How the PBoC's new MLF affects the yield curve

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Abstract

In this paper, we assess the impact of the Medium-term Lending Facility (MLF), an instrument recently introduced by the People's Bank of China (PBoC), on treasury and corporate bond yields. This instrument and, more specifically, the transmission of its use through treasury bond yields to corporate bond yields plays a major role in the more market-based policy the PBoC envisions for the future. Using a semi-parametric local projection framework, we show that the mechanism is already fairly effective, allowing the PBoC to manipulate the entire yield curve.

Keywords: Monetary policy; yield curves; MLF; Chinese bond market

JEL classification: E52, E43, G12, E44

1 Introduction

Over the past decades, the People's Bank of China (PBoC) has gradually adopted a more market-based approach in its conduct of monetary policy. Part of this movement was the introduction of the Medium-term Lending Facility (MLF) in September 2014. The MLF is a medium-term, collateralized loan from the PBoC to qualified commercial banks with a maturity of typically one year.[1] In a recent paper, the current governor of the PBoC, Yi Gang (Yi; 2021), outlined how the MLF plays a major role during the PBoC's transition to a market-based system, particularly in affecting the credit market and yield curve.

However, thus far, this instrument has not received much attention in the literature on Chinese monetary policy transmission. A large body of literature focuses on traditional measures of monetary policy, such as monetary aggregates (which have historically been important to the PBoC), the required reserve ratio, the benchmark loan rate or the money market rate. Another branch of literature claims that no individual indicator is appropriate to capture monetary policy in China and either estimates factor models with a latent monetary policy factor or develops narrative indices. Neither of those two bodies of literature attributes a large weight to the MLF.

To the best of our knowledge, this is the first paper to estimate the effect of the MLF on the Chinese treasury yield curve.[2] By linking what Governor Yi identifies as one of the PBoC's two core instruments with the yield curve, which is widely acknowledged as the anchor for asset pricing (See Nelson and Siegel; 1987; Diebold and Li; 2006; Gürkaynak et al.; 2007), we are able to shed light on one of the most important steps in monetary policy transmission in China.

Although MLF operations were officially made a "regular" tool that is implemented

[1] Right after the introduction of the instrument, the PBoC experimented with different maturities, i.e., three and six months, but has settled on exclusively using a one-year maturity since 2017.

[2] Porter and Cassola (2011) and Garcia-Herrero et al. (2011) discuss the role of yield curves in Chinese monetary policy transmission before the MLF was introduced.

by the PBoC every month only in 2019, it was used highly consistently before that time. Since the introduction of the MLF in 2014, there have been only 11 months during the early pilot stage when the PBoC did not issue any MLF loans. Therefore, unlike some other papers, such as Chen et al. (2022) and Fang et al. (2020), that treat MLF operations as a discrete shock, we treat it as a regular tool throughout our entire sample.

Using monthly data, we identify MLF surprises and use those surprises in a local projections framework to estimate their effect on the yield curves. We propose a semi-parametric method simultaneously capturing the movement of the entire yield curve without imposing a functional form while at the same time allowing us to exploit the data efficiently. This is particularly important, as our sample is relatively short and limited by the introduction of the MLF merely eight years ago.

2 Literature Review

After gradually shifting away from its original focus on monetary aggregates, the PBoC has never officially announced a primary intermediate target or committed to a single main instrument. Consequently, a large body of literature emerged that tried to understand the PBoC's monetary targets and how to measure Chinese monetary policy.[3]

Xiong (2012) generates a policy stance index aggregating changes in various individual instruments (that change over his sample period). Sun (2015) and Sun (2018) develop a narrative index based on the intent stated in the PBoC's monetary policy reports, and Funke and Tsang (2021) incorporates various tools into a compound index using a dynamic factor model, to name just a few examples.

The importance of Yi (2021) can thus hardly be exaggerated. For the first time, the sitting governor of the PBoC defines not only the key instruments but also the envi-

[3]An official overview of the diversified toolbox of the PBoC can be found here: `http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/index.html`

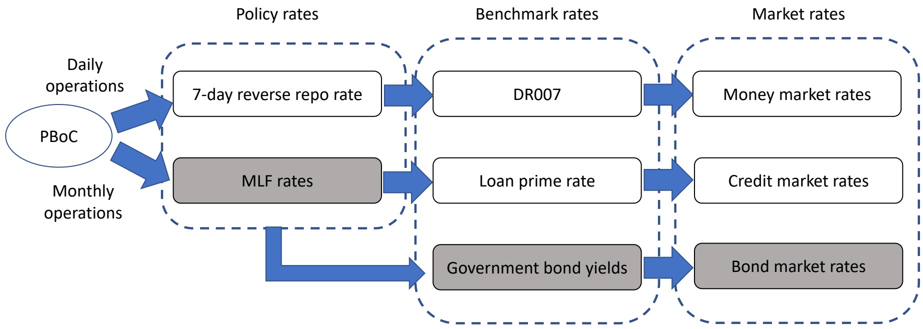
sioned transmission mechanism, including intermediary targets.[4] Figure 1 summarizes the transmission mechanism the PBoC envisions at the end of its gradual adoption of a market-based policy. In addition to the interest rate corridor for the short-term market rate, he emphasizes three interest rate transmission channels. First, there is the daily use of reverse repurchase agreements to control the 7-day reverse repo rate to affect money market rates through *DR007*, the short-term liquidity rate among Chinese deposit institutions, as an intermediate target. Second, there is the monthly use of MLF operations to control the MLF rate, thereby affecting the loan prime rate (LPR, as an intermediate target) and finally credit market rates. Third, and this is the primary interest of this paper, there is the use of both transactions mentioned above to affect government bond yields, which in turn drive corporate bond market rates.

