Mozambican Monetary Policy and the Yield Curve of Treasury Bills – An Empirical Study *

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Abstract

While there is a relatively large empirical literature on the link between monetary policy and yield curve for developed economies, studies on emerging and developing economies are very rare. This paper contributes to reduce this gap by studying the effectiveness of monetary policy in Mozambique. Using monthly data it examines the pass-through of changes in the policy rate to the yield curve of treasury bills in the period 2006 – 2015. The main finding is that there is a pass-through from policy rate to treasury bill. However, this transmission from short to long term maturities in the yield curve is weak and slow.

Key Words – Mozambique, Factor model, Policy rate, Effect, Estimation
JEL – C32, C51, C58, E43, G20

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1 Introduction

The Central Bank of Mozambique (Banco de Moçambique) has lately paid special attention to the effectiveness of the monetary policy transmission mechanism. Emphasis has been put on lowering the Standing Lending Facility (the policy rate) with the ultimate goal of reducing the average cost of capital for investors and households. In fact, the management of monetary policy in Mozambique is recognized as being one of the best in Africa due to its success in keeping inflation under control while building foreign exchange reserves (The Banker, 2015). However, while the central bank has more than halved its base rate from 16.5% in early 2011 to the current 7.5%, this has not stopped local banks from charging about 20% for loans (The Banker, 2015). Moreover, even though Mozambique has among the highest growth rates in the world with a 7% real GDP growth (Almeida-Santos et al., 2014), some 60% of the Mozambicans have no access to neither formal nor informal financial institutions. This is the largest financial exclusion in the southern Africa region (FinScope, 2014).

In addition to the central bank, the process of implementation of monetary policy involves financial intermediaries (mainly commercial banks for the case of Mozambique) and failures in pass-through may therefore either relate to imperfections in the financial structure (Gigineishvili, 2011) or to the limited ability of the central bank to affect the money market through open market operations. There are various channels within which monetary policy actions can be transmitted to the economy (Mishkin, 1996), but there is also a consensus among economists that interest rates play a key role in monetary policy (Fontana, 2006). There is also an agreement in the literature that a central bank is more likely to directly impact shorter rather than longer-term interest rates (Roley and Sellon Jr, 1995, Demiralp and Yilmaz, 2012, Aazim and Rhodes, 2011). The reason is that the long-term interest rates are also affected by macroeconomic variables such as expectations on inflation and growth. As pointed out by Bisignano (1996) the interventions of a central bank in the money market are crucial for signalling its policy and thus it influences the behaviour of the long-term interest rates.

In this empirical paper, we study the effectiveness of the interest rate pass-through in Mozambique, i.e. we analyse the effectiveness of the monetary policy transmission mechanism by relating changes in the policy rate to movements in the term-structure (yield curve) of the money market. Kozicki and Tinsley (2001) show that the effectiveness of monetary policy can also be evaluated by looking at its impact on longer-term interest rates. As mentioned before, the monetary policy transmission mechanism takes place through the relationship between the policy rate and the yield curve. In this sense, a monetary policy that is unable to influence the long-term interest rate is found ineffective, i.e. it has a limited impact on investors decisions, and thus, on the economic activity.

Theoretically, the shape of the yield curve provides important information about the potential performance of a monetary policy (Estrella and Hardouvelis, 1991). For example, the investors' expectations are, in part, built taking this information into account. Specifically, when the interest rates increase with maturity (increasing function) we have a normal yield curve, meaning that the economy is expanding. There is a high probability that the central bank will raise interest rates in the near future to offset the inflation pressure. In a case where the yields in the short-term are higher than the long-term ones (decreasing function), the term-structure is called an inverted yield curve. Here, the yield curve indicates an economic recession, and then investors believe that the central bank will act to lower interest rates in the future. Finally, the term-structure may be almost constant; this is the flat yield curve. In this situation, investors believe that the central bank will make cuts in interest rates to counter the economic slowdown signs.

This paper studies the effectiveness of the monetary policy in Mozambique. To the best of our knowledge, there is no study that has dealt specifically with yield curves and monetary policy in Mozambique. This study aims to contribute to the empirical literature by using the yield curve model to study the pass-through of the policy interest rate controlling for selected macroeconomic indicators. In line with recent literature (e.g., Ang and Piazessi, 2003, Hördahl et al., 2006) we add some macroeconomic fundamentals to strengthen the model's ability to describe the interest rate behaviour in Mozambique.

