JS make (usual) assumptions that ensure that the current account is always zero and the consumption of tradables is constant. On the other hand, the consumption of nontradables is equal to the output of nontradables:

$$C_{ht} = Y_t$$

Nontradables are produced with only labor with a linear technology, by monopolistically competitive firms that choose prices one period in advance. As is well known, the typical firm (z) chooses a price that is a constant markup over marginal cost:

$$P_{ht}(z) = \frac{\varepsilon}{\varepsilon - 1} E_{t-1} \frac{W_t}{A_t}$$

where ε is the elasticity of substitution between varieties, W_t the wage, and A_t aggregate productivity. Now, optimal labor choice implies:

$$\frac{W_t}{P_{ht}} = \frac{C_{ht}}{1-\alpha} = \frac{Y_t}{1-\alpha}$$

from which *z's relative price* is

$$\frac{P_{ht}(z)}{P_{ht}} = E_{t-1} \frac{Y_t}{Y_t^*}$$

where

$$Y_t^* = \frac{\varepsilon}{\varepsilon - 1}(1-\alpha)A_t$$

is the rate of *natural output.*

In equilibrium, $\frac{P_{ht}(z)}{P_{ht}} = 1$ because all firms are identical, so we arrive at the aggregate supply equation:

$$1 = E_{t-1}\frac{Y_t}{Y_t^*}$$

Here, the real exchange rate is defined as

$$Q_t = S_t/P_{ht}$$

which, in equilibrium, is given by

$$\begin{aligned} Q_t &= \frac{\alpha/C_{ft}}{(1-\alpha)/C_{ht}} \\ &= \frac{\alpha}{(1-\alpha)}\frac{Y_t}{\bar{C}_f} \end{aligned}$$

where $\bar{C}_f$ is the constant equilibrium consumption of tradables. The real exchange rate, therefore, depreciates if domestic output increases (this is one source of JS's main results).

To allow for the posibility of a "liquidity trap," assume that there is a nominal bond. Then the nominal interest rate must equal

$$e^{-i_t} = \delta E_t \frac{P_{ht}}{P_{h,t+1}}\frac{Y_t}{Y_{t+1}}$$

from the household's Euler condition. The real interest rate must then satisfy:

$$e^{-r_t} = \delta E_t \left(\frac{Y_t}{Y_{t+1}}\right)^{1-\alpha}$$

This is a key equation: it says that the real interest rate must fall if output is expected to decline. JS consider a situation in which at $t = 1$ the log of productivity is equal to its previous steady state, say a, but it becomes known that it will fall to $b < a$ from period $t = 2$ on. This can

lead the economy to a liquidity trap, as we argue next.

Start by assuming that the central bank minimizes a conventional loss:$E\sum \delta^t L_t$, where

$$L_t = \frac{1}{2}[(\pi_t - \pi)^2 + \lambda(y_t - \bar{y}_t)^2]$$

(Hereon, lowercase variables are logs of respective uppercase ones.) To see how a liquidity trap may emerge, note that

$$\pi_t = p_t - p_{t-1} = p_{ht} + \alpha q_t - p_{t-1}$$

Letting the "natural" real exchange rate be defined in the obvious way,

$$\bar{Q}_t = \frac{\alpha}{(1-\alpha)}\frac{\bar{Y}_t}{\bar{C}_f}$$

we obtain

$$\pi_t = p_{ht} + \alpha\bar{q}_t - p_{t-1} + \alpha(y_t - \bar{y}_t)$$

Under discretion, the policymaker would minimize L_t subject to the preceding equation, which would yield

$$\pi_t = \pi - \frac{\lambda}{\alpha}(y_t - \bar{y}_t)$$

Recalling, however, that there are no unexpected shocks in periods $t = 2$ on, in equilibrium $Y_t = \bar{Y}_t$ for all t except possibly for $t = 1$. Therefore, $\pi_t = \pi$, $t = 2, 3, ...$ This is key, and it means that inflation is at the target in all periods, expect possibly in period $t = 1$.

JS show that, if b is sufficiently low relative to a, the economy will fall in a liquidity trap in period one, that is, a situation in which the interest rate i_1 falls to zero, and output falls short of the natural level. This results in lower welfare than under commitment. With commitment, the central bank would promise to increase π_2 over π to spread the cost of the productivity fall between periods one and two. However, in the absence of a commitment device, this promise would not be kept: in period 2, it would be optimal for the central bank to reduce π_2 to the target π.

To see the role of debt management, let us focus on the pricing of bonds of different maturity.

Recall that there is no more uncertainty after period one. Hence, by arbitrage,

$$\frac{P_{t+1}}{Q_t^1} = e^{i_t}$$

This says that the return on one period bonds must be equal to the return on nominal bonds. Now, recalling that $\pi_t = \pi$ for $t \geq 2$,

$$\frac{P_{t+1}}{Q_t^1} = \frac{P_{t+1}}{P_t}\frac{P_t}{Q_t^1} = e^{i_t} = e^{r^*+\pi}$$

where r^* is the natural real rate of interest. So

$$Q_t^1 = e^{-r^*}P_t \tag{1}$$

Note that this says that the price of one period bonds is proportional to the price level from period 2 on.

Also, under perfect foresight, arbitrage implies that the price of a two period bond equals the product of the prices of one period bonds now and next period:

$$Q_t^2 = Q_t^1 Q_{t+1}^1 \tag{2}$$

These facts now lead us to our main result. Suppose that, at $t = 1$, after learning about the future fall in productivity, the central bank sells x short bonds and buys an equivalent amount of long bonds. Hence, the amount of long bonds purchased is such that $Q_1^1 x + Q_1^2 B_1^2 = 0$, that is

$$B_1^2 = -\frac{Q_1^1}{Q_1^2}x$$

By construction, this operation has no impact on either the budget constraint nor the capital position of the central bank at $t = 1$.

If the central bank could commit to the optimal (under commitment) policy, the operation would not affect its budget constraint nor its capital position in any subsequent periods either.

This is because the arbitrage condition (2) would then guarantee that the value of the inherited portfolio would be zero:

$$B_1^1 + Q_2^1 B_1^2 = x + Q_2^1(-\frac{Q_1^1}{Q_1^2}x) = 0$$

Notably, this is an instance of Eggertsson and Woodford's irrelevance result: under commitment, open market operations are irrelevant.

But suppose that the central bank has no commitment and can contemplate a deviation from the optimal plan. As shown in JS (and intuitively obvious), the central bank would then have an incentive to lower inflation towards the target, hence lowering P_2 from its optimal level to a lower level, say P_2'. But (since there are no incentives for further deviations) then the prices of bonds maturing at $t = 3$ would fall, by (1), to some level $(Q_2^1)'$. Then the value of the central bank portfolio would be:

$$\begin{aligned} B_1^1 + (Q_2^1)' B_1^2 &= x[1 + (Q_2^1)'(-\frac{Q_1^1}{Q_1^2})] \\ &= x(1 - \frac{(Q_2^1)'}{Q_1^2}) \end{aligned}$$

This is less than zero if x is negative and $(Q_2^1)' < Q_2^1$, that if, if the central bank surprisingly changes policy in a way that results in lower prices. It follows that the deviation is not profitable for the central bank if it cares about its capital position and x is negative and sufficiently large in absolute value.

In words, the central bank can ensure the credibility of an inflationary policy by changing the composition of its balance sheet, selling short term bonds and holding long term bonds. This is crucial for the equilibrium not because such "unconventional" measure changes the equilibrium outcome (which is the same as the outcome under commitment) but because the debt structure can change the incentives for the central bank so as to deter it from deviating from the desired equilibrium: a deflationary surprise would reduce the value of the latter, inflicting a punishment on the central bank.

The argument here is, hence, related to the classic Lucas and Stokey (1983) study of optimal

policy under time inconsistency. As in that paper, debt maturity is irrelevant under commitment, but can be crucial under discretion.

Our discussion also stresses that composition of the central bank's balance sheet can be managed in several alternative ways to provide the proper incentives for the central bank. As we have mentioned, our argument here is similar but not the same as in JS, who focused on international reserves management. Compared with their argument, the one here is cleaner because one does not need to worry about central bank transfers (the $Z's$ above), which figure somewhat prominently in *JS*. In fact, we eliminated the transfers completely. On the other hand, and obviously, we depend on having a rich enough menu of assets, in this case debts of different maturities.

Our analysis provides a concrete setting in which unconventional central bank policy not only helps but is in fact crucial for the implementation of optimal monetary policy. What is the value of such an exercise? For one thing, it clarifies the sense in which management of the central bank balance sheet can indeed complement conventional interest rate policy, in a way in which vague statements, such as "the central bank's open market operations should be chosen with a view to signalling the nature of its policy commitments ", do not. Indeed, our analysis has not relied on the existence of asymmetric information of any sort, and therefore leaves no room for any kind of signalling.

For another things, a formal analysis allows one to interpret and identify the validity (or lack thereof) of many claims in the policy literature. To cite but one example, one principle that the Bank of Canada has cited in conducting unconventional measures is "prudence ", meaning that the Bank should "mitigate financial risks to its balance sheet, which could arise from changes in yields (valuation losses) or from the credit performance of private sector assets (credit losses) " (Bank of Canada 2009, p. 29). But in the analysis above it is precisely the possibility of such valuation losses which lend credibility to the central bank's promises to keep interest rates low even as inflation overshoots its target.

Notably, our analysis explains why may justify why these operations have to be carried out *by the central bank*, instead of, say, the Treasury. This is relevant, because often the reasons given to justify altering the size and composition of the central bank's balance sheet are really reasons

to change "fiscal " policy rather than central bank policy. Here, the open market operations in play are designed to affect the central bank's incentives, which would not happen if an alternative agency were to carry out such operations.

2.1.2 Alternative Solutions to the Commitment Problem

Our discussion has emphasized that one fruitful way to rationalize unconventional policy may be to see the management of the central bank's portfolio as a commitment device. This perspective also suggests to look for insights, more generally, in the rich literature on policy under time inconsistency and lack of commitment.

Walsh (1995), for example, emphasized that one way to solve the classical time inconsistency problem in monetary policy is to provide optimal contracts to central bankers, a view that has been associated with the widespread acceptance of inflation targeting in a context of central bank independence.

One can argue that Walsh's view remains quite relevant to solve the credibility problem with zero interest rates as well. In the context of the model of the preceding subsection (and the analysis in *JS*), we mentioned that a critical part of the "solution" is the assumption that the central bank cares about its capital. But, where does this concern come from? The problem arose because, presumably, the central banker had been assigned (at some point before the start of the analysis) a mandate to minimize a loss function with inflation and the output gap as arguments. A suggestion echoing Walsh's would then be to enlarge that loss function with a term inflicting a penalty to the central banker if the capital of the bank fell below some value.

But if that is in fact the case, one could and should also ask the more general (Walsh's) question of what is the optimal contract to the central banker. This would recognize, in particular, that the contract may not entail an inflation target, even if inflation targeting would be optimal under commitment. This may not be just a theoretical issue but, in fact, may have been quite influential in practice. Specifically, Svensson (2001) has advocated that one way to solve the credibility problem in a liquidity trap may be to switch the objective of the central bank from inflation targeting to *price level* targeting, and that strategy has actually been embraced by Sweden. Our analysis

suggests that this reform may be understood as a way to modify the loss function assigned to the central banker to provide the correct incentives for implementing the optimal monetary policy.

2.2 Financial Frictions, Bank Capital, and Heterodox Policy

An alternative *prima facie* justification for central banks resorting to new policy instruments has been that the recent crisis witnessed a combination of skyrocketing interest rate spreads, frozen credit markets, and paralyzed financial institutions. In this context, it was observed that the traditional weapon of monetary policy, the supply of bank reserves to target an overnight interbank interest rate, seemed to have become completely ineffective. In particular, additional liquidity in the interbank market was hoarded by the banks, apparently in some cases in an effort to reconstitute their severely impaired capital levels. So, as we have already described, several central banks decided to step into credit markets and started expanding the size and scope of rediscounting operations, swapping questionable assets for safer government debt and, in some cases, lending directly to the private sector.