Rather than embedding this–not yet fully implemented–policy framework into a larger macroeconomic model, this paper aims to look at one key feature of this framework under the microscope in a purely empirical framework to assess whether the PBoC is meeting its objective.

Specifically, we look at MLFs and their effect on the government yield curve–one of the intermediary targets specified by Yi (2021)–and the corporate bond yield curve, i.e., the financial market objective corresponding to this intermediary target. We do not look at the loan prime rate in this paper because liberalization in this area is still ongoing, and lending rates were still largely determined by the PBoC's benchmark lending rate during a major proportion of our sample. In contrast, there is an active and functioning market for both government and corporate bonds.[5]

[4]Much effort has previously been made in interpreting the framework and transmission of Chinese monetary policy both theoretically and empirically. See He and Wang (2012, 2013); Fernald et al. (2014); Chen et al. (2017); Harjes (2017); Kamber and Mohanty (2018); McMahon et al. (2018); Jones and Bowman (2019); Das and Song (2022); Fu and Ho (2022); Kim and Chen (2022).

[5]The LPR was introduced in August 2019, but only became available to the Chinese loan market one year later in August 2020, when creditors received the option to follow the LPR for floating interest rate loans. Until now, the LPR is still augmented by a deposit rate ceiling.



Source: Yi (2021), gray highlights added by authors

Figure 1: Planned transmission mechanism of the PBoC

This paper contributes to the still small but growing literature on the impact of the PBoC's policy on the yield curve. In this sense, we are closely related to El-Shagi and Jiang (forthcoming), who study the asymmetric impact of various monetary policy instruments on the yield curves of the Chinese interbank and exchange bond markets; Sun (2020), who analyze the effect of monetary policy announcements on the market interest rates of different maturities; and Das and Song (2022), who show the transmission of monetary policy toward interest rates across all maturities when discussing the coordination between monetary and fiscal policies in China. However, none of these papers explicitly focuses on the MLF.

3 Data

3.1 The Medium-term Lending Facility

Since the introduction of the instrument in 2014, outstanding MLF loans have been rising constantly in outstanding volume until 2018, as shown in Figure 2. We observe a trough in MLF balances between fall 2018 and summer 2021. However, during this period,

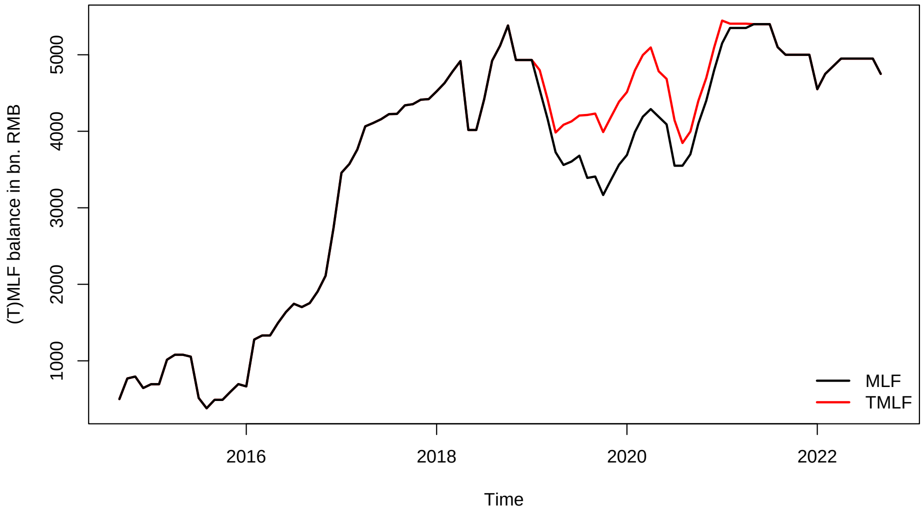


Figure 2: MLF and TMLF balances

the PBoC experimented with a related instrument, the Targeted Medium-term Lending Facility (TMLF), that partly compensated for the low levels in MLFs. While focusing on total MLFs, i.e., including TMLFs, in our baseline regression, we conduct robustness tests using MLFs that are largely consistent with our baseline and available on request.

3.2 Interaction with other monetary policy tools

The PBoC does not use its tools independent of each other, and many policy measures are packages of a variety of tools. In this paper, we treat the measures typically correlated with issuing new MLF loans or letting them expire as part of what we consider the MLF package. While this is fairly unproblematic for continuous policies such as open market operations and other lending facilities (e.g., SLF), it is more problematic with rare discrete policy events. In the case of the PBoC, this would mostly apply to changes in the benchmark loan and deposit rates and the required reserve ratio (RRR). While the use of changes in the benchmark loan rate has been phased out and was basically

