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Monetary and Fiscal Policies and the Dynamics of the Yield Curve in Morocco

by Calixte Ahokpossi, Pilar Garcia-Martinez, and Laurent Kemoe

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Abstract

We estimate the latent factors that underlie the dynamics of the sovereign bond yield curve in Morocco during 2004–14 based on the Dynamic Nelson-Siegel model. On this basis, we explore the interaction between macroeconomic variables and the yield curve, which is of direct relevance to macroeconomic policy-making. In Morocco's context, we find that tighter monetary policy increases short-end maturities, and that the impact is small and short-lived. Economic activity is also briefly but significantly impacted, suggesting that even under a pegged exchange rate, monetary policy autonomy and effectiveness can be increased through greater central bank independence. Fiscal improvements significantly lower yield levels. Policy conclusions are that improvement in the fiscal and monetary policy frameworks, as well as greater financial sector development and inclusion, could benefit Morocco and strengthen the transmission mechanisms and effectiveness of macroeconomic policies.

JEL Classification Numbers: G12; E43; E44; E58

Keywords: Yield curve; interest rates; government bonds; Morocco.

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I. INTRODUCTION

In the past two decades, Morocco's sovereign debt market has deepened and diversified, and the dynamics of its sovereign yield curve has changed. In parallel, the monetary, fiscal and debt management policy frameworks went through major improvements. This paper investigates the relationship between changes in the macroeconomic environment and the yield curve, and aims to inform decisions with regard to further changes in Morocco's policy frameworks.

The Moroccan authorities have expressed an intention to move to a more flexible exchange rate regime over the medium term. This entails a shift in the monetary policy regime away from the exchange rate anchor and toward an inflation targeting framework. A good understanding of how effective a monetary policy centered on interest rates is therefore essential. It is also important to assess the impact of the broader macroeconomic policy environment, and indeed, changes in the fiscal policy framework have taken place in the recent past, including the elimination of energy subsidies, or the adoption in 2014 of a new organic budget law which will considerably strengthen fiscal management. Exploring the yield curve dynamics can shed light on the environment in which the above policy changes are taking place and on possible implications for macroeconomic policymaking in Morocco going forward.

Specifically, modeling the yield curve and understanding its interactions with the macro-economy may bring several benefits for policymakers. First, it allows to better extract market expectations of future interest rates, inflation, and other macroeconomic variables. Second, knowing how interest rates respond to macroeconomic variables is key for policymakers, given the importance of the interest rate channel for monetary policy transmission. Finally, from a public debt management perspective, a better understanding of yield curve reactions may provide governments with additional tools to adjust the public debt structure in order to manage interest rate risks and potentially lower the debt burden.

The Moroccan economy provide an interesting macroeconomic environment that the literature has not covered yet. Indeed, Morocco is a small open emerging economy that pegs its exchange rate to a basket of two currencies (the U.S. dollar and the euro), and allows the exchange rate to vary within a band. Despite the fixed exchange rate regime, there is a degree of monetary policy autonomy due to the presence of controls on capital outflows for Moroccan residents.

In this paper, we model the yield curve in Morocco using the Dynamic Nelson-Siegel (DNS) model proposed by Diebold and Li (2006). The objective is to identify the key characteristics of the sovereign yield curve, specify a model that captures these characteristics, and explore how macroeconomic variables influence the interest rate dynamics along the curve.

Our model fits the data very well, and the results suggest that some features of the yield curve in Morocco are consistent with those documented in the literature, but others are not. For instance, we find that yield curve factors are highly correlated with each other, and thus are driven by common macroeconomic fundamentals.

Turning to assessing how macroeconomic variables influence interest rates, we use principal component analysis to extract five factors that best describe the dynamics of the sectors of the Moroccan economy and use these, along with the estimated yield curve latent factors, in a VAR model. We then use the VAR to investigate the transmission channels of shocks originating from monetary and fiscal policies.

Key results are as follows: First, a monetary policy tightening is shown to depress economic activity, and to somewhat lower short-end maturity yields; given the channels through which monetary policy transmits to other sectors, improving the financial sector is important to provide more monetary policy space for monetary authorities. Second, a fiscal improvement leads first, to a decline of short-end maturity yields, then to a decline of long-end maturity yields.

The remainder of this paper is organized as follows: section 2 presents a brief review of the literature on yield curve modelling in relation with macroeconomic variables.
Section 3 describes the domestic sovereign bond market in Morocco. Section 4 presents the DNS model, the VAR model, and the principal component analysis used to derive variables that best describe the dynamics of the four sectors of the economy. Section 5 presents the data, stylized facts regarding the yield curve in Morocco, the results of the DNS model, and how macroeconomic policy variables affect the dynamics of the yield curve. Section 6 concludes and provides some policy implications of our findings.

II. Literature Review

Over the last few decades, a lot of models have been developed to characterize the term structure of interest rates, i.e. the interest rates on bonds or assets of different maturities. From a financial point of view, interest rates in any economy should be driven by only a few latent factors. Building on this idea, a large literature in finance aims to characterize these latent factors (see Cox, Ingersoll and Ross, 1985; Nelson and Siegel, 1987, Dai and Singleton, 2000; Diebold, Piazzesi and Rudebusch, 2005, among others). However, this literature generally does not seek to analyze the macroeconomic fundamentals underlying these factors, unlike the macro-finance literature. The latter strand of the literature on yield curves seeks to link the above latent factors to specific macroeconomic variables and, therefore, investigate macro-financial linkages. Major contributions to this literature include

Evans and Marshall (1998), Ang and Piazzesi (2003); Rudebusch and Wu (2008), Piazzesi (2005); Diebold, Rudebusch and Auroba (2006), and Gurkaynak and Wright (2012).