These developments have stimulated a small but growing literature attempting to understand the interaction of unconventional monetary policies with financial imperfections and the behavior of the banking system. As the discussion suggests, significant progress on this front will require not only analyzing the implications of endowing the monetary authorities with a policy arsenal that includes more than interest rate control, but also introducing a nontrivial banking system into current theory. This will demand, in turn, dropping the crucial assumption of frictionless financial markets that pervades currently dominant models.[2]

Unfortunately, no current theory of banks exists yet that is both widely accepted and tractable enough to be embedded into the stochastic dynamic models that characterize modern monetary theory. As a result, recent attempts have been as much about this modeling issue as about the effects of unconventional policy. For example, an influential study by Christiano, Motto, and Rostagno (2007) models banks following what Freixas (2008) calls the "industrial organization" approach. In contrast, in Gertler and Karadi (2009) banks are agents that borrow from households and lend

[2]And needless to say, the analysis of the previous subsection may require significant changes if perfect financial markets are not assumed.

to firms subject to a moral hazard problem. Similarly, Cúrdia and Woodford (2009) modify the basic New Keynesian model by assuming that households differ in their preferences which creates a social function for financial intermediation.

Regarding the consequences for monetary policy of these studies, one initial conclusion is that augmenting a standard Taylor rule to respond mechanically to changes in the spread between lending rates and deposit rates may not be optimal. How effective this action is, it will depend on the type of shock that generates the increase in the spread. Now, in terms of credit policy, i.e. direct lending by the central bank to non financial firms, this policy would be optimal if private financial markets are sufficiently impaired (Curdia and Woodford (2010) and Gertler and Karadi (2009)).

However, the state of affairs is such that it may be premature to try to draw firm conclusions from these studies, and indeed the papers just cited are still being refined and may still change substantially. Nevertheless, they represent a change in perspective that is likely to stay and, hence, worth discussing in more detail. To do that, we discuss next a related model of ours that is designed to illustrate several of the issues involved.

2.2.1 An Illustrative Model

The model here is a stochastic, discrete time version of Edwards and Vegh (1997) with a crucial modification: that bank's lending is constrained by their capital. This change is not only warranted by current events but also implies, as we will see, a substantial departure in terms of the solution and dynamics of the model.

Consider an infinite horizon small open economy. There is only one good in each period, freely traded and with a world price that we assume to be constant (at one) in terms of a world currency.

The economy is populated by a representative household that maximizes

$$E \sum_t \beta^t (\log c_t + \log(1 - l_t))$$

where c_t and l_t denote consumption and labor effort.

To motivate a demand for bank deposits, we assume that deposits are necessary for transactions. This results in a deposit in advance constraint

$$d_t \geq \alpha c_t$$

where α is a fixed parameter. Deposits pay interest, which can be expressed in real terms by:

$$1 + r_t^d = (1 + i_t^d)\frac{P_t}{P_{t+1}}$$

The household owns domestic firms and banks, and receives transfers from or pays taxes to the government. Hence its flow budget constraint is given by:

$$\Omega_t^f + \Omega_t^b + T_t + w_t l_t + (1 + r_{t-1}^d)d_{t-1} = d_t + c_t$$

where Ω_t^b and Ω_t^f are profits from banks and firms, T_t government transfers (or taxes, if negative), and w_t is the real wage. For simplicity, we are assuming that the household cannot lend or borrow in the world market. Our arguments extend easily if the household can lend but not borrow there, as we shall see.

Let $\lambda_t\omega_t$ and λ_t be the Lagrange multipliers associated with the deposit in advance constraint and the flow budget constraint respectively. Optimal household behavior is then given by the first order conditions:

$$\frac{1}{c_t} = \lambda_t[1 + \alpha\omega_t]$$

$$\frac{1}{1 - l_t} = \lambda_t w_t$$

$$\lambda_t = \beta E_t \lambda_{t+1}(1 + r_t^d) + \lambda_t\omega_t$$

These have natural interpretations. In particular, the first condition emphasizes that the household equates the marginal utility of consumption to its shadow cost, inclusive of the cost of the

deposit in advance constraint. Likewise, the third condition emphasizes that the return to deposits must include the benefit from relaxing the deposit in advance constraint.

We now turn to production. There is a continuum of identical domestic firms, each able to produce tradables with a linear technology that employs only labor:

$$y_t = A_t l_t$$

where A_t is an exogenous productivity shock.

The typical firm maximizes the appropriately discounted value of dividends:

$$E \sum_t \beta^t \lambda_t \Omega_t^f$$

where flow profits are given by:

$$\Omega_t^f = A_t l_t - w_t l_t + h_t - (1 + r_{t-1}^l) h_{t-1}$$

Here, we assume that the firm must borrow from banks a fraction γ of the wage bill

$$h_t \geq \gamma w_t l_t$$

This working capital assumption is introduced to motivate a demand for bank loans. So h_t denotes the amount that the firm must borrow, and the real loan rate is r_t^l, with:

$$1 + r_t^l = (1 + i_t^l) \frac{P_t}{P_{t+1}}$$

In each period the firm chooses l_t and h_t.Letting ϕ_t be the multiplier on the finance constraint, the first order conditions for the firm's problem are

$$\begin{aligned} A_t &= w_t(1 + \gamma \phi_t) \\ (1 + \phi_t) &= E_t \beta \frac{\lambda_{t+1}}{\lambda_t} (1 + r_t^l) \end{aligned}$$

Note that the first condition stresses that the cost of labor must include the financial cost associated with the working capital constraint.

Next, turn to the banking sector. As in Edwards and Végh (1997) banks are modeled following an industrial organization approach. This is appealing because that approach implies that there will be spreads between deposit and lending rates. But, as mentioned, we depart from Edwards and Végh (1997) by assuming that bank lending is constrained by bank capital.

Banks maximize

$$E \sum_t \beta^t \lambda_t \Omega_t^b$$

where

$$\Omega_t^b = (1 + r_{t-1}^l) z_{t-1} + f_{t-1} \frac{P_{t-1}}{P_t} + d_t + x_t - (1 + r_{t-1}) x_{t-1} - z_t - f_t - (1 + r_{t-1}^d) d_{t-1} - \xi_t \eta(z_t, d_t)$$

where z_t denotes credit to firms, f_t required reserves, x_t foreign borrowing, and r_t cost of foreign borrowing. We also assume a reserve requirement:

$$f_t \geq \delta d_t$$

where δ is the required reserves coefficient. Finally, we assume that leverage is limited:

$$z_t \leq \chi n_t$$

where the bank's capital n is given by

$$n_t = f_t + z_t - d_t - x_t$$

The leverage ratio χ, which could be time varying, is the key innovation of this model relative to Edwards and Végh (1997) and others (such as Catão and Rodriguez 2000). One could rationalize the leverage constraint as a shortcut to modeling agency problems of the type emphasized by Kiyotaki and Moore (1997) and, more recently, Gertler and Karadi (2009). We assume χ is greater

than one, and reflects either regulation or agency issues.

Finally, $\xi_t \eta(z_t, d_t)$ is the resource cost of "producing" deposits and credit. We use the functional form for $\eta(.)$ proposed by Edwards & Végh (1997), but introduce a parameter κ that determines the weight of firm credit in the bank's cost function:

$$\eta = \sqrt{\kappa z^2 + (1-\kappa) d^2}. \tag{3}$$

Assume that the reserve requirement holds with equality, and let θ_t be the multiplier of the leverage requirement. The FOCs are

$$(1-\delta) - \xi_t \eta_2(z_t, d_t) - \theta_t \chi (1-\delta) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} (1 + r_t^d - \delta \frac{P_t}{P_{t+1}})$$

$$1 - \theta_t \chi = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} (1 + r_t) \tag{4}$$

$$1 + \xi_t \eta_1(z_t, d_t) - \theta_t (\chi - 1) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} (1 + r_t^l)$$

The model is closed by a specification of government policy. Clearly, we have set up the model so that we can discuss the effects of "unconventional" policy on allocations and prices, including the volume of bank intermediation and credit spreads.

For now, assume the simplest: the government rebates to households the gains from imposing reserve requirements. Also assume (as in Edwards and Végh 1997) that $\xi_t \eta(z_t, d_t)$ is paid to the government, perhaps because it represents monitoring services. Then

$$T_t = f_t - f_{t-1} \frac{P_{t-1}}{P_t} + \xi_t \eta(z_t, d_t)$$

To finish, we need a specification for inflation policy. Here the government controls $P_t / P_{t-1} = \Pi_t$. It matters, in spite of flexible prices, because required reserves are paying the inflation tax.

Note that, with these assumption, in equilibrium, the economy's overall constraint reduces to

$$(1 + r_{t-1})x_{t-1} = A_t l_t - c_t + x_t$$

whose interpretation is clear: the repayment on foreign borrowing is equal to the trade surplus plus new borrowing.

Finally, we need to make an assumption about the world interest rate r_t. For now, assume it is constant at r^*. Also, we will assume $\beta(1 + r^*) < 1$. The need for this becomes apparent upon examination of the nonstochastic steady state. In steady state, the bank's optimality condition for the amount to borrow in the world market, 4, reduces to

$$1 - \beta(1 + r^*) = \theta\chi \tag{5}$$

As we are about to solve for a linear approximation of the dynamics around the steady state, we need to make a decision as to whether the leverage constraint binds in steady state. We will assume that it does, which requires that θ be strictly positive in steady state. Hence $\beta(1+r^*)$ must be less than one.

The interpretation of the Lagrange multiplier θ is illuminating. θ is the shadow cost to banks of the leverage requirement. Accordingly, if the leverage coefficient χ increases, θ must fall. This is natural since a higher χ allows banks to increase leverage.

The model can be calibrated and solved in the usual way. Then one can examine the implications of alternative policies of interest. For illustrative purposes, we assume a world interest rate equal to two percent, a reserve requirement ratio (δ) equal to ten percent, and a leverage ratio (χ) equal to 3. The household's deposit requirement (α) is assumed to be 0.2 while the fraction of the wage bill that firms must borrow is assumed to equal 0.5. The remaining parameters are presented in table 1. Our parametrization implies that the steady state interest rate spread is equal to 7.7 percent. In the steady state, the economy's external debt corresponds to almost 30 percent of total lending to firms, deposits corresponds to 41 percent, and the remainder is financed with the banks' own net worth.

Table 1: Model Parameter Values

Parameter	Description	Value
δ	Reserve ratio requirement	0.1
χ	Leverage ratio	3
α	Household deposit requirement	0.2
γ	Fraction of wage bill firms must borrow	0.5
β	Discount factor	0.971
r_t	World interest rate	0.02
κ	Weight on firm credit in bank's costs	0.8
ϱ	Policy rule parameter	-2
Π	Inflation rate (P_{t+1}/P_t)	1
ρ_A	Persistence of shock to A_t	0.95
ρ_ξ	Persistence of shock to ξ	0.95
ρ_r	Persistence of shock to r_t	0.95

In order to evaluate the dynamics of the economy we study the impulse response functions of the main variables of the model to world interest rate and banking costs shocks. Figures 1-2 display the impulse responses of the calibrated model to a one percent shock to the bank cost ξ. As Edwards and Végh (1997) stress, this shock can be interpreted as a domestic shock (change in regulation or shocks to the underlying banking technology) or as an external shock (such as an international financial crisis). A shock to the bank's cost function is associated with an increase in the real lending rate and a fall in the deposit rate (see Figure 1). The increase in banking costs increases the marginal cost of extending credit. On the deposit side, the increase in producing deposits reduces the deposit rate paid to consumers. This reduction in the deposit rate increases the price of consumption. On the lending side, the increase in the marginal cost of producing loans increases the lending rate. In equilibrium, the lending spread increases. This is in line with intuition and agrees with Edwards and Végh's discussion. Figure 2 shows that the result is an aggregate contraction expressed in a fall in credit and, concomitantly, labor employment and wages.