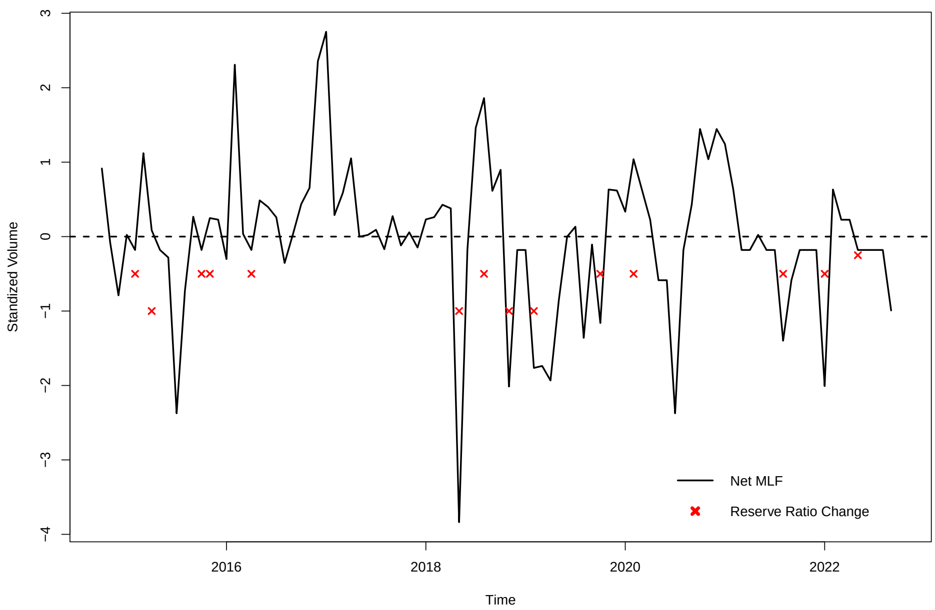


Figure 3: MLF and RRR changes

irrelevant during our sample, and changes in the loan rate were within the relatively wide corridor around the fixed benchmark rate, the PBoC–unlike its Western counterparts–still actively uses the RRR in its conduct of monetary policy.

During our sample, we observe several cases where the RRR was reduced to compensate for expiring MLFs that were not renewed, as discussed, for example, in the monetary policy reports published by the Center for Financial Development and Stability (El-Shagi et al.; 2019, 2018) (see Figure 3). We will therefore perform robustness tests, where we explicitly distinguish regular shocks from "sterilized" shocks, i.e., shocks that coincided with RRR reductions.

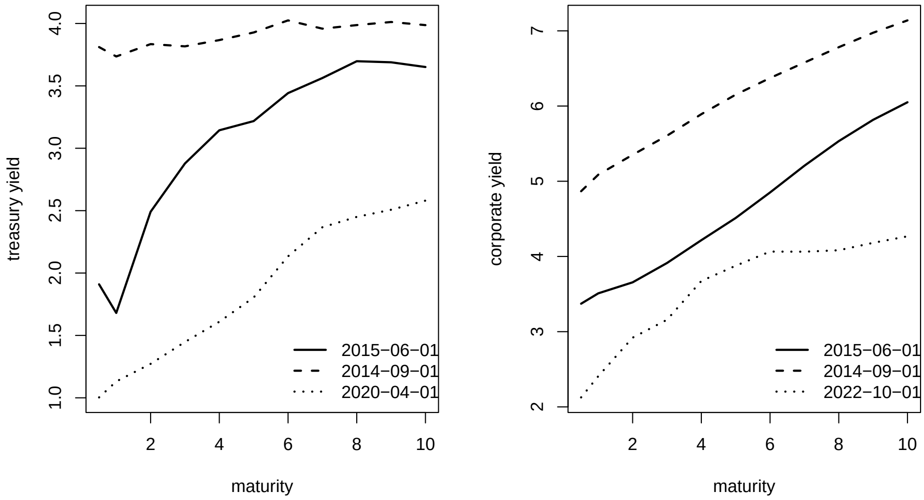


Figure 4: Treasury (left) and corporate (right) yield curves at selected dates

3.3 The treasury and corporate yield curves

We use monthly treasury and corporate spot rates obtained from the Wind financial database to represent our yield curve.[6] This data source provides treasury zero-coupon bond yields for maturities ranging from 6 months to 30 years and corporate zero-coupon bond yields for maturities ranging from 6 months to 10 years. However, the Chinese treasury rarely issues bonds with a maturity of more than 10 years. The yield estimates at this maturity are interpolated from widely scattered individual yields. Since monetary policy is rarely assumed to target expectations that far ahead and the lack of long maturity bonds introduces considerable uncertainty to the data, we consider only yields from 6 months to 10 years for treasury bonds.

The treasury yield curve was relatively steep in our early sample, with the largest term spread between 6-month and 10-year bonds being observed in summer 2015, when it looked as if the global economy was slowly returning to its trajectory before the global

[6]Treasury yields are from the Wind data series M1001695-1001704, while the corporate yields are from the Wind data series M1003897-M1003906 and M1007539.

financial crisis in 2008. Until December 2017, we observe that the yield curve gradually flattens and (in particular at the short end) moves upward. The yield curve at this time is both the most compressed in our sample and the time when we observe the highest average yields. Yields fell only slightly, and the yield curve remained highly compressed until the COVID pandemic hit in early 2020. After that, we observe a quick fall in rates, especially at the short end, with the yield curve reaching its low in spring 2020. At no point in our sample do we observe a yield curve inversion. The same is true when extending our yield curve sample further back to the mid-2000s, when the treasury started issuing more treasury bonds with the explicit aim of having a more complete yield curve to anchor the financial market. The left panel of Figure (4) shows the treasury yields of selected dates, which represent the typical steep, high, and low yield curves in our data sample. The dynamics of the average corporate yield roughly follow the government yields, as seen when comparing the right panel of Figure (4) showing corporate yields to the left panel depicting government yields, but are consistently higher due to the risk premium. However, the slope of the corporate yield curve does not flatten as much as the government yield curve. During the period where we observe an essentially flat government bond yield curve, the term spread of corporate yields is roughly two percentage points. Correspondingly, the credit spread between corporate and government bonds is typically higher at the long end, where it reaches up to three percentage points, while fluctuating between one and two percentage points at the short end.

Yield curve data have been available since 2005. However, our estimation is limited by the introduction of the MLF in 2014, yielding a sample ranging from September 2014 to the most recent month of available yield curves, August 2022.

4 Method

4.1 Shock identification

We identify surprise changes in MLF volume through a simple regression controlling for its autoregressive behavior, the yield curve and other monetary policy indicators, more precisely, 7-day repo rate and 7-day shibor rate. Our baseline approach assumes that the MLF is explained by past and current financial market developments——measured through the yield curve. This is closely related to a recursive SVAR identification where MLFs are ordered last and yields the equation:

$$mlf_t = \rho_0 + \rho_1 mlf_{t-1} + \sum_{\tau \in \mathbb{T}} \phi_\tau r_{\tau,t} + \Psi X_t + \varepsilon_t \tag{1}$$

where ε is the shock we seek to identify, $r_{\tau,t}$ is the yield of bonds with maturity τ at time t and X is a vector of further controls. This identification scheme essentially resembles identification in a VAR with recursive identification, where mlf is ordered first.