In the first strand of the literature, two classes of models are of particular interest: Nelson-Siegel (NS) models and affine term structure (ATS) models. The original NS model (Nelson and Siegel, 1987) is very popular among market participants and central bankers. This model seeks to extract three unobserved factors that summarize the entire dynamics of interest rates of a given market. Some authors include observable macroeconomic variables in these models in order to reflect the importance of such variables for the pricing of assets (Ang and Piazzesi, 2003; Diebold et al., 2006). An important particularity of the original NS model is that factor loadings are fixed. By allowing these loadings to vary over time, Diebold and Li (2006), brought a major contribution; they imposed a structure on factor loadings, which permitted to have precise estimation of factors and also allowed them to interpret latent factors as level (long term factor), slope (short term factor), and curvature (medium term factor) of the yield curve. Their model has the ability to replicate a lot of key stylized facts of the US yield curves. Alves et al. (2011) also use the Dynamic Nelson-Siegel (DNS) model to reproduce stylized facts of Brazil's term structure and find that the model fits well the data. Kaya (2013) do the same exercise for the Turkish economy and find similar results.

On the other hand, ATS models are traditional models in the finance literature, among these are single-factor models, the model of Cox, Ingersoll, and Ross (1985) and multi-factor models. These models are mostly characterized by restrictions that are imposed in order to rule out arbitrage opportunities. No-arbitrage restrictions ensure that the dynamics of interest rates over time is consistent with the cross-sectional shape of the term structure, after accounting for risk (Diebold et al. 2005). As the NS models, they link the dynamics of the yield curve to a few number of factors. Diebold et al. (2005) provide an affine interpretation of NS; they show that the NS model doesn't impose dynamic consistency restrictions and provide conditions under which no-arbitrage conditions can be applied to the NS model.

Another part of the literature seeks to uncover the interactions between economic fundamentals and the yield curve since the models described above propose little or no insight about those interactions. Piazzesi (2005) explores the role of macroeconomic variables in a no-arbitrage framework. She finds that introducing economic variables, especially the Federal Reserve's interest-rate target, in an ATS model considerably lowers pricing errors. This implies that understanding how fundamentals influence the dynamics of the term structure of rates is important for the prediction of asset prices and for the determination of portfolio allocation choices of investors.

Diebold et al. (2006) allow macroeconomic fundamentals (real activity, monetary policy instrument, and inflation) to affect state variables (factors) in a state-space framework that they estimate using Kalman filtering. They find strong evidence of the effects of macroeconomic variables on future movements of the yield curve and evidence for a reverse influence as well. They also examine the correlations between estimated factors and fundamentals and find that the level factor and the slope factor are highly correlated with inflation and real activity respectively.

Using a recursive VAR framework, Evans and Marshall (1999) studied the extent to which movements of the yield curve can be explained by various economic fundamentals including monetary policy, inflation, and economic activity. They showed that monetary policy shocks have significant impact on short term rates. Later on (Evans and Marshall, 2007), they showed that macroeconomic shocks account for most of the variability of nominal Treasury yields, inducing parallel shifts in the level of the yield curve. However, they found little evidence that fiscal policy shocks are an important source of interest rate variability. Afonso and Martins (2010) also found that fiscal shocks have little impact on German and US yield curves.

Ang and Piazzesi (2003), Ang et al. (2004), and Piazzesi (2005) use a structural framework to investigate the linkages between economic variables and the yield curve, and find that both observable macroeconomic factors and latent factors affect the dynamics of the yield curve. In the first two papers, macroeconomic factors are measures of real economic activity and of inflation, both constructed as the first and second principal components of a large number of macroeconomic time series. The first paper shows that real activity shocks affect the medium end of the yield curve (curvature) whereas inflation shocks affect the entire yield curve (level). The third paper shows that monetary policy shocks affect the slope of the yield curve by moving short rates more than long rates.

III. Domestic Sovereign Bond Market In Morocco

Morocco's sovereign bond market is well developed and diversified, though not very liquid. Morocco's public debt is composed mainly of marketable debt (81 percent at the end of 2014), including 73 percent of Treasury bills issued in the auction market and 8 percent of Eurobonds issued in international market. The non-negotiable debt (19 percent of the Treasury debt portfolio) is composed mainly of foreign debt. Most of the outstanding negotiable domestic debt (80 percent) has maturities superior or equal to 5 years (namely 5, 10, 15, 20 and 30 years). The rest is divided into 16.4 percent of 2-year bills, 3 percent of 1-year bills, and 0.5 percent of 26 and 13-week bills. The negotiable foreign debt has maturities of 10 and 30 years. Most of the public debt is denominated in dirhams (76 percent). Interest rates have decreased over time, mainly due to improvements in public finances. At the end of 2014, the outstanding of the Treasury's debt with fixed interest rates represented 91.5 percent of the total treasury debt (of which 63 percent have rates between 4 percent and 6 percent, 35 percent have rates inferior to 4 percent and 2 percent have rates superior to 6 percent).

The domestic Treasury security market has considerably deepened over the last two decades The market for auctions of Treasury securities created in 1989 became the main source of financing the Treasury. The other administered domestic financing methods (mandatory deposits in the form of base government stocks, the national borrowings and bonds) were gradually phased out in the late 90s while advances by the Central Bank were gradually repaid from 2001 onwards and paid off in full in 2007. A decree authorizing the government to undertake active cash management was introduced in 2008, with the aim of optimizing the availability of government funds. Since then the government invests its cash surplus whenever it forecasts that available fund are greater than the necessary cash buffer.