Figures 3-4 display impulse responses to an one hundred basis points increase in the world interest rate. Figure 3 shows that both domestic rates, lending and deposit rates, increase as a consequence. But interestingly, deposit rates increase more than lending rates, so the spread between the two of them falls. The increase in the world interest rate increases the cost of external

Figure 1:

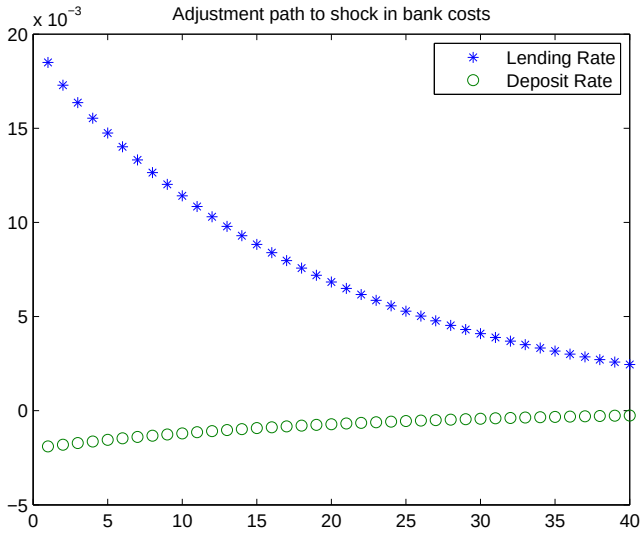
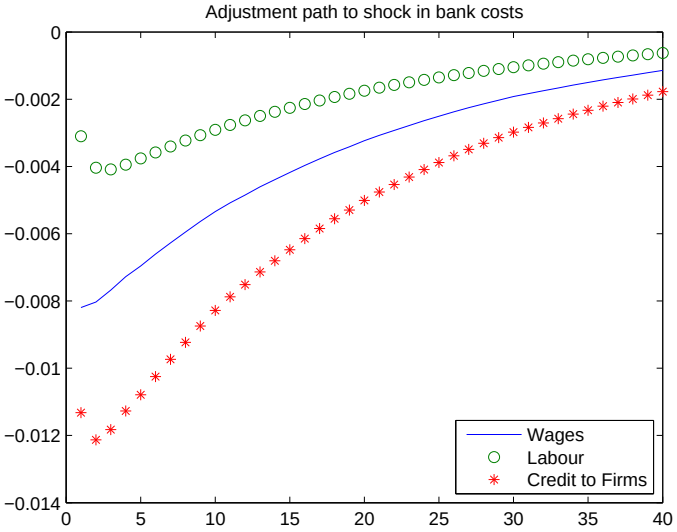
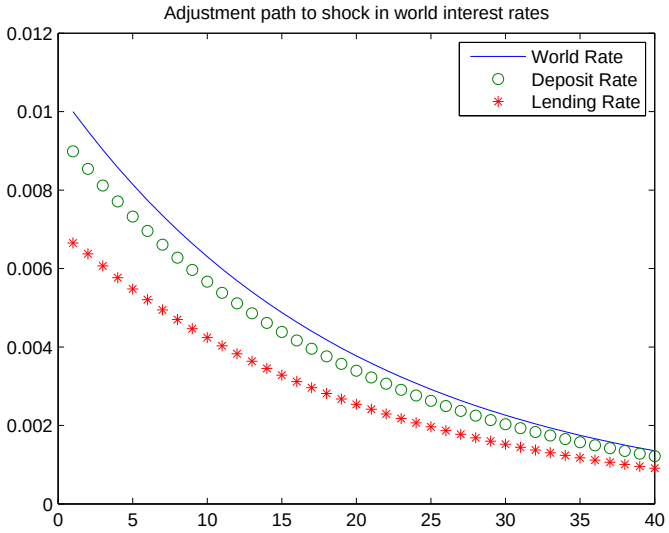


Figure 2:



borrowing. Banks will try to substitute this external lending by increasing the deposit rate. The lending rate increases but less than the deposit rate as the higher world interest rate has a negative wealth effect on the economy that reduces consumption and lending in equilibrium. Figure 4 shows that credit and consumption fall persistently. Aside from a small impact decrease, labor employment is essentially not affected.

Figure 3:



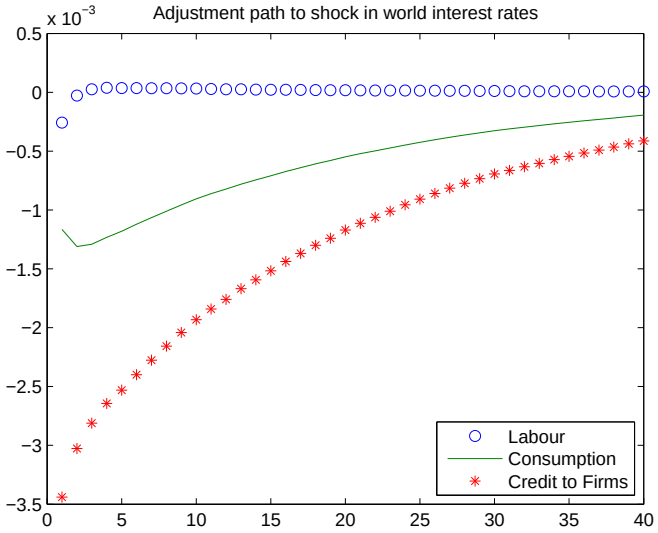
In this model, we can examine the effects of different, "unconventional" policies. For example, one might conjecture that a policy of reducing reserve requirements when spreads increase might be stabilizing. To analyze this conjecture in our model, we drop the assumption of a constant δ, and assume that

$$\delta_t = \bar{\delta} - \varrho(r_t^l - r_t^d)$$

where $\bar{\delta}$ is the steady state value of δ_t and ϱ governs the sensitivity of the reserve coefficient's response to the domestic spread.

Figure 5-6 and 7-8 display the impulse responses to the same shocks as in Figures 1-4, namely shocks to the banking cost function and to the world interest rate. Figure 5 is quite similar to Figure 1, suggesting that reducing reserve requirements in response to increases in the domestic spread may have little impact on deposit and lending rates. Comparing Figure 6 against Figure 2, however,

Figure 4:



shows that this policy has a significant stabilizing effect on credit and labor employment on impact, although for this parametrization the stabilizing effect only lasts for one period. The reduction in reserve requirement slightly mitigates the impact of higher marginal costs in the production of deposit and loans.

Figure 7 shows that the reserve requirement policy has also negligible effects on the response of domestic interest rates to an increase in the world rate. However, Figure 8 shows that the policy has somewhat surprising real effects: credit falls by more and consumption by less than without the policy (as depicted in Figure 4). The reason is that the policy rule makes δ_t increase, not fall, in response to an increase in the world interest rate: such a shock makes domestic lending rates and deposit rates increase, but their difference *falls*.

There are a number of lessons. The effect of an "obvious policy " is not obvious and depends delicately on the details of the model and the policy. But our model clarifies and provides useful information about the different channels. Here, for example, given our discussion, one could now conjecture that the problem is that δ_t is responding to the domestic spread, but that it may be

Figure 5:

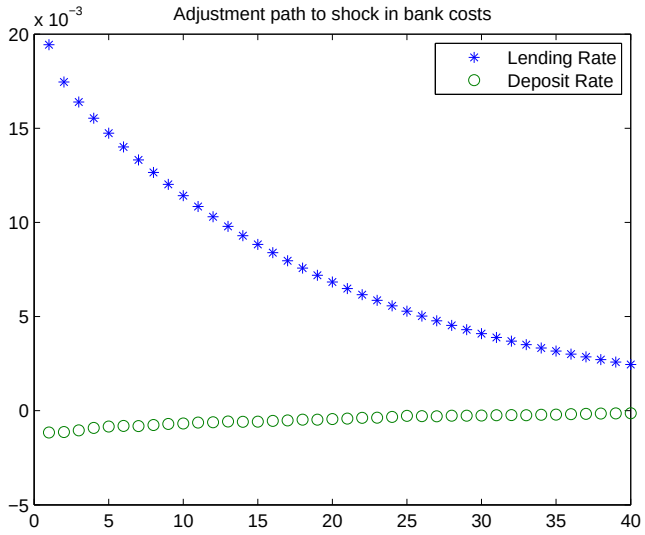


Figure 6:

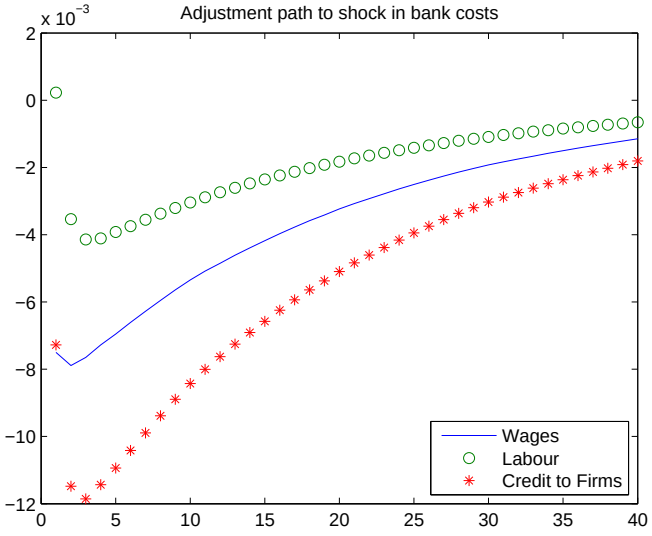


Figure 7:

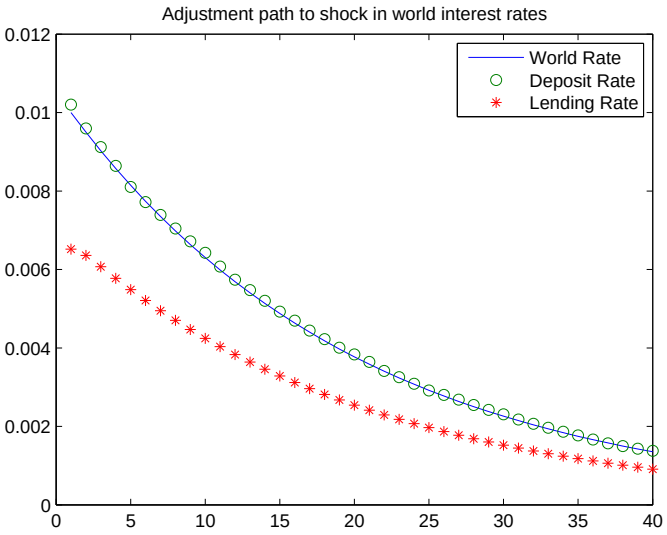
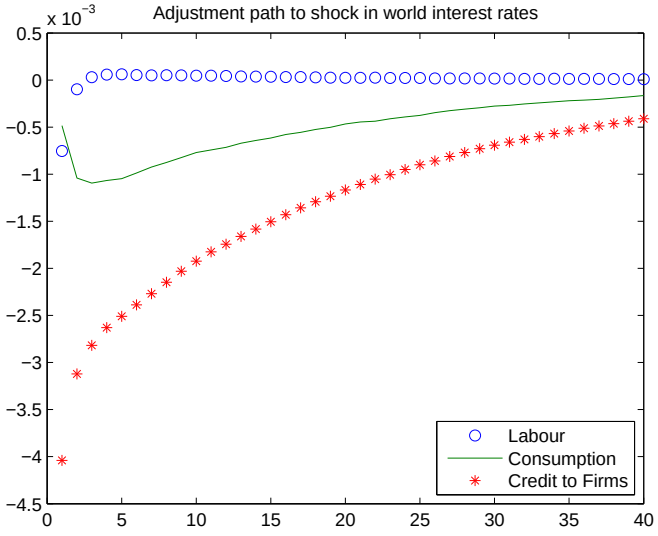


Figure 8:



better for δ_t to respond to the international spread, as in

$$\delta_t = \bar{\delta} - \varrho(r_t^l - r_t)$$

where r_t is the world rate of interest. But here such a change is probably of little help, because r_t^l increases by less than r_t in response to a shock to the latter, and hence δ_t would also increase (perversely) with the modified policy.

More generally, the model here is an example of the kind of theory that needs to be developed in order to be able to discuss consistently the unconventional policies that have been implemented in practice. Only with this kind of framework one can trace the effects of policies that respond to interest rate spreads or prescriptions to inject equity into banks. In contrast, standard models are simply silent about these issues because of their perfect financial markets assumption makes financial intermediation a veil.