In addition to this introduction, the paper consists of seven sections. The second section briefly describes some recent key facts about monetary policy. Section 3 presents an empirical literature review, with a particular emphasis on both neighbouring African developing economies and the Mozambican economy. This will serve as a reference for comparison with the results for Mozambique. The methodology and parameter estimation procedures are presented in Section 4. The fifth section presents and describes the data used in this paper. Section 6 gives the empirical results. Finally, the main conclusions are presented and discussed in Section 7.

2 Some Facts About the Monetary Policy in Mozambique

Before discussing the econometric analysis of yield curves and monetary policy analysis, we briefly highlight some important features related to the operational framework of monetary policy as well as the level of some key indicators of the financial system in Mozambique. This brief review will help to identify some explanations for the effectiveness of the interest rate pass-through process.

The main goal of the Banco de Moçambique (BM) is price stability (annual inflation between 3% and 5%). To achieve this objective BM adopts an operational framework based on the monetary aggregates where the money base is the instrument of the monetary policy (BM, 2007). Adjustments in the monetary base (or in the policy rate) are made by interventions in the money market through the so-called open market operations.

The structure and maturity level of the Mozambican financial sector represents a huge challenge for a good performance of a monetary policy. Despite some improvements in the last 15 years, the financial sector in Mozambique continues to be underdeveloped, although it has the potential to quickly expand in line with the country's decentralised growth (Almeida-Santos et al., 2014). Loans are only available to an estimated 5% of the population (FinScope, 2014). There are 18 registered banks representing 95% of total financial system assets. However, 85% of the financial sector's assets are concentrated in the three largest banks, all of which are foreign owned (two Portuguese banks and one South African bank). The formal micro-finance sector is also highly concentrated. Composed by 71 institutions (most of them located in the urban regions), 60% of the assets in this sector are concentrated in only 5 micro-finance institutions). According to the FinScope (2014) survey 19% of the Mozambicans only rely on informal mechanisms such as saving groups (friends and family).

The Mozambican Stock Exchange (BVM) currently lists just three private companies. Both government and corporate bonds are also listed on the BVM, although these represent just 3% of GDP. According to World Bank data, the credit to the private sector as percentage of GDP (33.1% in 2014) is growing but it is still relatively lower than for comparable countries in the region of southern Africa such as South Africa (67.2%), Namibia (47.5%) and Mauritius (100.2%). The majority of the population and businesses does not have access to financial services. Non-bank financial intermediaries and corporate debt and equity markets remain small and underdeveloped (Almeida-Santos et al., 2014).

3 Selected Empirical Studies

There is a relatively large literature studying the relationship between monetary policy and yield curves. This literature is divided into two approaches. The first is mainly concentrated on the dynamics of the expectations hypothesis and studies the effect of central bank announcements (e.g., information about changes on the monetary policy, interventions in the money market) on market interest rates. The results are mixed. While some researchers (e.g., Baker and Meyer, 1980; Cook and Hahn, 1988, Loeys, 1985, Glick and Leduc, 2012, Aazim and Cooray, 2012, Bong and Doh and Park, 2014) found some evidence that central bank announcements have effects on the money market rate, others (e.g., Smirlock and Yawitz, 1985, Mankiw and Miron, 1986, Roley and Walsh, 1985, Shiller et al., 1983) found no evidence.

The second approach, which is related to this study, concentrates on quantifying the monetary impact on the yield curve (Drakos, 2001, Aazim and Rhodes, 2011). The approach relies on the assumption that the monetary policy effectiveness is largely determined by the central bank's ability to impact the interest rates along the yield curves. Empirical studies (e.g., Wu, 2002, Diebold and Li, 2006, Ullah et al., 2014) have supported the idea that the yield curve (mainly the slope) carries important information regarding the monetary policy effectiveness.

For empirical purposes it is useful to have previous studies on the same subject to compare with. However, we could not find any study that empirically and explicitly merges analysing yield curves and monetary policy for a low-income country. Thus we, alternatively, select some works that studied the effectiveness of monetary policy in this group of countries. Mishra and Montiel (2013) conducted one of these studies. Their results are mixed. For example, the monetary policy is found to be effective in Namibia and Tanzania, while on the other hand the interest pass-through processes in Malawi, South Africa, Zambia and Lesotho appear weaker. Montiel et al. (2012) confirm the results for Tanzania. They found statistically significant price level effects of monetary policy. Aziakpono and Wilson (2013) find evidence of an effective interest rate pass-through process in South Africa.

There is also a complementary empirical literature that focuses on the determinants of the interest rate pass-through (e.g., Gigineishvilli, 2011) to access the differences in monetary policy effectiveness across countries. According to this study, the interest rate pass-through performance is determined by some macroeconomics factors (per capita GDP and inflation) and by financial market variables (exchange rate flexibility, credit quality, overhead costs and banking competition).