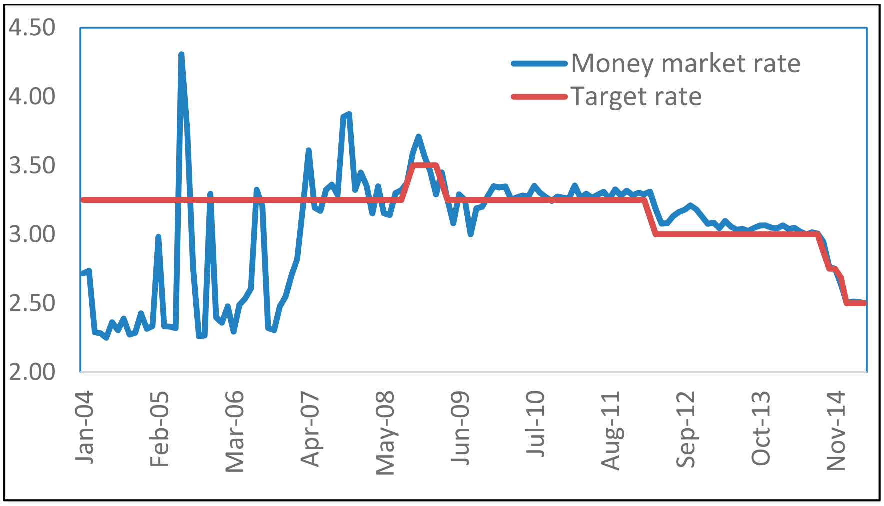
Debt instruments are sold through a bidding system. Since July 2009, a screen-based bidding and data transmission system is used to reduce delays. The screen-based system can also be used for buy-back, exchange transactions and for Treasury cash management transactions (inter-banking loans and borrowings and reverse repurchase agreements).

A new monetary operations framework for the central bank was established in 2006. The new law reinforced Bank Al-Maghrib's (BAM) independence in terms of monetary policy, and provided a legal basis for its responsibility over payment systems. The 2006 law established the bank as a public legal entity, controlled by the account commissioner, the government commissioner, and the Court of Account. The same year, another law expanded the jurisdiction of the banking law over certain institutions engaged in banking activities, redefined the roles of the National Council of Credit and the Committee of Credit Establishments, reinforced BAMs autonomy in banking supervision, and instituted a number of other measures covering the protection of clients of credit institutions and the treatment of credit institutions in distress. A new banking law was approved in November 2014 which further strengthens BAM’s supervisory and regulatory powers. A new central bank law to further strengthen BAM’s independence is in the process of being approved.

All these reforms have contributed to a better:

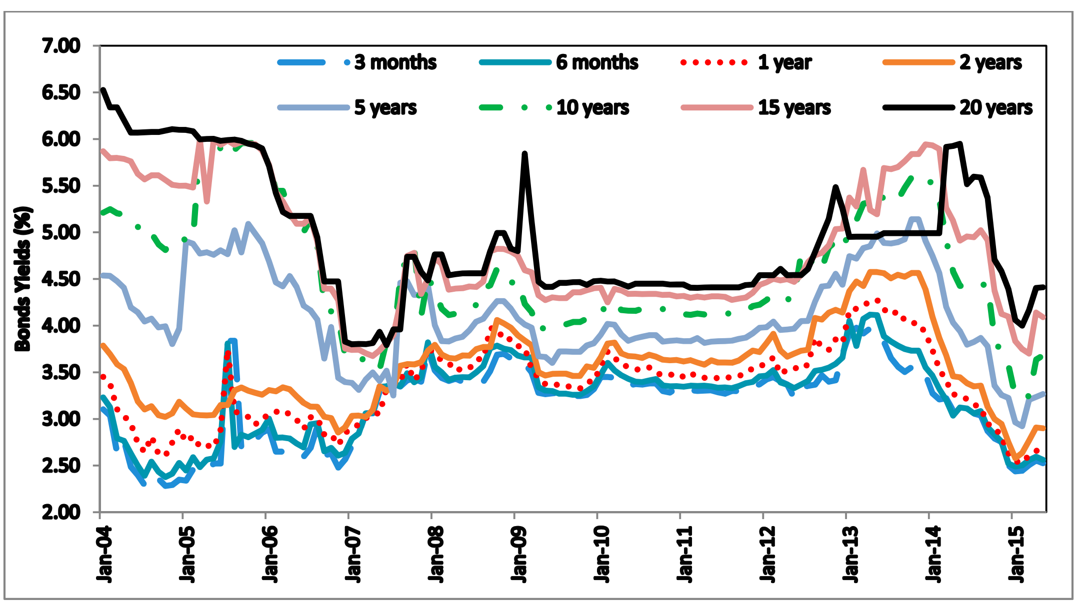
- Transmission of monetary policy to financial sector: the policy rate and the money market rate became gradually better aligned starting in 2007 and the latter became less volatile (Figure 1a).

Figure 1a. Policy Rate and Money Market Rate



- Functioning of the government securities market: interest rates differential between short and long maturities were reduced and a better co-movement of the interest rates of all maturities is observed since 2007 (Figure 1b). The decline in excess liquidity in the financial system contributed in part to this improved alignment of interest rates. In parallel, non-performing loans (NPLs) have declined consistently, from 11 percent in 2006 to 6 percent in 2008, before increasing to reach about 7 percent in recent years. The yield curve also displays the dynamic described above (Figure 2). The curve is steeper in early years, then becomes flat and lower in overall level, and steeper gain towards the end of the period.

Figure 1b. Bonds Yields at Different Maturities



IV. METHODOLOGICAL APPROACH

Our methodological approach consists of three steps. We first estimate the dynamic version of the Nelson-Siegel three-factor model proposed by Diebold and Li (2006). Second, we use principal component analysis (PCA) to estimate single factors that underlie the developments of each sector of the economy.[3] Finally, we use the factors estimated in the previous steps in a vector autoregressive (VAR) model in order to investigate the propagation of shocks originating from various sectors of the economy. This section describes the Dynamic Nelson-Siegel (DNS) model, the PCA, and the VAR. The description of the DNS model closely reflects that of Diebold and Li (2006).