3 Heterodox Monetary Policy: Recent Experience and Evidence

From the previous section we have concluded that quantitative easing (outright purchases of assets by the central bank and changes in the central bank portfolio) appears relevant only if it helps to increase the credibility of a given monetary policy rate path. Regarding credit easing we have discussed that it is still premature to conclude if this is useful as a policy itself or as commitment device for a particular monetary policy trajectory. Nevertheless, credit policy may be seen as necessary in case of disrupted financial markets or a complement to traditional monetary policy actions in particular cases.

With this in mind we present some evidence regarding monetary policy actions in the recent financial crisis, as some countries reached the (effective) lower bound. We restrict our analysis to countries with some (quasi) formal inflation target in order to have a more adequate comparison.

3.1 Recent experience with unconventional monetary policy

Starting with the sub-prime mortgage crisis, we have witnessed an unprecedented period of monetary policy activism. Even though the original trigger for the various kinds of interventions can be traced to the international financial crisis, the objectives and immediate motivations are somehow different. In a first period, the pre Lehman period, the setting of monetary policy rates in most countries was aimed at controlling inflation, which was high due to high energy and other commodity prices. At the same time, actions were taken to provide liquidity in foreign currency markets. In the period post Lehman bankruptcy, things changed. Liquidity provision intensified while the rapid fall in commodity prices opened the door for aggressive reductions in interest rates. In this period some central banks also implemented policies to address malfunctioning financial markets (credit policy). As interest rate cuts intensified, some countries reached a lower bound for the monetary policy rate. At this point, we saw some central banks implementing additional non conventional policies orientated to strength the credibility of the announcement that interest rates were going to be kept low for a prolonged period of time.

3.1.1 The Pre-Lehman Bankruptcy Period

The outbreak of the mortgage backed security crisis was the beginning of a period of significant tensions in financial markets around the world. These tensions were initially limited to the US and England but expanded to other developed economies during the first half of 2008. In most cases they led to the need to inject significant amounts of liquidity in foreign currency markets. The basic objective of the liquidity provision actions was to reduce pressures on US dollar short term funding markets. In particular, between September 2007 and September 2008, many central banks implemented different varieties of US dollar repo transactions. These operations in some cases were complemented by reciprocal swap agreements between the US Federal Reserve and some central banks.

In the same period, monetary policy in most central banks was oriented towards dealing with increasing inflation due to the commodity prices shock. In effect, many countries during this period increased interest rate at the same time as they were implementing measures to inject liquidity in

domestic financial markets. Nevertheless, the most exposed countries to the sub-prime mortgages crisis started reducing policy interest rates as credit conditions tightened and the macroeconomic outlook worsened (USA, Canada and the UK).

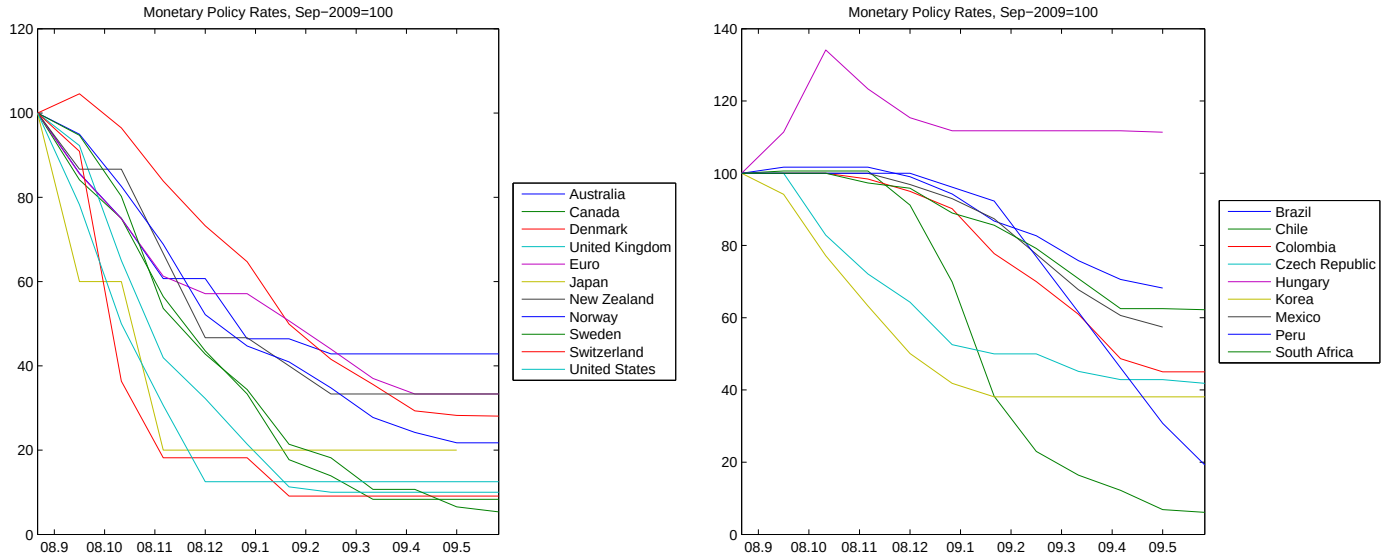
3.1.2 The Post-Lehman Bankruptcy Period

The bankruptcy of Lehman Brothers in September 2008 started a different phase in monetary policy implementation. After this event, the demand for liquidity intensified significantly which led central banks around the world to either introduce or intensify previous liquidity provision actions.

This is also the period in which we started to observe a clear change towards an expansionary monetary policy stance. With inflationary pressures moderating due to the marked decline in energy and other commodity prices, and the intensification of the financial crisis which increased the downside risks to growth and thus to price stability, some easing of global monetary conditions was warranted. Consistently, a group of countries started in the fourth quarter of 2008 an aggressive reduction of the monetary policy rate (see figure 9). Others ended the process of increasing interest rates due to the worsening in the economic outlook (see figure 9). An additional signal of the (potential) magnitude of the events that the world was facing was the unprecedented joint action taken by a group of major central banks in October 8: a coordinated interest rate reduction. The central banks involved in his reduction were the Bank of Canada, the Bank of England, the ECB, the Federal Reserve, the Sveriges Riksbank and the Swiss National Bank. The Bank of Japan expressed its strong support to these policy actions.

During this period, financial conditions deteriorated markedly. The combination of high uncertainty, lower growth perspectives (and commodity prices) and the deterioration in international financial conditions gave rise to very restrictive credit conditions. Lending spreads increased significantly (see figure 10) and credit to firms became quite scarce. In this scenario, the possibility of disruptions in the monetary policy transmission channel was contemplated by many central banks. That explain why in some cases monetary policy was oriented initially to restore the functioning of financial markets rather than to reduce interest rate. Also some countries did not reduce interest rate until was clear than inflation pressures were mitigated. As commodity prices started to

Figure 9: Monetary Policy Rates Since Lehman

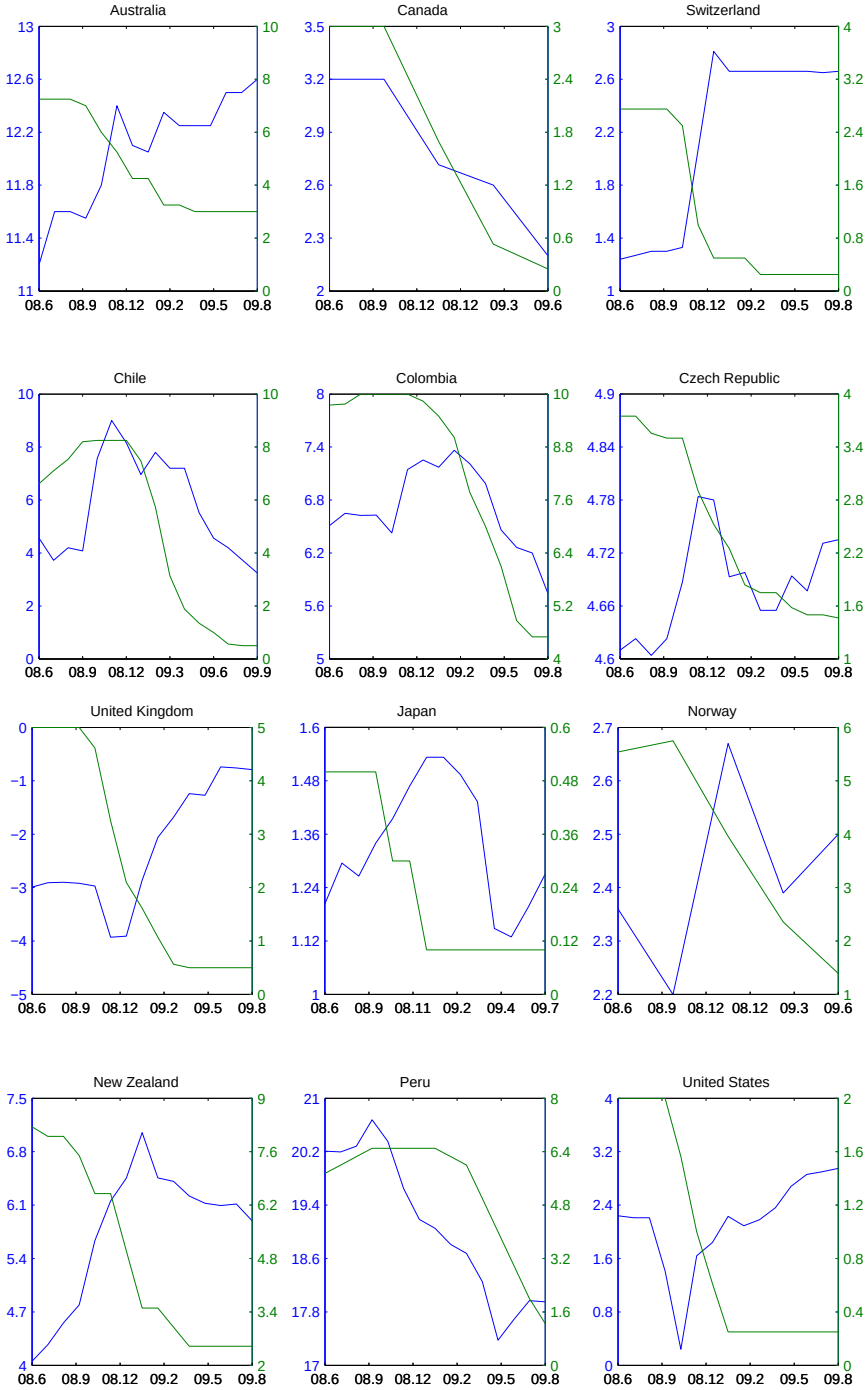


decrease along the last quarter of 2008, inflation started to decrease rapidly.

In the scenario of tight credit conditions, some countries implemented asset purchase programs while others started lending to banks accepting commercial paper as collateral. The asset purchase programs were orientated to push up the price of treasury bills. For countries with more severe financial market disruptions, the asset purchase programs involved buying private assets directly (US, England) or through special funds (Korea, Switzerland). Now, the most common action in order to improve the supply of loans to the corporate sector was to expand the list of acceptable collateral in operations with the central bank to include commercial paper, corporate securities, asset backed securities, mortgage securities and securities with lower credit rating. The easing of collateral requirements was in some cases complemented with the introduction of special credit facilities to eligible financial institutions against selected collateral, mainly commercial papers. Additionally, some central banks broadened eligible counterparties for liquidity provision operations.

Since January 2009 all central banks in our sample started to lower interest rates. At this point it was clear that the deterioration in world activity, the reduction in commodity prices, and higher output gaps was giving rise to deflation concerns. Many central banks did a significant downward revision of inflation forecasts. As a consequence, actions to inject liquidity to financial markets

Figure 10: Lending-Deposit Spread and Monetary Policy Rates



Note: The left axes indicates the lending-deposit spread and the right axes plots the monetary policy rate. The data for Canada and Norway is quarterly.

continued to be implemented but liquidity concerns subsided, and instead the focus of monetary policy shifted towards the effects of the financial crisis on economic activity . Some countries also hit the lower bound in this period and implemented measures to deal with this problem.