As a robustness check, we also use a second set of shocks mirroring a recursive SVAR where mlf is ordered first, i.e., where it is not affected by current financial markets, yielding:

$$mlf_t = \rho_0 + \rho_1 mlf_{t-1} + \sum_{\tau \in \mathbb{T}} \phi_\tau r_{\tau,t-1} + \Psi X_t + \varepsilon_t \tag{2}$$

4.2 Local projections

We estimate impulse responses to the shocks identified in the previous subsection using local projections as pioneered by Jordà (2005). Denoting the h step ahead maturity τ yield at time t as $r_t^{(h,\tau)}$, i.e., $r_t^{(h,\tau)} = r_{\tau,t+h}$, for ease of notation, we estimate:

$$r_t^{(h,\tau)} = \beta_0^{(h,\tau)} + \beta_1^{(h,\tau)}\hat{\varepsilon}_t + B^{(\tau,h)}R_t + u_t \tag{3}$$

where R is the vector of lagged corporate or government yields of all maturities, and $\hat{\varepsilon}$ is the estimated residual from Equations (1) or (2).

A key problem of this approach is that yields at a specific maturity are relatively volatile and include considerable noise. To increase the efficiency of the estimation, we therefore use a semi-parametric approach that allows us to exploit information over the entire yield curve simultaneously and produces smooth yield curve responses over the entire maturity range. To do so, we borrow from the literature on mixed frequency estimation and adapt an approach introduced by Breitung and Roling (2015).

Recall that the predicted effect of the yield curve over all maturities at horizon h can be written as

$$\hat{\beta}_1^{(h)} = \left[\hat{\beta}_1^{(h,\tau_0)}, \hat{\beta}_1^{(h,\tau_1)}, \ldots \hat{\beta}_1^{(h,\tau_{11})}\right] \tag{4}$$

where hat denotes the estimated coefficients from Equation (3).

To achieve a smooth yield curve–and utilize information from neighboring maturities in identifying the correct impact of an mlf shock on yields of a specific maturity–we penalize the second difference of $\hat{\beta}_1^{(h)}$ adjusted for the distance of neighboring datapoints on the yield curve. To this end, rather than estimating Equation (3) separately for each $\tau \in \mathbb{T}$, we estimate them jointly by stacking the time series for different maturities into a single equation and adding a penalty term to the objective function.

In other words, rather than finding $\hat{\beta}_1^{(h)}$ by minimizing

$$\hat{\beta}_1^{(h)} = \arg\min_{\hat{\beta}_1^{(h)}} \sum_{t=1}^{T} \sum_{\tau \in \mathbb{T}} u\left(\hat{\beta}_1^{(h)}\right)^2 \tag{5}$$

as done in OLS, we solve the minimization problem

$$\hat{\beta}_1^{(h)} = \underset{\hat{\beta}_1^{(h)}}{\arg\min} \sum_{t=1}^{T} \sum_{\tau \in \mathbb{T}} u\left(\hat{\beta}_1^{(h)}\right)^2 + \lambda \sum_{i=3}^{11} \left[\frac{\hat{\beta}_1^{(\tau_i,h)} - \hat{\beta}_1^{(\tau_{i-1},h)}}{\tau_i - \tau_{i-1}} - \frac{\hat{\beta}_1^{(\tau_{i-1},h)} - \hat{\beta}_1^{(\tau_{i-2},h)}}{\tau_{i-1} - \tau_{i-2}} \right]^2 \quad (6)$$

with λ being the smoothing parameter, and $u\left(\hat{\beta}_1^{(h)}\right)^2$ being squared residuals as a function of the parameter vector,namely $\hat{\beta}_1^{(h)}$. When the points on the yield curve are equidistant, the penalty term in Equation (6) collapses to the second differences. This is true for most points on our yield curve, as we have maturities from 1 to 10 years. However, at the very beginning, we move from 6 months to 12 months of maturity. Thus, we need this adjustment to avoid enforcing an arbitrary kink in the estimated smoothed yield curve.

This kind of regularization is closely related to the shrinkage estimators in particular ridge regression, but rather than penalizing deviations from 0, we penalize changes in slope, much like the seminal Hodrick–Prescott filter. Breitung and Roling (2015) demonstrate that λ can easily be mapped on the degrees of freedom lost by estimating $\beta_1^{(h)}$. With $\lambda = 0$, the estimator collapses to a simple OLS model, where all coefficients of $\beta_1^{(h)}$–in our case 12–are estimated separately (thus "costing" 12 degrees of freedom). As λ approaches infinity, all elements of $\beta_1^{(h)}$ are forced onto a straight line, which can be described by merely two parameters and thus corresponds to a loss of only two degrees of freedom. This mapping of λ on an implicit number of estimated coefficients allows us to use standard information criteria, in our case the modified Akaike criterion introduced by Hurvich et al. (1998) specifically to select smoothing parameters.

4.3 Conditioning on RRR adjustments

As previously mentioned, rather than renewing expiring MLFs, the PBoC reduced the reserve ratio to compensate for the loss of liquidity several times during our sample. While the MLF change itself might have come as a surprise, the resulting policy shock is clearly of a very different nature. We therefore perform a robustness check, where we explicitly distinguish sterilized and nonsterilized shocks, i.e., shocks that did or did not coincide with a reserve adjustment. Since all 14 RRR adjustments in our sample were reductions and all but one were half a percentage point or one percentage point, we do not consider RRR changes as a continuous variable but define an event dummy that flags RRR adjustments.