A. The Dynamic Nelson-Siegel (DNS) Model

The dynamic version of the Nelson-Siegel (1987) model proposed by Diebold and Li (2006) has become very popular in the literature. They model the yield curve as a three-factor exponential approximation of the cross-section of interest rates at any moment in time. Let $\mathrm{y}_t(\mathrm{n})$ denote the n-maturity (zero-coupon) bond yield at time t. The DNS model is given by

$$y_t(n) = \beta_{1t} + \beta_{2t}\left(\frac{1 - e^{-\lambda_t n}}{\lambda_t n}\right) + \beta_{3t}\left(\frac{1 - e^{-\lambda_t n}}{\lambda_t n} - e^{-\lambda_t n}\right) \tag{1}$$

The parameter λ_t governs the exponential decay rate, i.e. the rate at which the loading of β_{2t} decreases to zero. Small values of λ_t produce slow decrease and leads to a better performance of the model in capturing the long-end of the yields curve. In contrast, large values of λ_t produce fast decrease and fits well the short-end of the yield curve. λ_t also determines the maturity at which the loading of β_{3t} reaches its maximum.

The parameters β_{1t}, β_{2t} and β_{3t} are dynamic latent factors interpreted as the level, the slope and the curvature of the yield curve, respectively. The loading on the level factor is one, meaning that a change in this factor equally affect yields of all maturities; this factor can therefore the interpreted as a long-term factor. The loading on the slope factor starts at one and monotonically decreases to zero; so, a change in the slope factor affects the short-end of the yield more than the long-end. For this reason, the slope factor can be interpreted as a short-term factor. Finally, the loading on the curvature factor starts at zero, increases, and then decreases to zero; it therefore only affect the middle-end of the yield curve. The curvature factor is therefore a medium-term factor.

Fixing the value of λ_t allows one to consider OLS as a way to estimate (1), especially when long time-series on yields are not available. It also allows to avoid the challenges posed by numerical optimization used when solving nonlinear least squares for each month. This

[3] We estimate two factors for the real sector: one for inflation and one for real activity.

approach, used by Diebold and Li (2006), is therefore the approach that we will use in the next section.

B. The Principal Component Analysis (PCA)

For parsimony reasons, we use PCA to extract the best information out of many fundamentals that describe the developments of each sector of the economy. As the DNS model, the PCA is also a factor model; i.e. its aim is to summarize the information included in a large set of variables in a few number of factors.

Let X_i denote a $T \times n_i$ matrix with rows corresponding to months and columns corresponding to indicators that characterizes the developments of n_i different aspects of the sector i of the economy. The PCA allows X_i to be written as:

$$X_i = F_i \Lambda_i + \eta_i \qquad (2)$$

where F_i is a $T \times k_i$ matrix of unobserved factors (with $k_i < n_i$), Λ_i is a $k_i \times n_i$ matrix of factor loadings, and η_i is a $T \times n_i$ matrix of white noise error terms.

We assume that for each sector of the economy, there is a single factor that summarizes most of the information included in X_i, i.e. $k_i = 1$[4]. We consider five sectors, namely real, external, fiscal, monetary, and financial. We distinguish between the monetary and the financial sectors in order to have a better understanding of the transmission mechanism of shocks. For the real sector, we estimate factors so as to capture inflation developments and real activity separately; the inflation series corresponds to core inflation. Further information about indicators used for each sector is provided in section V. below.

C. The Vector Autoregressive (VAR) Model

In order to analyze the effects of macroeconomic shocks on the yield curve in particular, and investigate how these shocks propagate to the Moroccan economy in general, we use a standard VAR model and the recursive identification scheme.

The variables in the VAR are the factors obtained using the PCA and the DNS model described above. Denote the vector of variables in the VAR by $Y_t = [Inf_t, Ext_t, Act_t, Fisc_t, Mon_t, Fin_t, Level_t, Slope_t, Curv_t]$. The first six variables in square brackets respectively describe inflation, external sector, real activity, fiscal sector, monetary sector, and financial sector developments as captured by the first principal components. The last three variables in the square bracket are respectively the level, slope, and curvature of the yield curve as estimated by the DNS model. The VAR model is given by:

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[4] If $n_i = 1$, $F_i$then $F_i = X_i$, Λ_i is diagonal matrix with ones on the main diagonal, and $\eta_i = 0$.

$$Y_t = C + \sum_{k=1}^{P} B_k Y_{t-k} + \varepsilon_t \tag{3}$$

where C is a (9×1) vector of intercepts, B_k represents the matrix of k^{th} order autoregressive coefficients, P is the optimal lag length, and ε_t is the vector of white noise error terms.

In order to identify shocks, we use the so-called recursive identification scheme; i.e. we order the variables from the most exogenous to the least exogenous (as presented in the vector Y_t), and use Cholesky triangular decomposition of the variance-covariance matrix. The reason for choosing this ordering of variables is that the most exogenous variables affect others contemporaneously, while the least exogenous variables affect others with a lag, due to the fact that it takes time for economic agents to react to economic developments and policy decisions. The factors of the yield curve are considered the least exogenous. Policy variables (fiscal and monetary) typically react to developments in the economy (inflation, external sector and the level of economic activity), but affect the financial sector and the yield curve almost instantly. Therefore, these policy variables are considered contemporaneously exogenous to the financial sector, but endogenous to inflation, economic activity and the external sector developments.

V. Results

We first present our data and some stylized facts on the actual yield curve data. Next, we present the results of our estimation of the latent term structure factors. Then outputs from the principal component analysis are discussed. Finally, we present the results of the VAR as well as the reaction of the yield curve to different shocks.