Rungo and Manjate (2011) and Massarongo (2012) applied a vector autoregressive (VAR) model to analyse the monetary policy in Mozambique. They concluded that the interest rate pass-though is very weak. However, VAR models face criticism, i.a. for being atheoretical, for requiring relatively long times series and because they are sensitive to how lags are chosen.

4 Yield Curve Model and Estimation Procedure

The yield curve is a model for interest rates r_τ at different maturities τ. Given that the yield curve is not observed it may be estimated from the observed yields. There are different approaches to perform such estimations. The most popular is that proposed by Fama and Bliss (1987), who constructed the yield curve using estimated forward rates at the observed maturities. The Nelson and Siegel model, which we use in this paper, is based on this approach.

The original (Nelson and Siegel, 1987) framework is a three-component exponential approximation. This model has substantial flexibility to match the changing shapes of the yield curve, yet it is parsimonious and easy to estimate (Diebold and Rudebusch, 2006, Aruoba, 2005).

The corresponding time dependent version proposed by (Diebold and Li, 2006) is

$$\begin{aligned} r_{t\tau} &= \beta_{1t} + \beta_{2t}\left(\frac{1-e^{-\lambda_t\tau}}{\lambda_t\tau}\right) + \beta_{3t}\left(\frac{1-e^{-\lambda_t\tau}}{\lambda_t\tau} - e^{-\lambda_t\tau}\right) + \epsilon_{t\tau} \\ &= \beta_{1t} + \beta_{2t}\lambda_{1\tau} + \beta_{3t}\lambda_{2\tau} + \epsilon_{t\tau}, \end{aligned} \tag{1}$$

where $t = 1, \ldots, T$ indicates the time period and τ represents the maturities. The second line introduces the shorthand notation to be used below.

The $\beta_{1t}, \beta_{2t}, \beta_{3t}$ and λ_t are the four unknown parameters to be estimated. Since the loading on β_{1t} is fixed at 1, it is independent of maturity and it may be viewed as the long-term interest rate. At $\tau = 0$, $r_{t0} = \beta_{1t} + \beta_{2t}$ since $\lambda_{10} = 1$ and therefore it is the curve's initial value in the τ dimension, i.e. it is the instantaneous interest rate. The loading associated with β_{2t} is $\lambda_{1\tau}$, which is a decreasing function of τ, starting at one and most often decreasing to zero (cf. Figure A in the Appendix for an example of the $\lambda_{t\tau}$ functions). Therefore, the β_{2t} is the short-term factor. The β_{3t} may be viewed as a medium-term factor; if $\beta_{3t} < 0$ the yield curve is concave; if $\beta_{3t} > 0$, then the yield curve is concave; if $\beta_{3t} \approx 0$, the yield curve will be a monotonically increasing or decreasing function depending on whether β_{2t} is negative or positive, respectively. The λ_t is a measure of the speed of the pass-through from shorter to longer-terms interest rates. Thus, for a large (small) λ_t the maturity interest rates get its maximum or minimum value sooner (later) and will thereafter converge to the long-term value.

As $\beta_{2t}\lambda_{1\tau} + \beta_{3t}\lambda_{2\tau} \to 0$, when $\tau \to \infty$, a natural empirical measure of pass-through is the smallest value $\tau > 0$ that satisfies

$$|\beta_{2t}\lambda_{1\tau} + \beta_{3t}\lambda_{2\tau}| < \delta,$$

for some small positive value of δ. Note, that this measure varies with time t as it depend on the time-varying $\beta_{it}, i = 2, 3$.

Finally, turning to estimation of the model in (1) we let λ_t be preset to a value that remains constant across time, and then employ OLS to estimate the β_{it} parameters for individual times t for the given λ. The given λ-value together with know maturities enable calculating the $\lambda_{i\tau}$ functions following the β_{it}s in (1). Note also, that choosing a

λ-value within reasonable bounds does not severely influence final results. Thereafter, OLS estimation of β_{1t}, β_{2t} and β_{3t} at each t is straightforward as long as the number of observed values of the maturity (τ) is larger than or equal to three. As a rule the number of observations in these regressions is not very large.

The resulting estimates of $\hat{\beta}_{it}, i = 1, \ldots, 3$, can be displayed for descriptive purposes and/or used as inputs to a procedure that seeks to find explanations to the levels of the $\hat{\beta}_{it}$s.