At this point, some countries engaged in exchange rate intervention. In particular, and in line with the search for ways to deal with the lack of monetary policy stimulus at the lower bound, developed countries started to buy dollars in order to avoid further appreciation of their currencies. Additionally some central banks started to buy bonds issued by private sector borrowers. One special feature of these interventions was that many central banks stated clearly that unconventional measures did not compromise medium and long-term price stability.

Even though some central banks recognized that financial systems were well prepared to face the turbulence, the effect of the financial crisis in the provision of credit was evident. As mentioned before, that led some central banks to establish loan facilities to increase access to credit with longer duration.

The tight credit conditions led many central banks to open new facilities to financial intermediaries to stimulate bank lending from them to non financial companies. Many central banks were concerned about direct lending. The Riksbank stated in November 28 "... the Riksbank should not lend directly to non-financial companies because that would be a departure from the Riksbank's traditional role as the banks' bank". That position led the Riksbank to lend to financial intermediaries instead of lending directly to non financial firms (they did it by offering loans to banks against commercial paper as collateral).

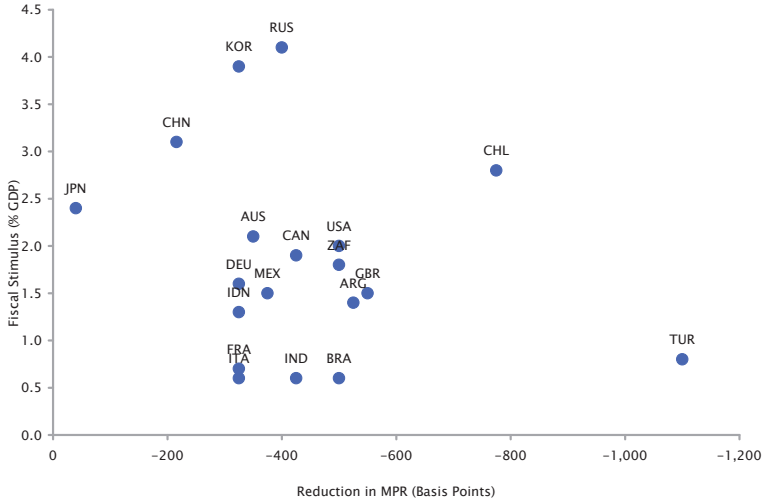
For the group of countries that reached the lower bound, in addition to indicate that the lower bound was reached, a new communication instrument was added to the monetary policy announcement: central banks indicated that the interest rate was going to be kept at that level for prolonged period of time. In addition to this announcement, some central banks opened credit facilities at fixed rates with maturities consistent with the announcement of a prolonged period of monetary policy rate at the lower bound. This was a clear indication that central banks were using mechanisms to increase the credibility of their announcements.

Regarding the period of time during which interest rates were going to be kept constant, some

central banks were very explicit (beyond the ones that already published monetary policy rate path). For example, the Bank of Canada announced in April of 2009 a reduction of its MPR to 0.25% and committed to hold that rate until the end of the second quarter of 2010. Other central banks announced exchange rate interventions in order to prevent any appreciation of the exchange rate or to restore the level of foreign currency reserves.

Finally, it is worth noticing that most of the aggressive policies implemented by central banks were generally followed by important fiscal stimulus packages as well, as can be seen in figure 11 for a selected group of countries.

Figure 11: Fiscal Stimulus and Monetary Policy Rates



3.2 Alternative Measures of Monetary Conditions

As we have seen, central banks around the world have engaged in many unconventional operations in recent times. Excluding those exclusively oriented to restore liquidity, we can associate the other measures to the need to further the monetary policy stimulus to the economy, particularly in the presence of the lower bound, and to the need of unlock financial markets, a key channel of the monetary policy transmission process. In normal times, the evolution of the monetary policy rate is generally used as a sufficient statistic to describe the stance of monetary policy. This practice presents a challenge when this rate reaches its lower bound and it is of interest to analyze different

measures to account for the monetary conditions. In what follows we describe a number of exercises trying to quantify the monetary policy stance after September 2008. In particular, we analyze the size and composition of central bank balance sheets as well as a Monetary Conditions Index. This is an initial step to later evaluate the effectiveness of unconventional monetary policy actions. Before going into this exercise we will present estimations for the monetary policy interest rates implied by Taylor rules. From this exercise we can evaluate the potential magnitude of the need to generate additional monetary policy stimulus at the lower bound.

3.2.1 Taylor Rules

In order to evaluate the need for monetary policy stimulus we perform a simple exercise: we compare the observed behavior of monetary policy rates against the path implied by a Taylor rule. For countries that have reached the lower bound, the difference between these two paths can indicate that a further monetary impulse is warranted. We proceed by estimating a rule where the current value of the monetary policy rate responds to a three-month-lagged value of this rate, the output gap (measured as a deviation from an HP trend) and the annual rate of inflation of CPI inflation.[3] Additionally, we also considered the possibility of the policy rate reacting to either nominal (against the U.S. dollar) or real (multilateral) annual exchange rate depreciation. The estimation was performed using data until 2007, using the resulting coefficients to compute the implied paths for the Taylor rule from that date onwards.[4]

Columns three to five in table 2 display the percentage reduction in the policy rate implied by different specifications of the Taylor rule between September 2008 and the last available observation, while the second column reports the actual change for comparison. The results do not show a clear pattern. Only for Japan, Sweden, Switzerland, the U.S. and, to less extent, the Euro Area, the Taylor rule indicates a bigger reduction than actually observed.[5] For the other countries, the

[3]The results are robust to using the deviations of observed inflation from the target, for those countries that announce an explicit target.

[4]We used iterative GMM for the estimation, using as instruments the lagged values of the regressors as well as current and lagged values of oil prices and the CRB commodity price index. In an attempt to make results robust to the lag selection for the instruments, we estimated each equation using from two to twelve lags for monthly data (one to four for quarterly), and use the median across the different alternatives of each coefficients to make the out-of-sample forecast.

[5]Rudebusch (2009), for instance, finds a similar result for the U.S., although using forecasts from the FOMC

Table 2: Taylor Rules. Percentage reduction between Sep-08 and Aug-09.

Country	Data	Baseline No E.R.	Baseline Real E.R.	Baseline Nominal E.R.	Long run No E.R.
Australia	50	32	31	30	71
Canada	92	90	84	84	171
Chile	88	59	58	58	104
Colombia	51	40	42	43	102
Euro	67	81	67	68	288
Japan	80	108	112	112	150
Korea	62	55	55	55	30
New Zealand	49	9	9	9	41
Norway	72	50	51	54	17
Sweden	89	126	127	124	260
Switzerland	99	103	117	103	149
England	90	85	85	81	101
United States	88	128	128	–	347

Note: Except for the following countries, the data is monthly. For Australia, New Zealand and Switzerland all results are based on quarterly data, and data ends in the first quarter of 2009. For Canada, Japan, and Korea we used quarterly data in the case of rules including the real exchange rate. Chile was estimated using data from 07-2001 onwards to account for the change in the policy instrument. The long run Taylor rule is one in which the coefficients for output gap and inflation were multiplied by $1/(1-\rho_i)$, with ρ_i being the estimated coefficient on the lagged policy rate. The last two columns correspond to the specification without exchange rates.

predicted changes in these three columns are either close to the actual reductions or significantly smaller.

A concern about the results based on a rule that contains a smoothing parameter is that this backward looking component may not be appropriate to describe the behavior in a situation when the lower bound is binding. One would expect this coefficient to change (probably becoming closer to zero) as the rate approaches to the lower bound, particularly during a period of a sudden financial distress, for the monetary authority will be less concerned about reducing the volatility in the interest rates than in regular times. One way to control for this effect is to use a "long run" Taylor rule, in which the interest rate depends only on inflation and output gap and the coefficients for these variables are those estimated in the baseline case adjusted by $(1 - \rho_i)$, with ρ_i being the estimated coefficient on the lagged policy rate. This is, if the originally estimated rule is

$$i_t = \rho_i i_{t-1} + \rho_\pi \pi_t + \rho_y \tilde{y}_t,$$

the long run effect of a change in π_t and $\tilde{y}_t$ are, respectively, $\rho_\pi/(1 - \rho_i)$ and $\rho_{\tilde{y}}/(1 - \rho_i)$, provided $|\rho_i| < 1$. In this way, this alternative assumes that the response to inflation and output gap is the same as historically described, once we adjust for the usual reaction to lagged interest rates.

The sixth column in table 2 computes the implied reduction using the "long run" rule.[6] With a few exceptions, results appear more conclusive in this case: the long run rule recommends a much lower rate than the observed one. For instance, if we compute the average reduction implied by this rule for countries that have maintained a low policy rate we obtain a reduction of 140 %, while this same statistic for the other countries (not shown in the table) is 46%. Additionally, it is interesting to notice that for those countries that have decreased and maintained the rate to a low level but at a value significantly greater than zero (Australia, Korea, New Zealand and Normay), the Taylor rule implies, with the exception of Australia, that the policy rate should be above the actual low level it had reached. In particular, the average observed reduction within this group was 58% while the rule suggested an average reduction close to 40%. Moreover, these are the only

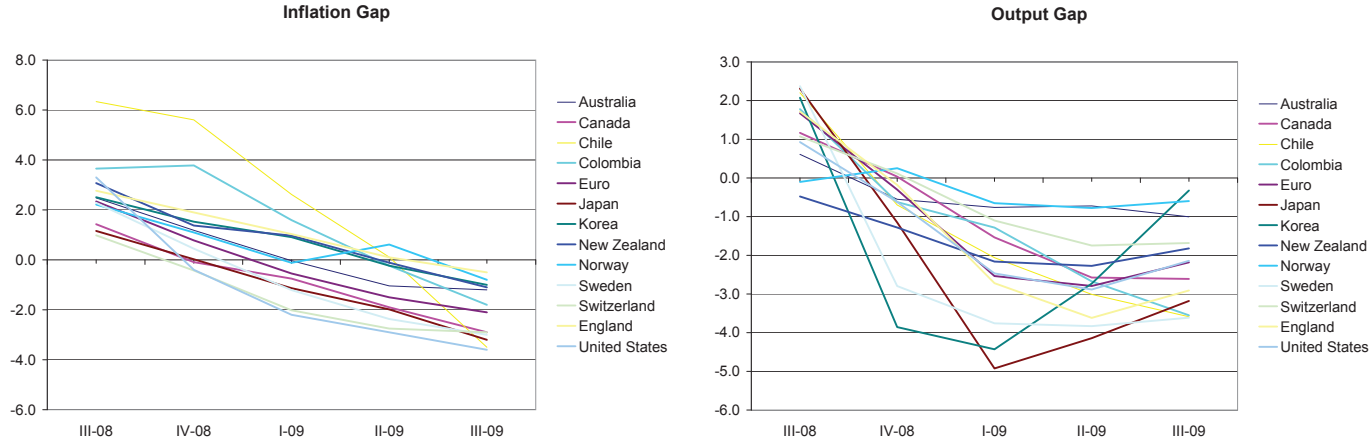
meetings to compute the predicted path instead of actual data as we do.

[6]Results are similar if we included measures of exchange rates in the rule.

countries in this sample for which this long run rule would not have predicted a negative interest rate. On the other hand, for those that have reached a bound close to zero, the mean observed reduction was 83% while the Taylor rule suggested a drop of near 186% on average. In particular, the biggest differences between the actual change in the policy rate and that implied by the rule are for the U.S., the Euro Area and Sweden, while for Chile, Colombia and England the rule would have recommended driving the rate to a value just below zero.

In order to check for the robustness of our results we do a simple exercise. We compute a common-parameter Taylor rule for the countries under analysis. In particular we compute an implicit monetary policy rate from the following Taylor rule: $i_t = i + \rho_\pi (\pi_t - \overline{\pi}) + \rho_y \tilde{y}_t$, where i corresponds to the average rate in the last 10 years, and $\overline{\pi}$ corresponds to the inflation target. This is equivalent to have a common central banker for these countries. We use quarterly data in order to have a common measure of activity (output). In figure 12 we show the arguments of our Taylor rule, the deviation of inflation from the target and the output gap. The output gap is computed using the HP filter.