A. Data and Stylized Facts

We use monthly data on government bonds yields for 2004M01-2015M05. Ideally, we would use zero-coupon yield equivalent for bonds with coupons, but as in most emerging markets this is not available for Morocco (Bulíř and Vlček, 2015). This could hinder the estimations below. These data comprise 8 series on government bond yields of maturities: 3, 6, 12, 24, 60, 120, 180, and 240 months. Data availability drove the choice of the sample (both the cross-section and the time-series dimensions of our yield curve data). These data are collected from Bank Al-Maghrib.

Figure 2. The Yield Curve (2004-2014)

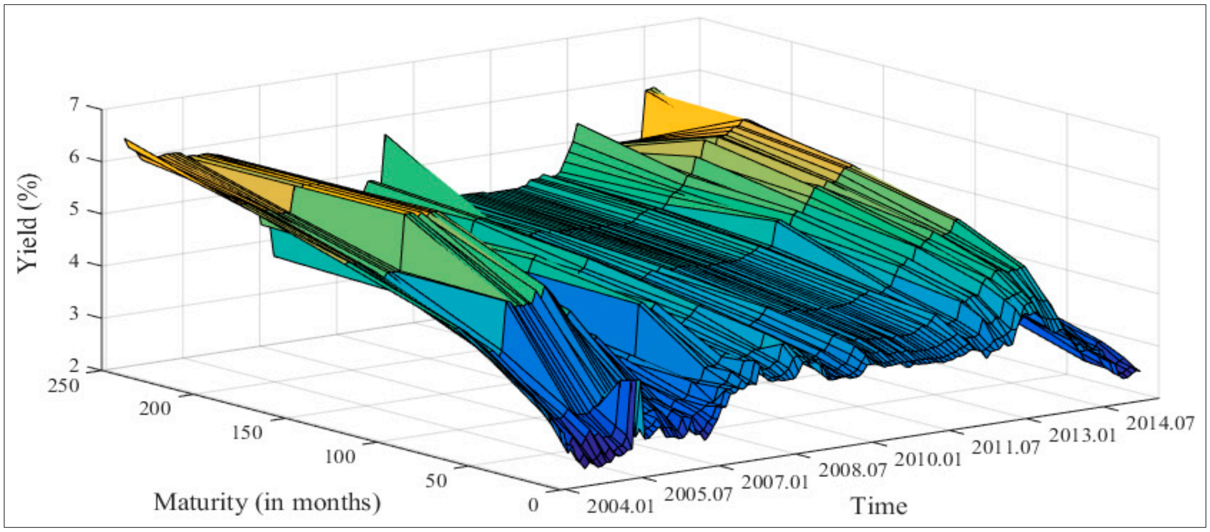


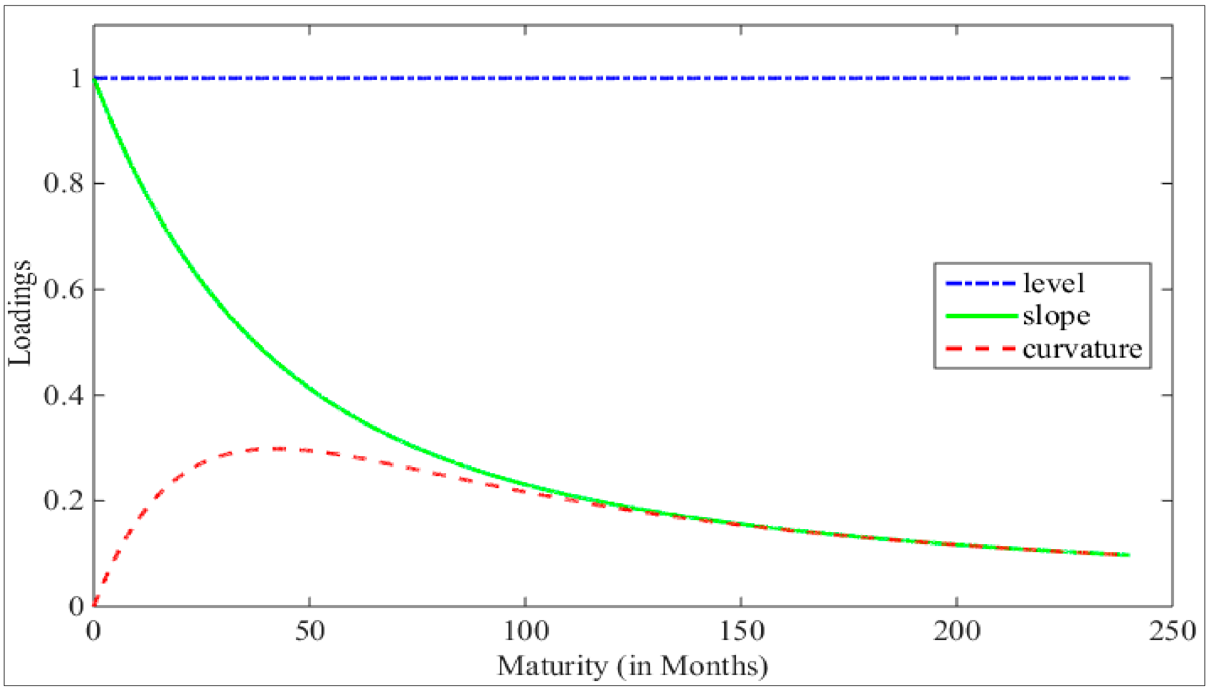
Figure 2 shows a plot where different patterns assumed by the actual yield curves in Morocco could be examined. It is visually apparent that within the 2004M01-2015M05 time span, the yield curve has varied a lot. Particularly, one can notice various episodes during which the level, the slope and the curvature of the yield curve have considerably changed. For example, the years 2004, 2013 and part of 2014 have been more characterized by the higher levels and more pronounced concavity of the curve whereas the remaining periods are characterized by more linear yield curves with lower levels. Figure 1b also makes apparent a lot of temporal variation in the slope of the yield curves.