When it is believed that different of partly equal sets of exogenously determined variable vectors $\mathbf{x}_{it}$ explain the $\beta_{it}, i = 1, 2, 3$, there are two alternative approaches to estimation. First, using specifications

$$\beta_{it} = \mathbf{x}'_{it}\boldsymbol{\beta}_i,$$

where the number of elements in the $\mathbf{x}_{it}$ vector is k_i, we may substitute to get the yield curve model

$$r_{t\tau} = \mathbf{x}'_{1t}\boldsymbol{\beta}_1 + \mathbf{x}'_{2t}\boldsymbol{\beta}_2\lambda_{1\tau} + \mathbf{x}'_{3t}\boldsymbol{\beta}_3\lambda_{2\tau} + \epsilon_{t\tau}. \tag{2}$$

This is an example of a functional time series model and it can directly be estimated by OLS or some alternative estimator, given that new variables, say, $\mathbf{z}_{t\tau} = \mathbf{x}'_{it}\lambda_{i-1,\tau}, i = 2, 3$, are calculated and used during estimations. One major benefit is that the number of unknowns $(\sum_{i=1}^{3} k_i)$ but time invariant parameter vectors $\boldsymbol{\beta}_i, i = 1, 2, 3$, contain much fewer unknowns than the number $(3T)$ of unknown β_{it} parameters. Second, when there is uncertainty about which variables to include among the different $\mathbf{x}_{it}$s, it may be more practical to first run regressions of the type $\hat{\beta}_{it} = \mathbf{x}_{it}\boldsymbol{\beta}_i + \xi_{it}$. Once, a reasonable specification with respect to the content in $\mathbf{x}_{it}$ is arrived at, the resulting full model as specified by (2) may then be estimated.

Note from (2) that to evaluate the impact of a variable $x_{it,k}$, which is present only in one $\mathbf{x}_{it}, i = 1, 2, 3$, on $r_{t\tau}$ we would use the estimate

$$\partial \hat{r}_{t\tau} / \partial x_{it,k} = \hat{\beta}_{ik}\lambda_{i-1,\tau}, \tag{3}$$

with $\lambda_{0\tau} = 1$. This effect is time invariant but it varies with the maturity τ. The estimated sign of the effect is that of $\hat{\beta}_{i,k}$ since $\lambda_{i\tau} \geq 0$. Obviously, we may display the effect across both the observed τ-values as well as between them and beyond. For a given λ-value the variance is simply $Var(\partial \hat{r}_{t\tau}/\partial x_{it,k}) = Var(\hat{\beta}_{ik})\lambda_{i\tau}^2$ so that providing point wise confidence bands is straightforward. When the variable is present in more than one of the $\mathbf{x}_{it}$ vectors the marginal effect is additive with components of the type as in (3). Obviously, the variance then needs to be adapted to this extended setup. For a case where the variable is present in two components i and j the variance is $Var(\partial \hat{r}_{t\tau}/\partial x_{it,k}) = Var(\hat{\beta}_{ik})\lambda_{i\tau}^2 + Var(\hat{\beta}_{jk})\lambda_{j\tau}^2 + 2\lambda_{i\tau}\lambda_{j\tau}Cov(\hat{\beta}_{ik}, \hat{\beta}_{jk})$. Closely related results will be useful when we wish to give confidence bands for yields between and beyond observed maturities.

5 Data and Descriptive Statistics

The empirical study is based on monthly data from September 2006 through March 2015, i.e. the time series length is $T = 103$. We consider the average bid price for the Mozambican government's treasury bills with maturities 91, 182 and 364 days. These are the only treasure bills available in the Mozambican money market. As all maturities fall within a narrow time span of one year a real separation of short and long maturity effects is aggravated. In a developing market, the estimation of the yield curve entails use of only a few known yields for certain maturities while yields for other maturities are estimated by interpolation. Moreover, the data available is only related to the transitions in the primary market. In a few instances, missing data in single periods are replaced by linearly interpolated numbers across time.

Figure 1 exhibits the three interest rate time series for treasury bills of different maturities and the policy rate. A general feature is that interest rates have declined over the sample period, with a particularly rapid decline following July 2011 (the 60th month). Throughout 2010 BM revised its policy rate upwards, going from 11.5% in December 2009 to 15.5% in December 2010. These adjustments affected, in a similar direction, the other instruments used in the money market, including treasury bills (BM, 2010). This was after a period of increasing rates, starting about April 2010 (the 45th month). To offset the inflation pressures in early 2010, BM implemented a tight monetary policy, which includes an increase in the policy rate by 100 basis points (BM, 2011).