The adjusted model takes the form:

$$r_{\tau,t+h} = \beta_0^{(h,\tau)} + \beta_1^{(h,\tau)} \hat{\varepsilon}_t \mathbb{1}_{\Delta RRR_t < 0} + \beta_2^{(h,\tau)} \hat{\varepsilon}_t \mathbb{1}_{\Delta RRR_t \geq 0} + \beta_3 \mathbb{1}_{\Delta RRR_t < 0} + B^{(\tau,h)} R_t + u_t \quad (7)$$

Note that we define two dummies, one signifying RRR adjustments and one signifying the absence of adjustments, and interact the shock indicator $\hat{\varepsilon}$ with both, rather than having only one interaction. This way, we can interpret $\beta_1^{(h)}$ and $\beta_2^{(h)}$ as conditional responses of the yield curve at horizon h without further computations. For smooth reactions of the yield curve to both sterilized and non-sterilized shocks, we now need to apply our semi-parametric smoothing approach to both $\beta_1^{(h)}$ and $\beta_2^{(h)}$. We consider the possibility of different smoothing parameters for both and perform a grid search over eligible combinations.

5 Results

We present our results in a slightly unusual way. This paper focuses on the effect of a shock over the entire yield curve. Therefore, rather than regular IRF plots, where a single figure would show the effect of a shock on one individual yield over the forecast horizon, we display the effect over the entire yield curve for a single forecast horizon in one figure. To limit the number of plots, we do not present the full set of forecast horizons but focus on the effect on impact and then in three-month intervals up to the maximum forecast horizon of one year.

5.1 Baseline model

Over all forecast horizons, the AICc suggests an extremely high degree of smoothing for our semiparametrically estimated yield curve responses. Namely, the effect of an MLF shock typically is a shift over the entire yield curve and/or a tilting of the yield curve, rather than the creation of a hump somewhere in the middle maturities.[7]

We find a counterintuitive effect on impact, as seen in the first panel of Figure (5), where the government yield curve and–although insignificantly–the corporate yield curve are shifted upward in response to a positive MLF shock, i.e., a liquidity injection. This could either indicate that MLF injections are often sterilized in some way, and the opposing policies dominate in the short term or could be an artifact generated by portfolio rebalancing on the banks" side to compensate for their need for specific collateral.

At higher forecast horizons, we find the expected results. The yield curve is shifted downward (starting with the short end but soon reaching the further end of the yield curve) and then slowly returns to its original position. The effects look quantitatively small, but keep in mind that interest rates were highly stable during our entire sample period. Indeed, the typical interest rate step for MLF operations (if the interest was changing at all) was 0.05 percentage points, matching the order of magnitude we find quite exactly.

At low horizons, the response of corporate bond yields is stronger than that of treasury yields, but it is slightly less persistent. A strong effect on the corporate yield curve is clearly intended by the PBoC. Indeed, when the PBoC expanded the set of qualified bonds for MLF operations in June 2018 to include AA+ corporate bonds, this was widely

[7]This is an indicator that the simplified version of the level, slope, curvature models introduced by Nelson and Siegel (1987) where the curvature parameter is omitted might be sufficient for the analysis of the Chinese financial market. This is particularly interesting for dynamic multimarket models, as proposed, for example, by Diebold et al. (2008), to assess international spillovers.

interpreted by market analysts as evidence that the PBoC aims to use the MLF to stimulate demand for corporate loans more directly as MLF operations create demand for eligible collateral assets.[8]

Our findings suggest that the envisioned transmission of the MLF toward the government and eventually corporate yield curves, i.e., the market-based transmission the PBoC seeks to establish, is already working at least partially at this point.

5.2 Robustness: Considering RRR adjustments

As discussed in the data section, changes in outstanding MLFs, especially reductions due to expiring MLFs, frequently happen jointly with cuts of the RRR. In this subsection, we disentangle the effects of these two operations, that is, MLFs with corresponding RRR changes (or sterilized MLFs) and pure MLF adjustments (or nonsterilized MLFs). The results of this robustness test are summarized in Figures 6 and 7. Conditioning on RRR adjustments shows that the baseline results were clearly driven by nonsterilized shocks, i.e., shocks without a contemporaneous RRR adjustment. The response of both government and corporate bond yields to nonsterilized shocks largely tells a similar story as the baseline model. The main difference is, that the immediate (counterintive) response of government bond yields on impact, is now limited to the short end of the yield curve.

We do, however, find highly counterintuitive responses to sterilized shocks. For government bonds, we observe a positive response of yields over all horizons except the highest horizon. Note that we control for RRR adjustments (contemporaneously) in our local projections model, so this does not merely reflect that the RRR adjustment overcompensates for the MLF operation. It is possible that the MLF operations (typically nonrenewal of expiring MLFs in this case) were part of an even larger policy package that is not fully observable looking at the standard indicators.

[8]Fang et al. (2020) provide a detailed policy background of the relevant event.