The descriptive statistics of the yield curve appear in Table 1. Regarding the empirical yield curve factors, the curvature is more variable than the slope which, in turn, is more variable that the level. Both ends of the yield curve are equally variable relative to their means, as depicted by the coefficient of variation. Table 1 (last three columns) also shows that short and long maturities yield are more persistent than medium maturity yields. Unlike many findings in this literature, the empirical yield curve factors are highly correlated (Table 3); the correlation between the level and the slope and curvature are respectively -0.9 and -0.44, and the correlation between the slope and the curvature is 0.55. This suggests that these factors are influenced by common fundamentals.

B. Fitting the Yield Curves: The Dynamic Nelson-Siegel Model

Before presenting the results of our estimation, it is important to mention that since our estimation strategy is similar to that of Diebold and Li (2006), we had to set the value of the exponential decay rate, λ_t, prior to the estimation. Most of the papers in the literature choose λ_t so that the medium term (curvature) factor reaches its maximum between two and three years. Since our data include yields on government bonds of higher maturities than most of the papers in the literature,[5] we choose a value of λ that maximize the curvature factor at maturity 42 months, the average of middle maturities (2 years and 5 years). The corresponding value of λ is 0.0427. Diebold and Li (2006) set λ equal to 0.0609; Diebold, Rudebusch and Auroba (2006) estimate a value of 0.077. These imply that the curvature factor reaches its maximum respectively at 23 and 29 months. In contrast, Afonso and Martins (2010)'s estimate of λ is 0.03706, which corresponds to a curvature factor reaching its maximum at maturity 48 months. Figure 3 shows the latent factors implied by our choice.

Figure 3. Yield Curve Factor Loadings



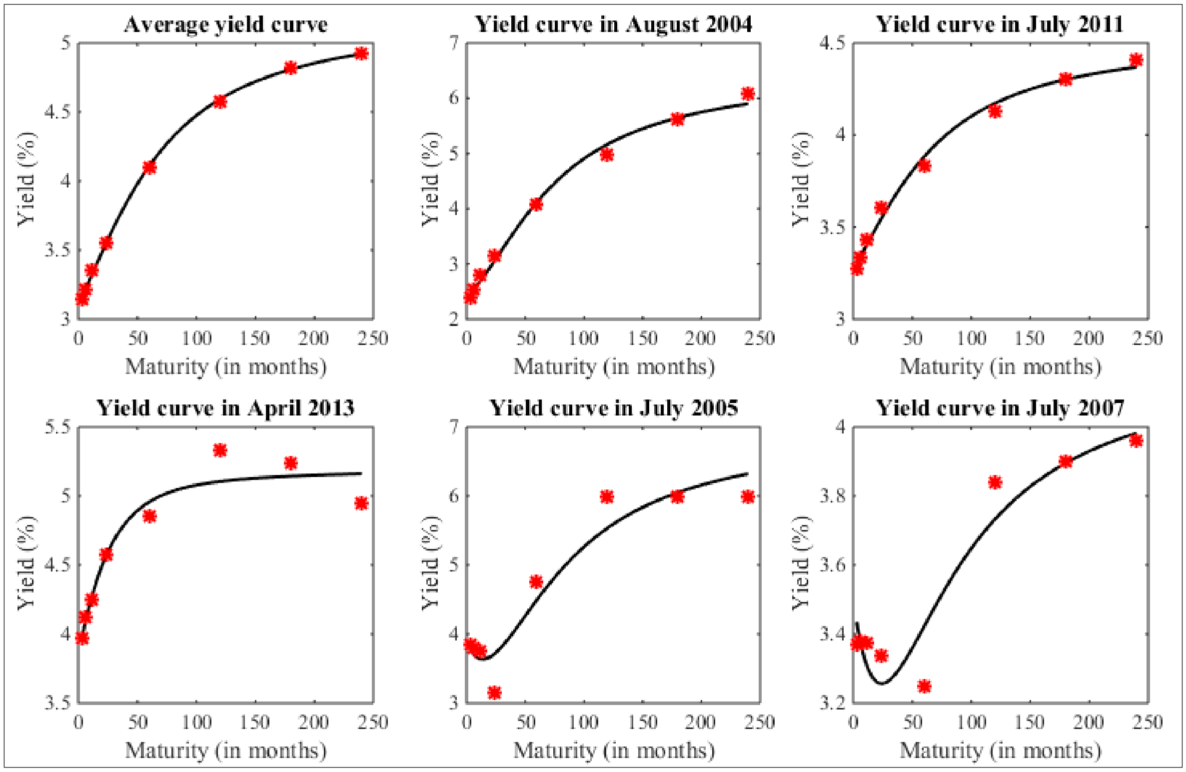
Model fits the data well

We assess the ability of our model to fit the data well by performing a number of exercises. In the top left panel of Figure 4, we plot together the average actual and the average fitted yield curves. Our model performs very well in fitting the average Morocco yield curve and replicates many other patterns assumed by the yield curve: the top middle and top right panels respectively show two months when the yield curves had high slope combined with high concavity, and low slope and low concavity as one can see in Figure 1a. The model replicates well the yield curves at these dates. However, the bottom panels of Figure 4 show that the model is less successful in replicating the shape of the yield curve when it displays

[5] Most of the papers in the literature estimate the DNS model on yield curve data with the highest maturities being 10 years.