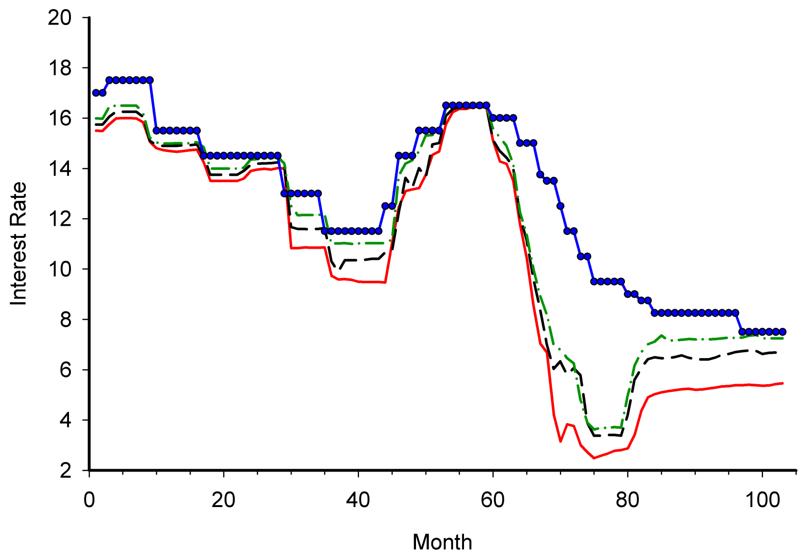

Figure 1: Interest rate series 2006:9 – 2015:3 $(T = 103)$ for treasury bills (for maturity $\tau = 91$ solid line, for $\tau = 182$ dashed line, for $\tau = 364$ dot-dash line) and for the policy rate (solid line with marker).

With a few exceptions of rapid increase or decline, the interest rates are increasing in time to maturity, i.e. there are predominantly normal yield curves in the studied period. This pattern is also apparent for the sample statistics reported in Table 1. Moreover, the correlation between the series is close to one.

For the macroeconomic variables, we use data on the following three variables: Policy interest rate, inflation, and the exchange rate between Metical and US dollar (MZN/USD). These are some of the variables used in the exiting empirical literature (e.g., Diebold and Rudebusch, Aruoba, 2005). The series for treasury bills and the policy rate are available on www.bancomoc.mz. The source for the exchange rate series is www.oanda.com. Finally, the data on inflation is from www.ine.gov.mz. Although theoretically GDP growth is one of the main variables used in the literature on this issue, it is not included in the write-up of our study as it was found statistically insignificant in our model.

Table 1 also gives descriptive measures for the exogenous macroeconomic variables

Table 1: Descriptive statistics of monthly interest rate series for treasury bills (r_τ) at maturities $\tau = 91, 182, 364$ and time series length $(T = 103)$ as well as the included macroeconomic time series.

Series	Mean	Variance	Min	Max
$r_{\tau=91}$	10.21	21.92	2.49	16.45
$r_{\tau=182}$	10.93	17.41	3.38	16.48
$r_{\tau=364}$	11.38	16.54	3.63	16.50
Policy interest rate	12.77	10.57	7.50	17.50
Inflation	6.87	19.78	1.12	17.08
Exchange rate (MZN/USD)	28.60	10.58	23.77	37.22

Table 2: Autocorrelation functions for the first differences of monthly interest rate series for treasury bills at maturities $\tau = 91, 182, 364$. The s.e. of estimated coefficients is about 0.095.

Lag	Autocorrelations		
1	0.131	0.375	0.500
2	0.160	0.306	0.330
3	0.307	0.217	0.313
4	0.261	0.219	0.319
5	0.054	0.191	0.222
6	0.222	0.170	0.158

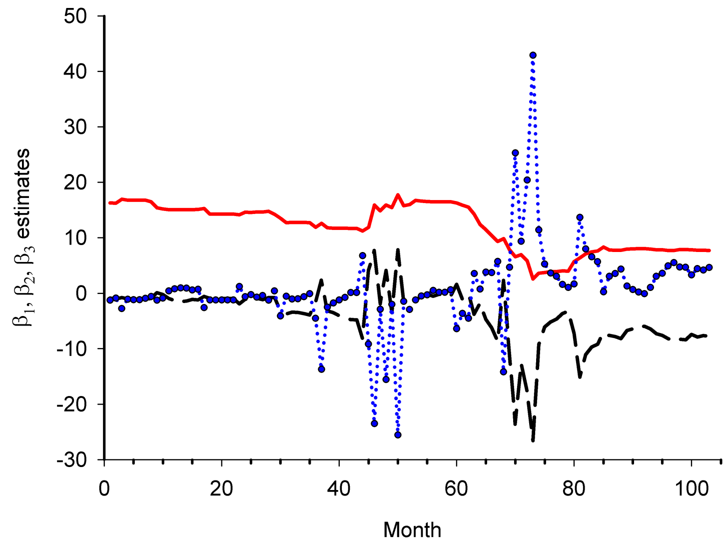

Figure 2: The OLS estimated $\hat{\beta}_{it}$ series, 2006:9 – 2015:3 $(T = 103)$, for maturities at $\tau = 91, 182, 364$. The solid line is for $\hat{\beta}_{1t}$, the dashed line for $\hat{\beta}_{2t}$, and the dotted line with circle marker for $\hat{\beta}_{3t}$.