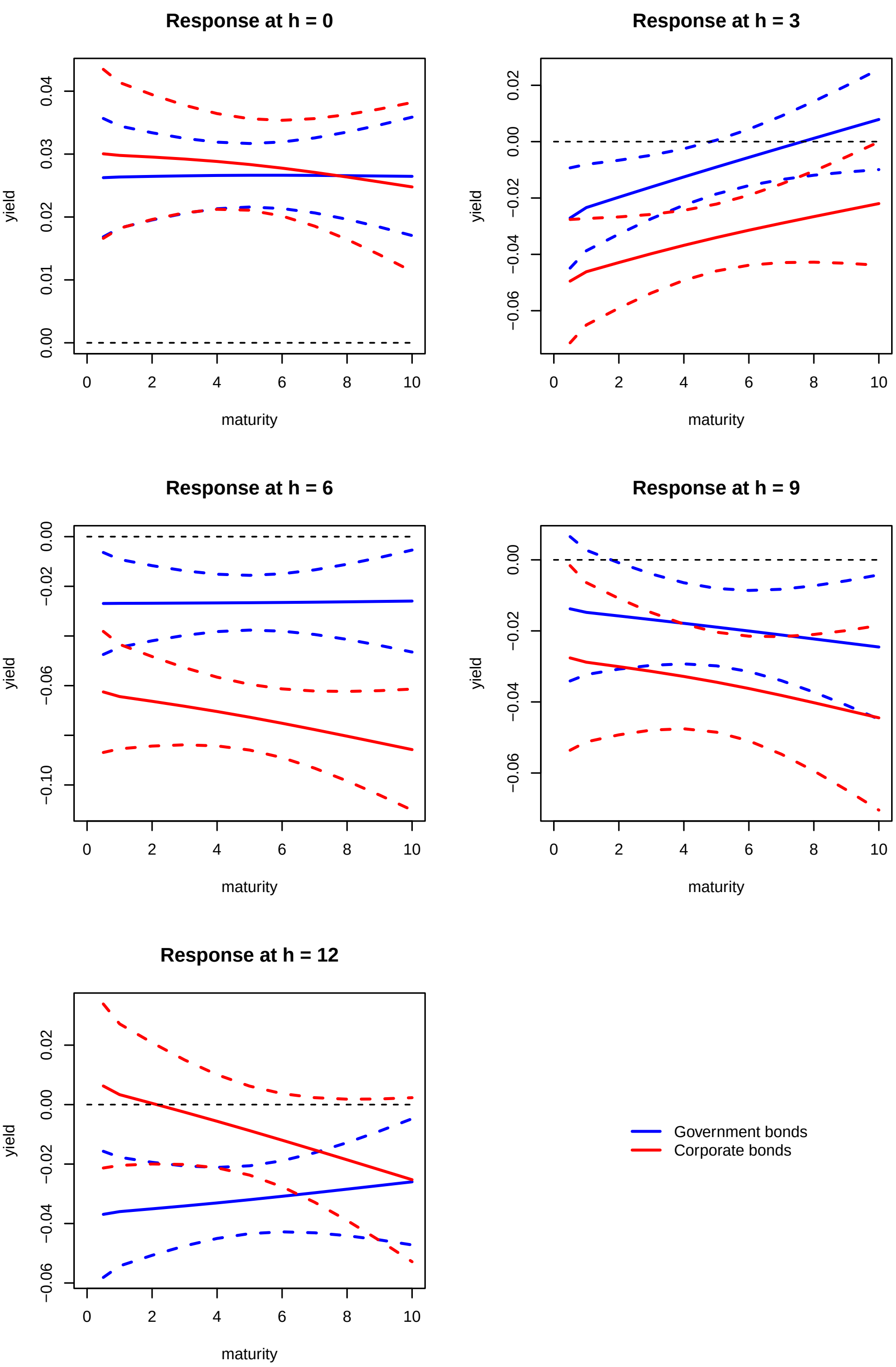


Figure 5: Effects of MLF shocks on the yield curve

When comparing sterilized and non-sterilized shocks with respect to their effect on corporate yields (see Figure 7), the general story seems similar at first glance. We find the same counterintuitive effect on impact (i.e. increasing rates), that we discussed before, before yields decline below the equilibrium rate and eventually return to normal. What is striking though, is that sterilized shocks have almost no impact on the short end of the yield curve at most forecast horizons, while affecting the long end significantly. Again, this speaks to the fact that those operations are part of larger bundles, where the PBoC deliberately targets certain parts of the yield curve, rather than generic easing or tightening. In particular, they seem to encourage portfolio rebalancing from government bonds towards (long term) corporate bonds, increasing supply of the former and demand for the latter, causing government bonds rate to increase (as can be seen when comparing the RR components of Figures 6 and 7).

5.3 Robustness: Alternate ordering

Figure (8) presents the results using alternative shock identification following Equation (2), which is analogous to using a different ordering in VAR-based identification. The results, when not controlling for contemporaneous yield curve changes, are largely similar; however, the initial counterintuitive effect of liquidity injections on interest rates seems stronger. Given our previous argument that it seems MLFs are often partly compensated, this was to be expected. By controlling for the current yield curve in shock identification, at least some of the effect of other simultaneous instruments is partly accounted for. Removing this, thus makes the effect of those simultaneously used instruments more visible in the results.