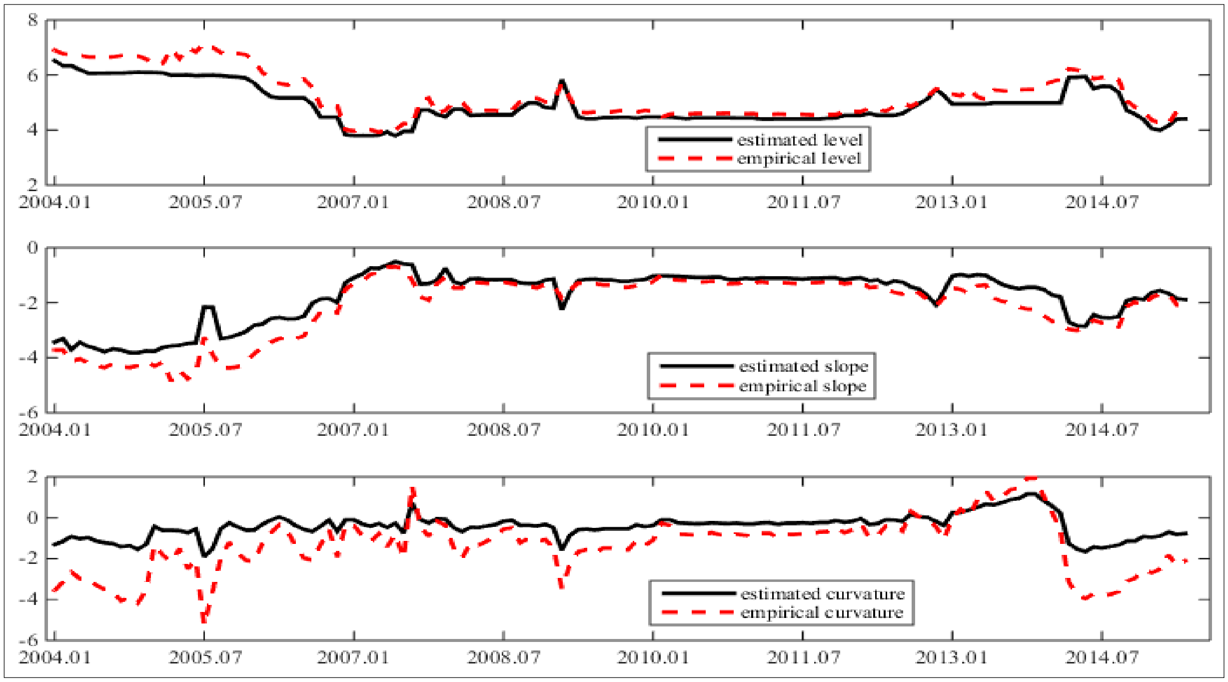
local minima and maxima, and when the slope changes across maturities; this pattern is also common in the literature (Diebold and Li amongst others).

Figure 4. Actual (Red Stars) and Fitted (Black Solid Lines) Yield Curves



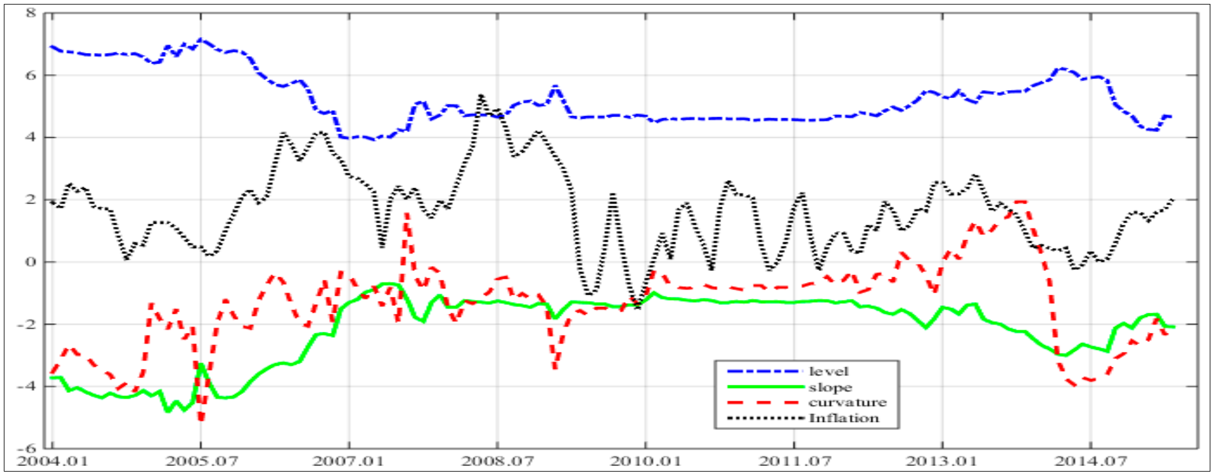
In order to provide additional information about the performance of the model, we present some descriptive statistics on yield curve residuals in Table 2. For each maturity, the residuals mean is very close to zero, indicating that the model fits the data very well. A well-known problem encountered by many authors when estimating the term structure of interest rates is the persistence of residuals; this happens regardless of the estimation method used (Bliss, 1997; Diebold and Li, 2006). The yield curve residuals that we obtain from our model also display such persistence as can be seen in the last three columns of Table 2, especially at the middle and the long end of the yield curve. This persistent discrepancy between actual and estimated yields is often considered as arising from liquidity effects; this might be particularly true in our case because not only are Morocco bills and bonds not very liquid in general, but also we include bonds of maturities up to 20 years in our model, although bonds of such maturities are usually relatively less liquid as compared to advanced markets.

Figure 5. Empirical and Estimated Yield Curve Factors



The good performance of the model is confirmed when we plot empirical and estimated yield curve factors in Figure 5. The empirical level is simply the yield on the 20-year maturity bond; the empirical slope computed as the term spread (the 3-month yield minus the 20-year yield); and the empirical curvature factor is computed as the sum of yields on extreme maturity bonds (3-months and 20-year) minus the sum of yields on medium maturity bonds (2-year and 5-year). The correlations between the empirical and the estimated yield curve factors are 0.97, 0.97, and 0.98 respectively for the level, the slope and the curvature factors (Table 3). However, the estimated curvature factor appears to be more volatile than its empirical counterpart.