that are expected to have explanatory power through the $\beta_{it}, i = 1, 2, 3$ parameters of the yield curve model. These variables also manifest sizeable serial correlations indicative of trending variables. This is also obvious from individual autocorrelation functions. Table 2 gives autocorrelation functions for the first difference of the interest rate series. It appears the autocorrelations are much larger for longer maturities.

Before we can estimate the β_{it}s of the yield curve model we need calculated values for $\lambda_{1\tau}$ and $\lambda_{2\tau}$ that serve as explanatory variables in regressions (1) or (2). For this, we employ the approach of Diebold and Li (2006) and maximise the medium-term curvature $\lambda_{2\tau}$ at $\tau = 91$ days to get $\lambda = 0.01971$. The $\tau = 91$ day treasury bills are the most traded ones. The $\lambda_{i\tau}$ functions are displayed in Figure A in the Appendix.

6 Results

The starting point is to present the results for the yield curve model without macroeconomic variables, cf. (1), and then the results for the yield curve with macroeconomics

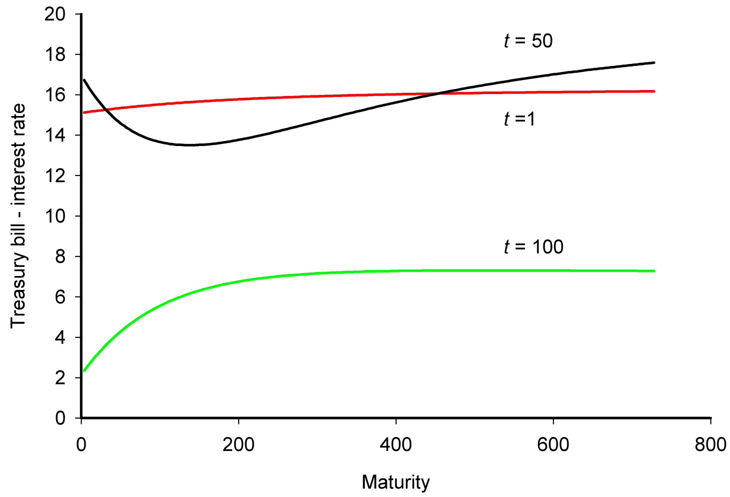

Figure 3: Three illustrative yield curves.

variables, cf. (2) follow. We depict the first phase estimation results of β_{1t}, β_{2t} and β_{3t} across all time periods in Figure 2. The sizes of $\hat{\beta}_{1t}$ and $\hat{\beta}_{2t}$ decay with time, while the pattern for $\hat{\beta}_{3t}$ is more mixed and also quite volatile in some periods. The long-term interest rate corresponds to $\hat{\beta}_{1t}$ and it is decaying across time. The estimation results are conditional on the λ-value discussed in the previous section and the model in (1) is estimated by OLS at each t. Note that at each time t, there are three unknown parameters and three maturities so there is a perfect model fit to the observations.

Figure 3 displays three estimated yield curves based on estimates from Figure 2 that not only contain the observed maturities (91, 182 and 364 days), but also give estimated interest rates both between and beyond these maturities. The figure shows that the features of the yield curve for Mozambique have changed across time during the sample period. It went from a flat curve in early 2006 to a normal curve in early 2015. This is an indication of changing market conditions in the studied period. Indeed, as pointed out by (Diebold and Rudebusch, 2012) a key yield curves fact is that they move across both maturity and time.

The empirical procedure uses, as a first step, these $\hat{\beta}_{it}$ estimates of Figure 2 as dependent variables in regressions on the macroeconomic variables discussed above. In

Table 3: Regression estimates (OLS) for yield curves of monthly interest rates of treasury bills series at maturities $\tau = 91, 182, 364$ (sample size $n = 303$). The s.e. of parameter estimates is from a Newy-West estimated covariance matrix (lag = 18) and significance at the 5 percent level is indicated by a *.