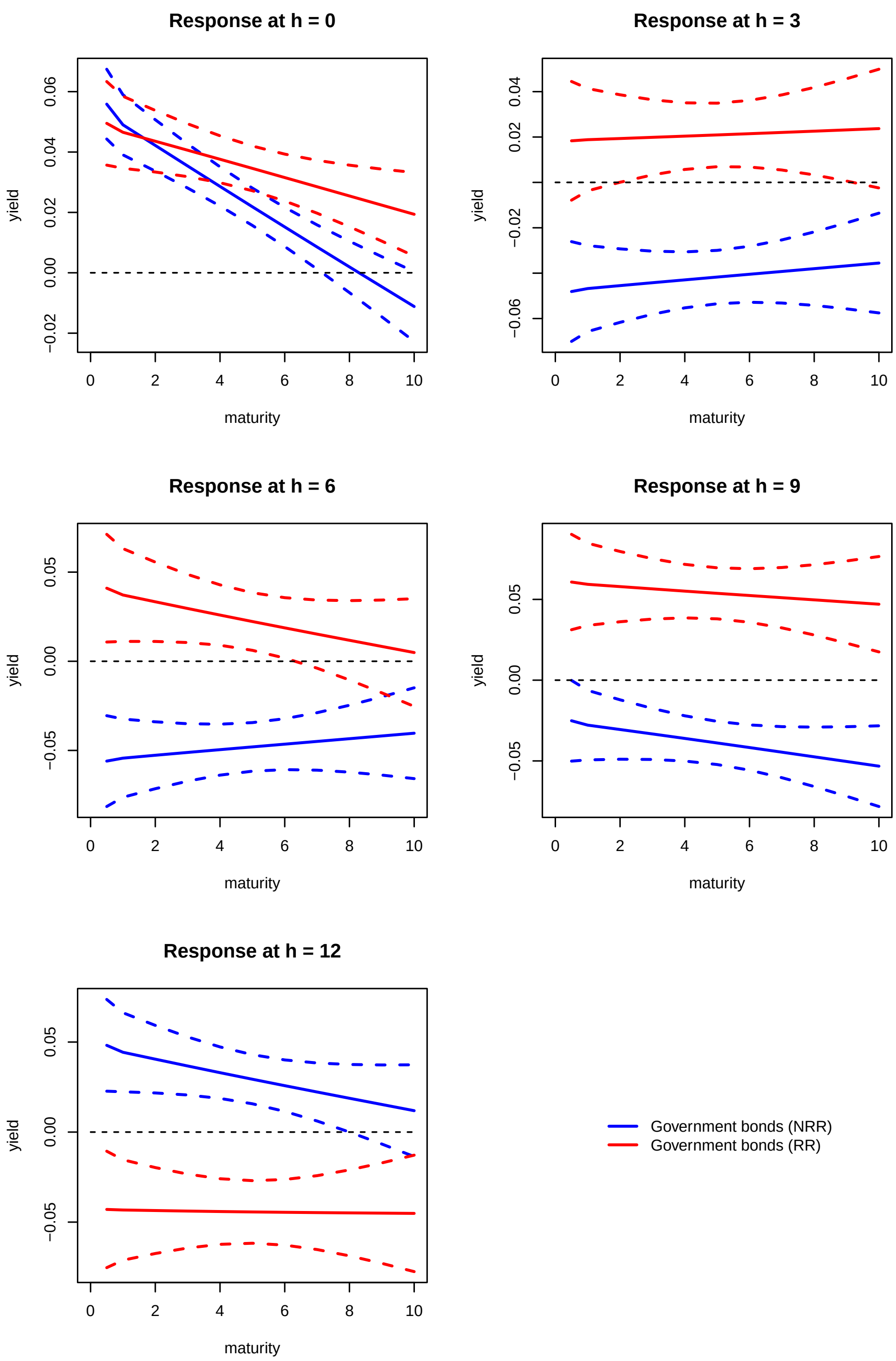


Figure 6: Effects of sterilized and nonsterilized MLF shocks on the government yield curve