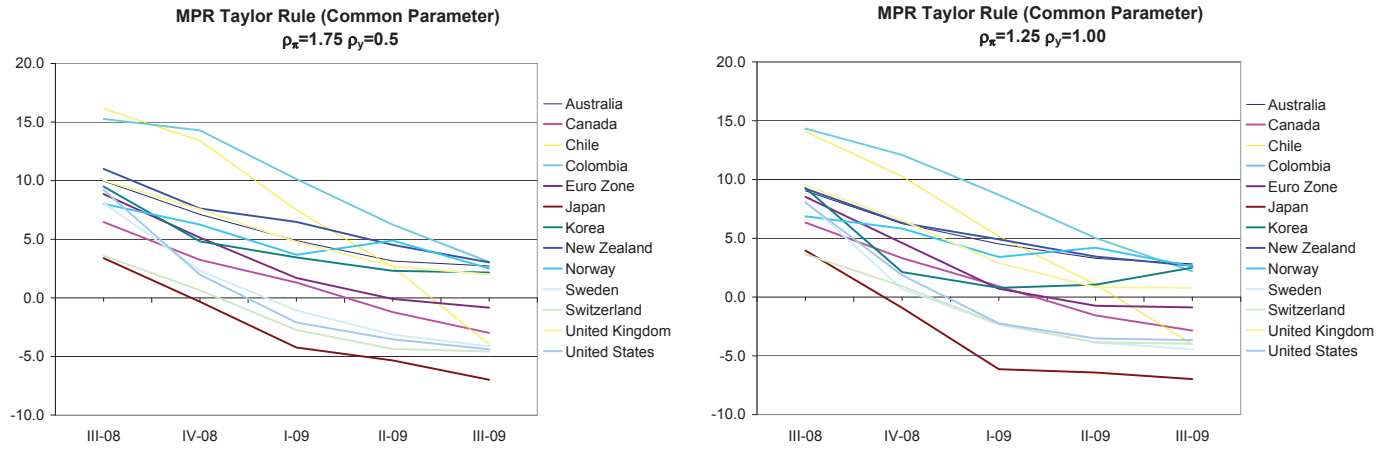
Figure 12: Deviation of Inflation from Target and Output Gap. Percentage points



As can be seen, previous to September 2008, all of the countries in our sample had inflation rates above the inflation target (in the case of the US and Euro Area we use (implicit) targets of 2% and 1.5% respectively). This is consistent with monetary policy rate management previous to the Lehman bankruptcy. In some cases, this deviation persisted, at a lower intensity, in the last

quarter of 2008. Nevertheless, the general picture is that after the third quarter of 2008 there was a rapid decrease in inflation which falls below the target, in most of the cases, between the fourth quarter of 2008 and the third quarter of 2009. Regarding the output gap, by the first quarter of 2009, all of the countries in the sample were experiencing a negative output gap.

Figure 13: Monetary Policy Rate implied by common-parameter Taylor rule. Percentage points



Next, we use the previous information to estimate monetary policy rates for two different versions of Taylor rules, which are presented in figure 13. The results indicate that, for all the countries that reached the lower bound, our common parameter monetary policy rate became negative or just above zero at some point in time. Only the Euro Zone exhibits a negative estimated monetary policy rate while the effective interest rate is significantly above zero.

Obviously the exercise just presented does not take into account the forward looking nature of monetary policy. However, it is useful to indicate that the rapid deterioration in the economic environment called for a rapid monetary policy reaction, as the one we observed, and that for those countries that reached the lower bound there was the need of significant additional monetary policy stimulus.

3.2.2 Balance Sheets

For those countries that reached the lower bound and, more generally, for those countries that have implemented non conventional monetary policy actions, the interest rate is not the only, and

perhaps not the best, aggregate indicator of monetary policy actions. In principle, an alternative to quantify monetary policy impulse is to look at the evolution of monetary aggregates. However, given that most policies implemented during this current crisis entailed more that simply printing money, it is probably more appropriate to look at the evolution and composition of the central bank's balance sheet. Moreover, we have argued that (at least from a theoretical point of view) the size and composition of the central bank balance sheet can be relevant to deal with the lack of credibility arising at the lower bound.

Table 3: Central Bank's Assets and Liabilities. Percentage change.

	Assets		Liabilities		Capital	
Country	Mean-07 to Aug-08	Aug-08 to Sep-2009	Mean-07 to Aug-08	Aug-08 to Sep-2009	Mean-07 to Aug-08	Aug-08 to Sep-2009
Australia	-6.8	-2.9	-7.2	-3.5	0.0	5.5
Canada	10.6	33.7	10.4	33.9	116.8	-11.3
Chile	25.0	41.9	20.7	19.2	2.9	138.2
Colombia	0.8	17.9	12.3	14.7	-28.3	30.8
Euro	11.0	1.6	11.1	0.8	9.7	12.9
Japan	-2.7	6.4	-3.0	6.7	1.8	0.8
Korea	10.2	19.3	-10.8	16.6	680.5	33.1
New Zealand	12.8	18.6	-84.8	-6.3	793.5	22.0
Norway	6.7	18.0	-6.5	2.4	11.9	23.2
Sweden	-0.1	240.9	-1.7	334.6	4.0	9.0
Switzerland	17.7	50.2	43.9	84.6	-4.7	5.9
England	2.7	142.8	4.0	146.1	-30.5	11.7
United States	1.4	139.8	0.7	145.2	18.3	26.5

Note: Data was obtained from the webpage of the different central banks.

Table 3 shows, for those countries that reached a bound as they dropped policy rates, the percentage change in total assets, liabilities and capital (i.e. assets minus liabilities), comparing both the mean value in 2007 with that at August 2008, and the change from August 2008 to September 2009. Except for Australia, all these countries have increased their asset positions since August 2008. The mean and median of these changes are 56% and 20%, respectively. In addition, it appears also that the growth in total assets has accelerated relative to the recent past after September 2008, the only exception being the ECB which increased the size of their assets

proportionally more during early 2008. The most dramatic increases were in Sweden, England and the U.S. A similar increasing pattern can be seen in terms of liabilities as well.

Another potentially useful measure is the central bank's capital. On one hand, one can argue that increasing the capital level may be useful in coping with a financial crisis, for it might, for instance, reduce the likelihood of a run against the local currency. On the other hand, however, a possible way to increase the expectations about future inflation to deal with a zero bound situation is to increase the size of the bank's liabilities proportionally more than the assets holdings: for instance, if the bank is at some point concerned with its level of capital, it will have incentives to produce inflation in the future. Therefore, it is in principle not clear what would the policy recommendation be in this dimension during a crisis like the recent one. The evidence presented on table 3 appears to indicate that the central banks decided to increase the value of their capital since August, 2008. The only exception is Canada, whose capital has fallen by near 11%, although the value of its capital had more than doubled in the first part of 2008. Also Japan presents a mild increase in assets over liabilities by less than one percent since August, 2008. On the other extreme, Chile increased its capital by more than 100%, breaking a negative trend that had been experienced in previous years.

While the size of the bank's balance sheet may be a good approximation to the stance of monetary policy, another dimension to consider is the composition of their portfolio, given that most unconventional policies entailed purchases of assets that were not part of the usual holdings. Table 4 presents a simple decomposition of the asset side of the balance sheets. For most countries, the table shows the shares of foreign assets, domestic credit to the government (mainly composed by holdings of treasury bonds) and other domestic credit. On the other hand, we present a different decomposition for England and the U.S.: for England, the columns are, respectively, Short term repos, Long term repos, and Bonds and others, while for the U.S. they are Treasury securities, Other securities held outright (including mortgage-backed securities), and All Liquidity Facilities. To better understand the size of these changes, the table displays, for each country, the mean during 2007 as well as the composition in August 2008 and September 2009.

The evidence gathered does not show a clear pattern in the actions taken by these central

Table 4: Central Bank's Asset Composition. Shares of total Assets.

	Foreign	Domestic Credit			Foreign	Domestic Credit	
Country	Assets	Goverment	Others	Country	Assets	Goverment	Others
Australia	59.2	0.0	39.5	New Zealand	77.7	20.2	1.8
	47.5	0.0	51.1		67.0	17.9	0.0
	59.8	0.0	38.8		61.9	12.1	25.7
Canada*	0.0	95.7	3.8	Norway	14.9	82.9	2.0
	0.0	96.5	0.1		10.4	85.6	1.8
	0.0	61.2	38.4		9.9	87.4	2.6
Chile	78.0	0.0	15.8	Sweden	94.8	0.0	3.2
	80.5	0.0	11.3		97.5	0.0	0.6
	69.7	0.0	9.9		50.5	0.0	48.5
Colombia	74.5	3.5	11.1	Switzerland	70.9	0.0	28.3
	85.2	0.4	3.6		59.4	0.0	39.8
	82.1	0.7	6.9		60.1	10.9	28.6
Euro	23.9	11.1	56.7	England**	26.3	20.9	52.8
	23.4	10.4	57.3		36.5	23.6	39.8
	20.0	11.9	57.7		0.0	17.4	82.6
Japan	4.6	65.5	28.8	United States***	87.0	0.0	4.1
	5.0	60.9	32.9		53.6	0.0	29.1
	4.8	58.5	35.6		35.9	38.4	21.9
Korea	93.5	4.3	2.2				
	93.6	4.6	1.7				
	83.9	10.0	6.1				

Note: For each country the lines are, respectively, mean of 2007, August 2008, and September 2009. * For Canada, Foreign assets is just foreign currency deposits. ** For England, the columns are, respectively, Short term repos, Long term repos, and Bonds and Others. *** For the U.S. they are Treasury securities, Other securities held outright, and All Liquidity Facilities.

banks. Some countries do not appear to have significantly changed the composition of their assets during the sample. This is the case for Japan, the Euro area and, to a less extent, Australia (which decreased their holdings of foreign assets in favor of other domestic credit in early 2008, but reverted the change in the latter part of the sample). For others, the change has been more dramatic. In most cases, the central banks have reduced the share of foreign assets in their portfolio, with the exceptions of Canada (still having a negligible amount of foreign assets, and having increased domestic credit to the private sector in detriment of their holding of government assets) and Colombia (which increased this weight by almost ten percentage points since 2007, decreasing both components of domestic credit). Korea and Switzerland have increased their holdings of government assets proportionally more, while New Zealand, Norway and Sweden significantly raised domestic credit to the private sector.

Finally, in terms of the countries with a different decomposition, both the Fed and the Bank of England have drastically altered the composition of their assets holdings. For the former, the shares of U.S. treasuries decreased by more than 50 percentage points, increasing instead the portion devoted to other securities held overnight as well as the liquidity facilities, which by 2007 represented a negligible part of its portfolio. In the case of the Bank of England, it is striking the reduction of short term repos –decreasing to almost zero– which was replaced by the rise in holdings of bonds and other domestic credit.

3.2.3 Monetary Condition Indexes

An additional measure of monetary expansivity that we explore is the Monetary Condition Index (MCI),[7] which became popular on the mid 90's for its use at the Bank of Canada and the Reserve Bank of New Zealand, among others. The idea of this index is that the stance of monetary policy cannot be properly captured by just looking at the monetary policy rate, particularly for a small open economy, and that the real interest and exchange rates better summarize the monetary

[7] See, for instance, Freeman (1995).

conditions. In particular, the index is computed as

$$MCI_t = \omega(r_t - r_0) + (1 - \omega)(q_t - q_0),$$

where r_t is the interest rate, q_t is the real exchange rate (an increase is an appreciation), r_0 and q_0 are the values in the base year, and ω is the relative weight on the real interest rate.[8] Therefore, a rise in the index implies a tighter monetary condition. Although the usefulness of this index has been subject to a debate (see, for instance, Stevens, 1998, and Gerlach and Smets, 2000) most of the arguments in favor and against were based on analyzing "normal" times, and then it is worth to explore its virtues to account for monetary conditions during a zero bound period.

Table 5: Monetary Condition Index. Percentage.