Variable	Estimate	s.e.
	β_1 estimates	
Policy rate$_t$	1.008*	0.293
Policy rate$_{t-2}$	-0.455	0.360
Inflation$_t$	0.134	0.141
Inflation$_{t-2}$	0.239	0.126
MZN/USD$_{t-1}$	-0.217*	0.091
Constant	8.403*	3.651
	β_2 estimates	
Policy rate$_t$	0.556*	0.069
Constant	-11.071*	1.315
	β_3 estimates	
Constant	0.866	1.648

each case up to two lags of the macroeconomic variables are considered for inclusion. Retaining only the significant variables we use them to, in a second and final step, estimate model versions of the type in (2) by OLS. The benefit of using (2) is that the testing of parameters is feasible in a standard way.

The estimation results based on all observations[1] and the model in (2) are presented in Table 3. The explanatory power of the fitted model is quite high, $R^2 = 0.86$, but there are sizeable serial correlations remaining in the residuals for each τ. To account for these serial correlations we employ a Newey-West covariance matrix estimator for the standard error of the OLS estimator. We retain all variables that were significant when

[1] $n = 303$, i.e. there are three maturity series, $T = 103$ time series observations and maximally two time lags.

using the OLS standard errors.

The policy rate has a significant and enhancing direct but small effect on the long and short-term interest rates through the β_{1t} and β_{2t} parameters, respectively, but not on the medium-term parameter β_{3t}. This result allows us to conclude that, although with a small size, the policy rate in Mozambique succeeds in influencing the short and long-term interest rates. However, β_{1t} is larger than β_{2t}, suggesting the magnitude of the impact of changes in policy rate increases with maturity. Inflation seems to impact positively the long-term interest rates but its effects are insignificant.. The MZN/USD exchange rate has a long-term lagged and negative effect. There is no significant medium term effect as seen from the insignificant constant in β_{3t}. These results then suggest that although there is a significant link between the policy rate and the treasury bill yield curve (money market), the pass-through of the policy rate seems to be slow. In fact, by calculating pass-through as explained in Section 4 using the parameter estimates of Table 3 and with δ set smaller than 0.2 indicates that pass-through speed is slow, i.e. changes in policy takes more 364 days to impact the treasury bill rates.

Figure 4 illustrates the evolution of the effects of increasing the policy rate over time. The results suggest that the effect of increasing the policy rate is diminishing over time. This means that the effect of policy rate get smaller along time.

7 Concluding Discussion

This paper applied a factor decomposition approach to study the effectiveness of the monetary policy of Mozambique. First, we found evidence of a link between the policy rate and the yield curve. These results are in line with those found in other studies by Baker and Meyer (1980I, Cook and Hahn (1988), Loey (1985), Glick and Leduc (2012) and Aazim and Coora (2012).

The results also indicate that the policy rate affects the interest rate pass-through but that this transmission from short-term to long-term maturities on yield curve is weak and slow. Thus, the finding of Rungo and Manjate (2011) and Massarongo (2012) receives support from the current and different approach. As expected, the sizes of $\hat{\beta}_{it}$s decay with maturity. This result is in line with the literature (e.g., Roley and Sellon Jr,