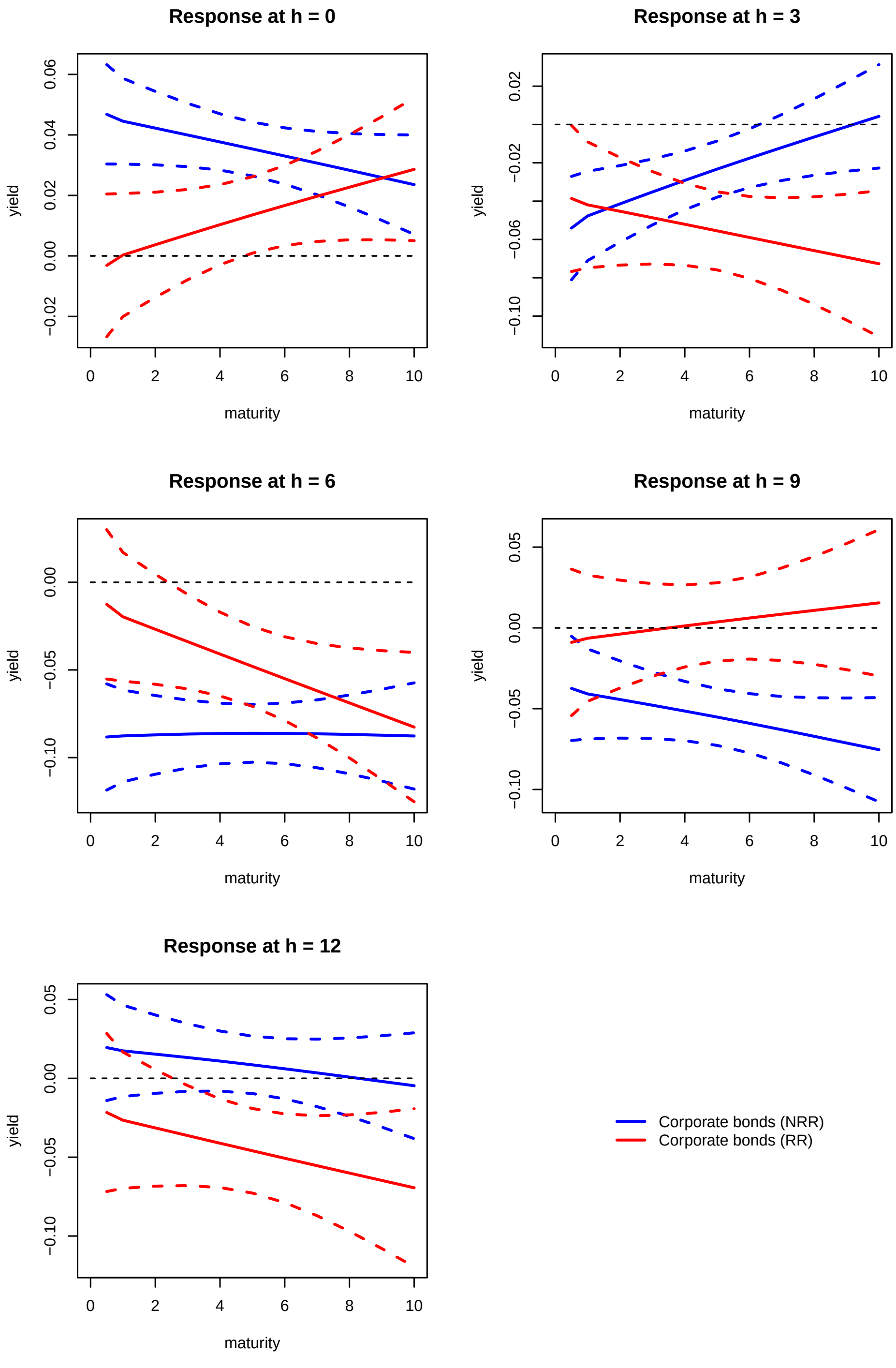


Figure 7: Effects of sterilized and nonsterilized MLF shocks on the corporate yield curve

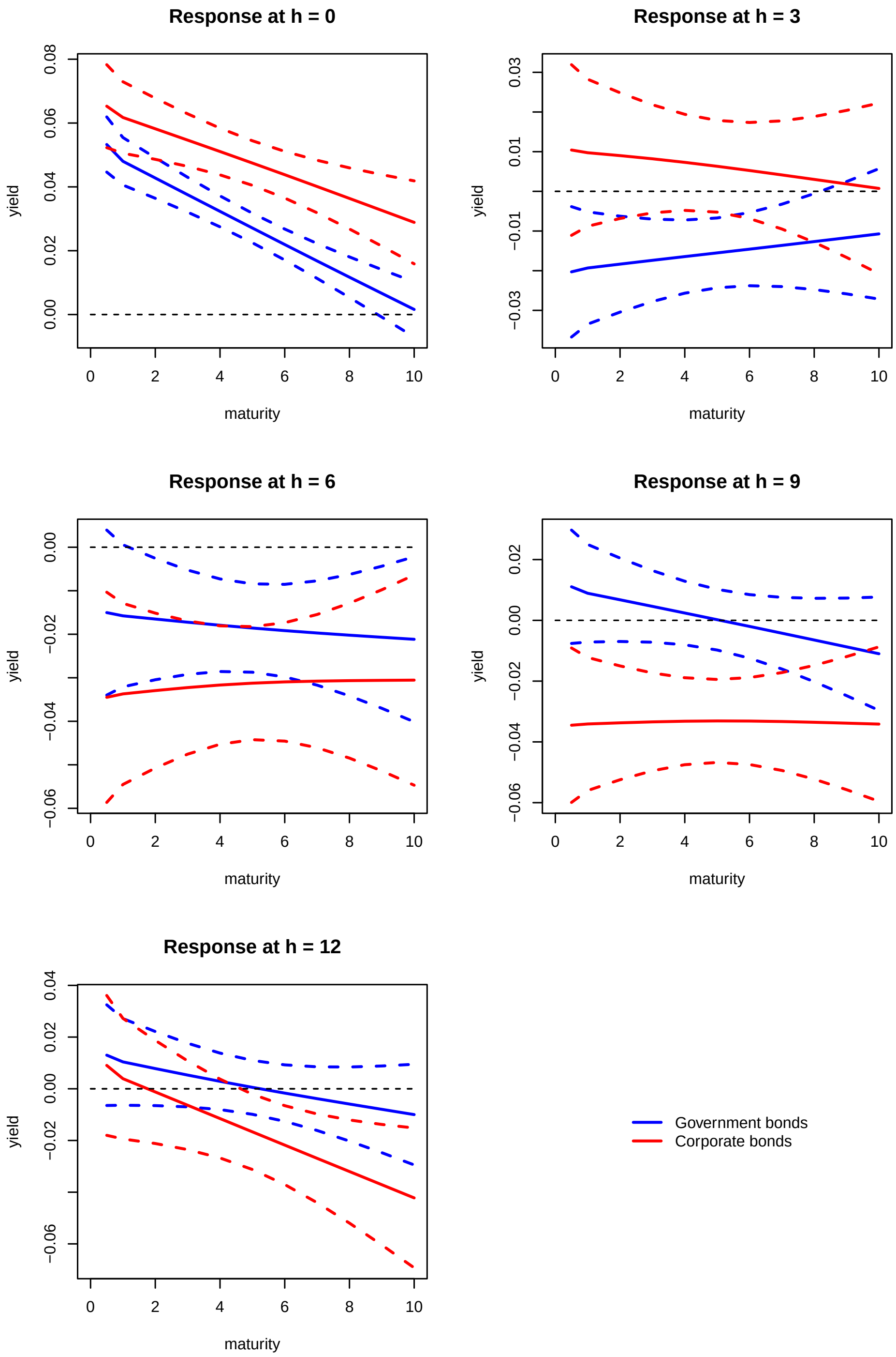


Figure 8: Effects of MLF shocks on the yield curve (alternative model)

6 Conclusion

Our results have mixed implications for the empirical study of Chinese monetary policy. On the one hand, MLF operations–which have been declared a primary instrument by Governor Yi–clearly have the intended effect. They are a driving force for both government and corporate bond yields and affect the yield curve over all maturities. However, our results also imply that the transformation has not yet progressed far enough to rely on a single instrument when assessing the PBoC's policy. Even in a simple framework, the presence of other policies in large policy packages obfuscates the effects we wish to observe. This is particularly problematic for VAR studies, which often identify shocks through their contemporaneous effects. Thus, while MLF operations–or the intermediate targets affected by them–should be accounted for in larger macroeconomic frameworks, it does not seem that simple one-instrument models are sufficient at this point.

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