		Historical		
	Change	Annual	Change	Reduction
	MCI	mean	Median	MPR
Australia	-2.43	-0.03	-0.26	50
Canada	-1.23	-0.06	-0.11	92
Chile	-3.15	0.85	0.75	88
Colombia	-1.66	-0.45	0.20	51
Euro	-0.42	-0.05	-0.14	67
Japan	-0.04	-0.08	-0.12	80
Korea	-3.15	0.55	0.16	62
New Zealand	-2.26	0.01	0.04	36
Norway	-1.58	0.12	-0.01	72
Sweden	-0.87	-0.14	-0.30	89
Switzerland	-1.02	0.06	-0.05	99
England	-0.01	-0.01	-0.04	90
United States	2.41	-0.12	-0.05	88

Note: Columns two and five are the percentage changes between September, 2008, and September, 2009.

Table 5 presents the percentage change in the MCI between September, 2008, and the same month in 2009, for each of the countries that reached a bound in their policy rate. For comparison,

[8]These weights are a function of the importance of these variables in explaining fluctuations of output. We followed the implementation suggested in Bundesbank (1999).

we also report the mean and median annual change observed historically, as well as the observed reduction in the policy rate. In general, the index has significantly decreased since September 2008. The exceptions are the U.S., Japan, England and the Euro Area.[9] Moreover, the size of the drop seems to be significantly bigger that the average size of the annual historical change in this coefficients. This seems to have been particularly the case for Chile, Korea, Australia and New Zealand.

3.2.4 Comparing the Different Measures

These alternative measures allow us to have an account of the policy expansivity from different relevant perspectives. A final issue that we try to assess is the extent to which they reflect the same phenomena. To answer this question, table 6 shows the cross-country correlation between the observed reduction in the monetary policy rate, the drop implied by the Taylor rule (both in its baseline and long run specifications),[10] the change in total assets and liabilities as well as the change in the share of other domestic credit and foreign assets between the average of 2007 and September 2009,[11] and the difference between the percentage reduction in the policy rate implied by the long run Taylor rule and the observed reduction in that rate.

The correlations between the observed drop in MPR, the changes implied by the Taylor rule, the change in assets and liabilities as well as the compositions of assets have the expected sign, while that is not the case with the MCI.[12] In particular, we can see a high correlation of changes in both assets and liabilities with the reductions implied by the Taylor rule, as well as with the difference between the reduction implied by the rule and the observed reduction. Also, both indicators of the change in the composition of the central bank's portfolio seem to be related to the changes implied by the Taylor rule, particularly with the change in Foreign assets,[13] which has historically been the most important part of the assets holding by central banks.

[9] That the index does not perform properly in these countries is, in principle, not necessarily an important concern. As commented before, the index was originally developed to represent the monetary stance of a small open economy which is clearly not the case for these.

[10] These three are comparisons between September 2008 and the last available observation.

[11] For England and the U.S. the items are those described in table 4.

[12] This results for the MCI is robust if we exclude the U.S., Japan, England and the Euro Area.

[13] Treasuries for the U.S. and short term repos for England.

Table 6: Correlations of different measures of monetary expansion.

	Drop in MPR	Drop in TR	Drop in LR TR	Rise in Assets	Rise in Liabilities	Change in Share Others	Change in Foreign Assets	Change MCI
MPR	1							
TR	0.83	1						
LR TR	0.46	0.78	1					
Assets	0.52	0.63	0.50	1				
Liabilities	0.53	0.67	0.52	0.98	1			
Share Others	0.28	0.41	0.32	0.72	0.70	1		
Foreign Assets	-0.38	-0.57	-0.56	-0.87	-0.81	-0.61	1	
MCI	0.44	0.73	0.76	0.46	0.43	0.34	-0.57	1
LR TR - MPR	0.48	0.89	0.84	0.56	0.62	0.40	-0.58	0.78

3.3 On the Effects of Heterodox Policies

As a final exercise, we present some descriptive evidence of the effects that the unconventional policies described here have had on a set of variables that are relevant for the transmission of monetary policy and were (and still are) at center stage in policy discussions during the current crisis. In particular, we attempt to assess the changes generated after policy announcements in the shape of the yield curve, and in the lending-deposit spreads.

We proceeded as follows. For a group of twelve central banks that reached a bound on their policy rates,[14] we analyzed their press releases since mid 2007, identifying 56 policy announcements concerning unconventional measures. For each of these events,[15] we computed the slope of the yield curve (based on daily data of government bonds) for the available terms one week before the announcement as well as one and two weeks after it, and calculated the change in the slope.[16] For the lending-deposits spread our data is more limited,[17] and we computed the difference in the

[14] Australia, Canada, Chile, Euro Area, Japan, Korea, New Zealand, Norway, Sweden, Switzerland, England, and the United States.

[15] Two different announcements can be part of the same event if they have occurred within two business weeks.

[16] While this is clearly not a rigorous econometric event study, given the limited size of our sample this exercise would at least give us a rough idea of the impact of the announcement. A proper characterization of the causal effects of these policies is beyond the scope of this paper, mainly because not enough time have passed to have a relevant sample to attempt to measure them.

[17] The data is the average monthly rate, and for some of the more recent dates we have missing observations.

spread between its average one month before and one month after the announcement.

To analyze the results, we grouped the announcements into six broad categories: assets purchases and direct lending to financial firms, expanding list of eligible collateral, paying interest on reserves, swap lines with other central banks, and term loan and liquidity facilities.[18] We also categorize the different yield curve slopes into three groups according to the maturity of the longest bond in the comparison: up to six months, from six months to two years, and more than two years.[19] This categorization of the different slopes is aimed to represent the short run, a medium term generally associated with the monetary policy horizon, and the long run.

Table 7 presents the average change (across events) in the grouped tranches of the yield curve, for each of the categories described before, as well as the number of events in each group.[20] While there is a significant dispersion within each group (not reported), it appears that policies of asset purchases and term loan and liquidity facilities generated a reduction in the medium part of the yield curve (between 10 and 20 basis points) while generating increases in the slopes at short horizons (particularly the last group). On the other hand, measures expanding the list of eligible collateral seem to have had an insignificant impact during the first week after the announcement. In addition, the creation of swap lines with other central banks appear to have increased the slope at terms between six month and two years, while also increasing the shorter part of the curve after two weeks. Finally, the two cases in our sample of central banks paying interest on reserves were followed by decreases in the slope at short terms. Overall, it seems that the effects on the longer part of the curve have been minor on average.

While the results reported in table 7 are a good first approximation to the data, it pools observations for different periods in a sample that have been characterized by different levels of financial volatility. In an attempt to control for the different phases in the observed implementation of unconventional policies, we split the observation in different time frames to see whether these observed co-movements differ over time.

[18] A list describing each of the announcements included can be be found in the appendix.

[19] Unfortunately, the same maturity structure is not available for all countries, which forced us to make this grouping to compare the results.

[20] A missing value in the table implies that for the country that has implemented the particular policy we do not data on bonds within that particular maturity in the yield curve.

Table 7: Effects of Policies in the Yield Curve and Lending-Deposits spread. Average across events, change in basis points.

		Weeks	Term Structure			Lend. -
Measure Type	Obs.	After	Up to 6M	6M to 2Y	2Y+	Dep.
Assets purchases and	12	1	7	-19	-5	4
direct lending to financial firms		2	3	-11	-5	
Expand list of collateral	10	1	1	-1	3	5
		2	39	2	1	
Interest on reserves	2	1	-4		6	20
		2	-25		1	
Swap lines with other CB	6	1	-1	14	4	35
		2	22	17	3	
Term Loan and liquidity	26	1	15	-12	2	12.7
Facilities		2	25	-11	2	

Note: For the terms structure (columns 4 to 6) the table shows the (average across observations of the) change in basis point in the slopes between the observation one week before the announcement of the policy and either one or two weeks after. For the Lending-Deposits spread (column 7), it is the change (in basis points) of the spread between its average one month before and one after the announcement.

Table 8 reports the results for three different time frames: before September 2008, between September and December of 2008, and after January 2009.[21] In terms of asset purchases, the minor reduction in the slope for the first part of the curve observed in the full sample contrasts with the quite important rise characterizing the three events occurring between September and December of 2008,[22] but for the other nine events the impact on the short part of the curve was mildly negative.

A similar pattern can be observed for policies that extend the list of eligible collateral. Before September 2008, these type of announcements where associated with reductions in the slope of the short part of the yield curve, while after that month this tranche of the slope increased after the press release. In term of policies introducing term loans and liquidity facilities, it seems that the

[21] We do not show the results for policies in the group Interest on reserves because the two observations in our sample occurred in the same time frame (between September and December of 2008). The same is true for the categories missing in the next table.

[22] These number are mainly driven by the announcement of the Canadian government that it will purchase up to $25 billion in National Housing Act Mortgage-Backed Securities.

flattening of the yield curve was more evident when these measures were implemented between September and December 2008 than after that period.

Table 8: Effects of Policies in Yield Curve and Lending-Deposits spread. Average across events, different time frames, change in basis points.

	Time		Weeks	Term Structure			Lend. -
Measure type	Frame	Obs.	After	Up to 6M	6M to 2Y	2Y+	Dep.
Assets purchases and	Before	1	1	-6		4	-3
direct lending to financial firms	Sep-08		2	-9		5	
	Sep-08 to	3	1	115	-19	-2	28
	Dic-08		2	70	-11	0	
	After	8	1	-2		-8	-5
	Jan-09		2	-1		-8	
Expand list of collateral	Before	2	1	-9	1	-1	-43
	Sep-08		2	-13	2	0	
	Sep-08 to	6	1	5	-6	4	25
	Dic-08		2	56	2	1	
	After	2	1		3	2	3
	Jan-09		2		3	1	
Swap lines with other CB	Sep-08 to	4	1	-1	-6	7	7
	Dic-08		2	22	3	5	
	After	2	1		33	1	77
	Jan-09		2		32	1	
Term Loan and liquidity	Before	1	1	15		6	61
Facilities	Sep-08		2	5		5	
	Sep-08 to	19	1	22	-14	3	7
	Dic-08		2	42	-13	2	
	After	6	1	1	-5	1	29
	Jan-09		2	0	-6	-1	

Another potentially useful split of the sample is based on whether these policies were associated by different movements depending on whether the rate had already reached its lower bound or not, which is reported in table 9. While we can see that unconventional policies were mainly implemented before the central bank chose to drove the policy rate to a low value, some difference can still be noticed. In terms of policies in the group of asset purchases, it appears that those implemented after the lower bound was reached had been associated with stronger flattening effects on the yield curve. On the other hand, the opposite seems to be the case for policies creating term loans and liquidity facilities.

Finally, turning to the behavior of the lending-deposits spread, table 7 shows that, on average, unconventional measures were followed by increases of this spread. However, looking at the different time frame decompositions in tables 8 and 9 reveals some exceptions. In particular, assets purchases seem to have been associated with increases in the spread only in the period between September 2008 and and December 2008. Moreover, there appears to be a marked difference in the observed behavior of the spread depending on whether the rate was at its lower bound or not. Additionally, the two announcements of expansions in the list of eligible collaterals implemented before September 2008 (both at the Bank of Canada), were apparently associated with reductions in this spread as well. Nevertheless, it is worth to mention once again that the frequency of the data on these spreads is probably not the most adequate to analyze the effects of these types of events.

Table 9: Effects of Policies in Yield Curve and Lending-Deposits spread. Average across events, different time frames, change in basis points.

	MPR		Weeks	Term Structure			Lend. -
Measure type	Bound	Obs.	After	Up to 6M	6M to 2Y	2Y+	Dep.
Assets purchases and	Before	4	1	-6		0	36
direct lending to financial firms			2	-6		2	
	After	8	1	11	-19	-9	-14
			2	7	-11	-9	
Expand list of collateral	Before	9	1	1	-1	3	5
			2	39	2	1	
	After	1	1		3	0	
			2		3	-1	
Term Loan and liquidity	Before	22	1	21	-14	3	14
Facilities			2	36	-14	2	
	After	4	1	1	7	0	-3
			2	0	6	-2	

Overall, it appears that announcements of Assets purchases and direct lending as well as of Term Loan and liquidity facilities produced a reduction of the slope of the yield curve at medium horizons; for the other types the evidence is less clear. These effects seem to have been more marked between September and December 2008 for both of the aforementioned categories. On the other hand, while the reduction in the slope generated by Assets purchases and direct lending was apparently stronger after the policy rate reached the lower bound, the impact of Term Loan

and liquidity facilities was stronger before reaching the lower bound. In contrast, the effect on the lending-deposits spread of both types of policies was more pronounced after the lower bound was attained.