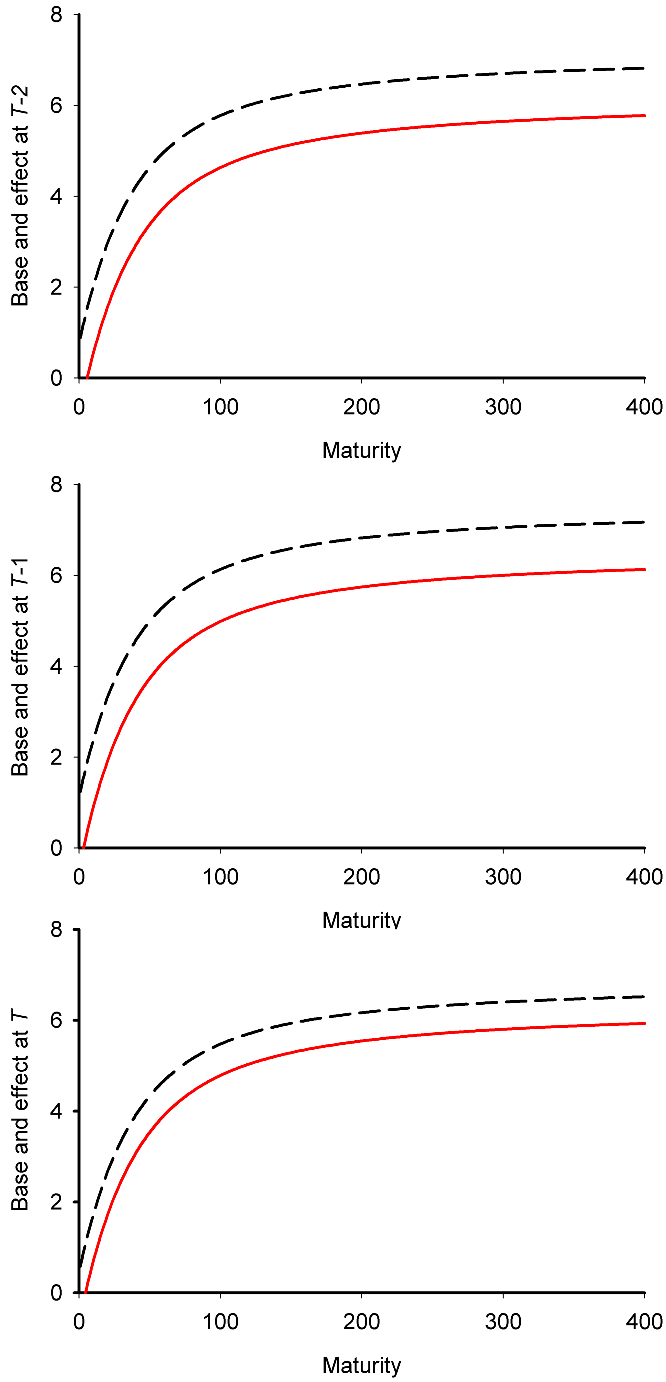

Figure 4: Estimated effects of a sustained unit increase in the policy rate (dashed lines) over the final three time periods in the sample with model (eq. (4)) fitted interest rates (solid lines) across maturities.

1995, Demiralp and Yilmaz, 2012, Aazim and Rhodes, 2011, and Diebold and Li, 2006).

Compared to some previous yield curve studies (e.g., Diebold and, Li, 2006) the maturities of this study are few in number and all within one year, while in some studies there are more maturities of which some may even extend up to 30 years. Therefore our use of short, medium and long-term interpretations of the β_{it} parameters needs to be understood in the light of the restrictions of our data. There are two additional consequences arising from the use of our type of dataset. First, the constant λ for the $\lambda_{i\tau}$ functions is smaller than used in other studies. One implication is that the λ_{it} functions are very close for $\tau > 200$ and as a consequence multicollinarity may be a problem when estimating eq. (2). The second problem arising from few maturities is that the OLS estimated $\hat{\beta}_{it}$ series are less efficiently estimated. The substitution and full re-estimation using eq. (2), at least, partly circumvents this problem.

Another aspect of the few and close maturities and the static specification with respect to the dependent variable is that one can expect to find remaining serial and cross correlations in OLS residuals. We choose to avoid specifying a three-variate dynamic model for the residual vector and hence also abstain from using a feasible GLS estimation approach.

Appendix

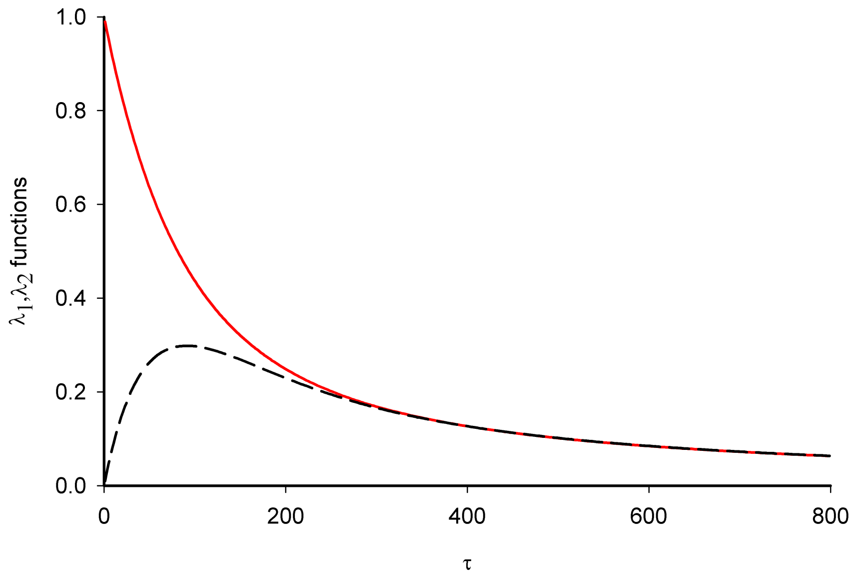

Figure A: Yield functions $\lambda_{1\tau}$ (solid line) and $\lambda_{2\tau}$ (dashed line) for fixed $\lambda = 0.01971$.

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