4 Conclusions

Motivated by the numerous unconventional monetary policies that have been implemented during the current crisis, a new wave of research in monetary policy has been triggered devoted to analyze the scope and desirability of this *heterodox* behavior of central banks. Moreover, the discussion is far from being settled and it will probably keep both theorists and applied economists busy for years to come.

In this context, the goals of this paper were twofold. On one hand, we provided a theoretical analysis of the mechanisms that are relevant to understand the effects of these unconventional policies, and that can be used as a ground for an ex-post evaluation of the measures implemented. In particular, we first discussed the role of credibility in implementing inflationary goals once the nominal interest rate is at its lower bound, paying particular attention to the importance of the central bank's balance sheet. Additionally, we presented a model which has at its core a financial imperfection that highlights the role of bank's capital as well as the relevance of alternative credit policies that can be used to deal with a situation of financial distress.

On the other hand, we reviewed evidence regarding the recent experience of central banks that implement inflation target regimes. We first described the timing and the type of unconventional policies that have been implemented. Second, we explored several alternative measures to asses the expansivity of monetary policy in a situation when the policy rate has reached its lower bound. Finally, we presented some descriptive evidence on the effect that the policies implemented had over two variables that are relevant for the propagation monetary policy: the shape of the yield curve and the lending-deposit spread.

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A Appendix

A.1 Data Sources

Monetary Policy Rates: Central Banks web pages and Bloomberg, daily observations from Jan2007 to Sep2009 Monthly and quarterly averages were used for calculation purposes

Interest Rates and Yields: IFS, Bloomberg and Central Banks web pages. Lending and borrowing rates correspond to a monthly average interest rate. Yields corresponds to daily Nominal Government Bonds (GGR Bloomberg)

GDP, CPI and Indusatrial Production:[23] The source of this data is the IFS. All sereis are seasonally adjusted. CPI inflation corresponds to the quarterly annual percentage change in CPI. GDP gap is a percentage deviation from an HP trend. WTI corresponds to the average West Texas Intermediate oil price in current USD. RER is the real exchange rate provided by the IFS. NER is the nominal exchange rate provided by the IFS. CRB is the Commodity Research Bureau/Reuters US Spot all commodities.

[23](*) For Australia, New Zealand and Swizterland we used quarterly data for estimation purposes. Quarterly data set starts in 1980q1 for Autralia, Canada, Switzerland, Danmark, UK, Japan, Korea, Mexico, Norway, Sweden and USA. For Brazil the data set starts in 1996q4, for Czech Republic the data set satarts in 1993q1, 1999q1 for the Euro Area, 1985q1 for Hungary, 1995q4 for Peru, 1996q1 for Chile and 1994q1 for Colombia. For all the countries of our sample the data set ends in 2009q1 except for Colombia whose data set ends in 2008q4. For monthly estimations data sets start in 1980m1 for: Brazil, Canada, Danemark, UK, Japan, Korea, Norway and USA. For Switzerland the data set starts in 1995m1 and finishes in 2007m12, for Chile the data set starts in 1987m7, for Mexico in 1981m5, 1989m12 for South Africa, 1993m1 for Czech Republic, 1995m3 for Colombia, 1995m10 for Peru, 1999m1 for the Euro Area and 1999m10 for Hungary. All the data sets ends between 2009m5 and 2009m8, except for Switzerland whose data set finishes in 2007m12.

Time Line of Policy Announcements I

Country	*Date*	*Measure*	*Type*
Australia	24-Sep-08	Domestic term deposit facility	Term Loan and/or liquidity Facilities
	29-Sep-08	Swap Facility with US Federal Reserve	Sawp lines with oher CB
	08-Oct-08	Expansion of Domestic Market Facilities	Term Loan and/or liquidity Facilities
	06-Nov-08	Domestic Market Dealing Arrangements	Term Loan and/or liquidity Facilities
	04-Feb-09	Reserve Bank of Australia and US Federal Reserve Swap Facility	Sawp lines with oher CB
	02-Mar-09	Domestic Market Dealing Arrangements	Term Loan and/or liquidity Facilities
Canada	15-Ago-07	Temporarily Expands List of Collateral Eligible for SPRA Transactions	Expand/or list of collaterals
	31-Mar-08	Accepting Asset-backed Commercial Paper (ABCP) as Collateral for the Bank of Canada's Standing Liquidity Facility (SLF)	Expand/or list of collaterals
	10-Oct-08	The federal government announced that it will purchase up to $25 billion in National Housing Act Mortgage-Backed Securities	Assets purchase and/or Direct lending to financial firms
Chile	29-Sep-08	Reserve accumulation program was terminated, USD repo 1 month operations announced (sales of USD spot + 1 month forward USD purchases, through competitive auctions)	Term Loan and/or liquidity Facilities
	10-Oct-08	Broadening of eligible collaterals for money market operations (now encompassing CDs), USD repo program extended to six months.	Expand/or list of collaterals
	10-Dic-08	Extension of liquidity measures for all of 2009.	Term Loan and/or liquidity Facilities
		Enhancement of liquidity facility through credit lines accepting a broader range of collateral for longer tenors.	Expand/or list of collaterals
	09-Jul-09	MPR at lower bound, short term liquidity facility, suspension of debt emision of long maturities	Term Loan and/or liquidity Facilities
Euro	26-Sep-08	Measures designed to address elevated pressures in the short-term US dollar funding markets,	Term Loan and/or liquidity Facilities
	29-Sep-08	Conduct of a special term refinancing operation	Term Loan and/or liquidity Facilities
	07-Oct-08	US dollar liquidity-providing operations	Term Loan and/or liquidity Facilities
	18-Dic-08	Tender procedures and the standing facilities corridor	Term Loan and/or liquidity Facilities
	06-Abr-09	Central banks announce expanded swap arrangements	Sawp lines with oher CB
	07-May-09	Longer-term refinancing operations. ECB decided to enhance its set of non-standard measures	Term Loan and/or liquidity Facilities
	04-Jun-09	Coverded bonds Purchases of 60 billion Euro	Others
	08-Jul-09	EIB(European Investment Bank) an elligible counterparty	Expand/or list of collaterals
Japan	14-Oct-08	Increase in the frequency and size of repo operations. Steps to Facilitate Corporate Financing	Others
	31-Oct-08	Introduction of lending facilities	Term Loan and/or liquidity Facilities
Korea	27-Oct-08	Increased of agg credit. Remuneration of reserves	Interest on reserves
	08-Nov-08	Broadening eligible collaterals for OMOs	Expand/or list of collaterals
		Liquidity provisions to financial institutions	Term Loan and/or liquidity Facilities
New Zealand	12-Oct-08	Deposit guarantee scheme introduced	Others
	29-Oct-08	RBNZ, Federal Reserve announce USD facility	Term Loan and/or liquidity Facilities
	07-Nov-08	Reserve Bank announces new facilities	Term Loan and/or liquidity Facilities
	12-Dic-08	Reserve Bank announces further liquidity measures	Term Loan and/or liquidity Facilities
	13-Ene-09	Tuesday OMO to accept Corporate and Asset Backed securities	Expand/or list of collaterals
Norway	24-Sep-08	Central banks announce expanded swap facilities with U.S. Federal Reserve	Sawp lines with oher CB
	12-Oct-08	Two-year F-loan for small banks	Term Loan and/or liquidity Facilities
	29-Oct-08	Easing collateral requirements	Expand/or list of collaterals

Time Line of Policy Announcements II

Country	*Date*	*Measure*	*Type*
Sweden	22-Sep-08	Press Release: Changed collateral requirements for credit in RIX	Expand/or list of collaterals
	24-Sep-08	Central Banks Announce Swap Facilities with U.S. Federal Reserve	Sawp lines with oher CB
	29-Sep-08	Riksbank announces new swap facility in US dollars	Term Loan and/or liquidity Facilities
	02-Oct-08	Riksbank lends SEK 60 billion over three months	Term Loan and/or liquidity Facilities
	06-Oct-08	Increased loans and longer maturity	Term Loan and/or liquidity Facilities
	08-Oct-08	Changed collateral requirement for credit in RIX	Expand/or list of collaterals
Switzerland	26-Sep-08	Measures taken by central banks to calm the money markets 30 bn swap line with the FED to p´rovide USD in Swiss market	Sawp lines with oher CB
	29-Sep-08	USD swap line with the U.S. Federal Reserve increased, Swap line expanded to 60 bn and until April 2009	Sawp lines with oher CB
	15-Oct-08	Swiss National Bank and European Central Bank cooperate to provide Swiss franc liquidity	Term Loan and/or liquidity Facilities
	16-Oct-08	Steps to strengthen the Swiss financial system.SNB finances transfers of UBS illiquid assets	Assets purchase and/or Direct lending to financial firms
	18-Dic-08	SNB StabFund acquires first tranche of assets from UBS	Assets purchase and/or Direct lending to financial firms
	25-Jun-09	Swiss National Bank continues to provide Swiss francs through EUR/CHF foreign exchange swaps	Term Loan and/or liquidity Facilities
England	19-Ene-09	BoE announces GBP 50 billion in purchases of high-quality private sector assets	Assets purchase and/or Direct lending to financial firms
	09-Abr-09	BoE reduces bank rate to 0.5% and continues APF with £75 Billion	Assets purchase and/or Direct lending to financial firms
	07-May-09	BoE maintains Bank Rate at 0.5% and Increases Size of Asset Purchase Programme by £50 Billion to £125 Billion	Assets purchase and/or Direct lending to financial firms
	04-Jun-09	BoE Maintains Bank Rate at 0.5% and continues with £125 Billion Asset Purchase Programme	Assets purchase and/or Direct lending to financial firms
	08-Jun-09	Asset purchase to be expanded to includesecured commercial papers	Assets purchase and/or Direct lending to financial firms
	09-Jul-09	BoE Maintains Bank Rate at 0.5% and continues with £125 Billion Asset Purchase Programme	Assets purchase and/or Direct lending to financial firms
	06-Ago-09	BoE Maintains Bank Rate at 0.5% and Increases. Size of Asset Purchase Programme by £50 Billion to £175 Billion	Assets purchase and/or Direct lending to financial firms
	10-Sep-09	BoE Maintains Bank Rate at 0.5% and continues, with £175 Billion Asset Purchase Programme	Assets purchase and/or Direct lending to financial firms
United States	21-Dic-07	Federal Reserve intends to continue TAF auctions as necessary	Term Loan and/or liquidity Facilities
	13-Jul-08	Lending to Fannie Mae and Freddie Mac at the primary credit rate is autorized	Assets purchase and/or Direct lending to financial firms
	19-Sep-08	AMFL or "the facility" established	Term Loan and/or liquidity Facilities
	06-Oct-08	FED will begin to pay interest on depository institutions' required and excess reserve balances and Increase of TAF	Interest on reserves
	02-Dic-08	Extension through April 30, 2009, of three liquidity facilities: the Primary Dealer Credit Facility (PDCF), the Asset-Backed Commercial Paper Money Market Fund Liquidity Facility (AMLF), and the Term Securities Lending Facility (TSLF)	Term Loan and/or liquidity Facilities
	10-Feb-09	Expanding TALF and accept wider set of collateral (FED states willingness to expand TALF to $1 trillion)	Term Loan and/or liquidity Facilities
	18-Mar-09	FED increases balance sheets by purchasing further 750 billions of asset backet-securities from agencies bringing this year total purchases up to 1.25 trillions. Announcement of program to buy $300b worth of Treasury securities.	Assets purchase and/or Direct lending to financial firms
	25-Jun-09	Extension of Liquidity Facilities and Swap lines	Term Loan and/or liquidity Facilities