Figure 6. Estimated Yield Curve Factors, and Inflation



Model replicates key stylized facts well

In Figure 6, we plot the estimated yield curve factors as well as the inflation time-series. The slope curve and most of the curvature curve are below the zero line underlying the fact that the yield curves are typically concave and upward slopping, confirming the stylized facts described above. As expected, the long term factor (level) appears to be smoother than the short and the medium term factors; this was also the case for empirical factors shown in the last three lines of Table 1. One can also notice that the level and the slope are highly negatively correlated (with a correlation coefficient of -0.94 as shown in Table 3). This means that high yield curve levels are associated with high slopes, and vice versa. Furthermore, this means that when the yield curve shifts (either upward or downward), the long end moves more than the short end, suggesting that inflation expectation may not be well anchored. The high correlation between the level and the slope of the yield curve also highlights the fact that these two factors might be driven by the same economic fundamentals.

Two of the stylized facts in the term structure literature are that (1) in high inflationary episodes, the level of the yield curve tends to increase, and to decrease when inflation is low, and (2) in periods of disinflation, the market risk associated to financial assets decreases and the long end of the yield curve shifts downwardly, often leading to downward sloping yield curves (Alfonso and Martins, 2010). These facts are not apparent in Figure 6. In contrast, the level of the yield curve has decreased during inflationary periods (e.g. from 2005 to 2006), and remained stable during periods of disinflation (e.g. from 2008 to 2013). Moreover, it is apparent that the evolution of the slope of the yield curve is not affected by that of inflation. This is confirmed by the analysis in the next section.

C. Yield Curve and the Macroeconomy

In this section, we analyze the relation that exists between macroeconomic fundamentals and the yield curve. In these analysis, we focus on the period 2007M01-2014M12, as a coherent dynamic of the government bond yields curve is observed only since 2007, following the central bank reform that took place in 2006.During that period, the central bank had more independence and monetary policy gained more credibility[6]. We first present the output from the principal component analysis and then, we show shocks to some of our variables of interest propagate and affect the yield curve.

Principal component analysis

Table 4 shows the indicators used to construct variables that capture the dynamics of each sector of the economy. The real sector dynamics is captured by two indicators: one that accounts for inflation and one for economic activity. All other sectors are captured by one indicator. We also do a distinction between the financial sector and the monetary sector, in order to have a deeper understanding of the transmission mechanisms of different shocks. The signs in parentheses in the second column of the table describe how the first principal component loads on each indicator.[7] The last column of the table shows that all factors explain more than two third of total variance. The monetary sector is described only by the money market rate whose movement is closely related to those of the main instrument of the central bank, the target rate. Besides, we transformed quarterly GDP growth series into monthly series using cubic splines interpolation, and divided annual series of government financing needs by 12 in order to have monthly approximates. Also, series used in the PCA differ from the original series in that the latter were demeaned and divided by their own standard deviation before being included in the PCA. More details on data definitions and sources are available in Table 7.

In order to get a preliminary insight into the relation between yield curve factors and macroeconomic variables, we show the correlations in Table 5. The table shows that these correlations are non-negligible, meaning that these variables affect each other. More specifically, we look at the correlation between sectoral indicators and yield curve factors. Improvements in the different sectors are often associated with lower levels of the yield curve. Since the level and the slope of the yield curve are highly correlated,[8] improvements

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[6] It could be interesting to do a comparative analysis of the implications of macroeconomic variables for the yield curve before and after the central bank reform. But due to data limitation (yield curve data before 2004 is not available as the secondary market data was first established and published in 2004), we cannot do such analysis.

[7] In some cases, data availability dictated the choice of variables used in the PCA.

[8] Remember that a negative value of the slope factor corresponds to an upward slope. So, the negative correlation between the slope and the level of the yield curve means that high slopes are often associated with

in the sectors will also be associated with lower slopes, meaning that the long-end of the yield curve decreases more than the short-end. The correlations with the curvature factor are small except with the fiscal indicator.

Impulse response functions

Table 6 reports the estimates of the VAR described in section IV. According to the Schwatz Information Critetion, the optimal lag length of the VAR is $P = 1$, so the total number of estimated coefficient is 90. Notwithstanding the limitations of VAR models in advanced countries with long time series and well-defined business cycles (Christiano, Eichenbaum and Evans, 1999), and in countries with relatively short series with potential structural breaks (Berg and others, 2013), the results presented below provide a good overall sense of the impacts of monetary and fiscal policy shocks in Morocco. The focus on the period 2007–14 reduces the risk of structural break in the data. While there may also be some serial correlation in the residuals, we do not expect this to be a major problem for the results, which are in line with the circumstantial evidence of recent monetary policy actions presented below.

For the impulse response, we are interested in the propagation of shocks originating from two sectors of the economy, namely monetary and fiscal. The figures shown below depict these effects. Given the short sample length, we used two thousand bootstrap replications of the VAR(1). The solid lines represent the median impulse responses to a one standard-deviation shock to the variables of interest, and the gray shaded areas represent the two standard-deviation confidence band from the bootstrap.

Monetary policy shock

Morocco has a fixed exchange rate regime, but the presence of controls on capital outflows gives some room for monetary policy to be autonomous. The analysis in this section should be interpreted in light of this fact. Figure 7 shows the effect of a monetary policy tightening on our variables of interest.[9] First, monetary policy tightening lowers outpout and this reaction could be attributed to the effect of the tightening on credit to the economy. The tightening of monetary policy does not lead to a significant decline of inflation. This could be due to the fact that inflation is very stable in Morocco and does not appear to significantly react to monetary policy in any direction. With the possible abandon of the peg in the near future, inflation might become more volatile and inflation targeting would anchor monetary policy.

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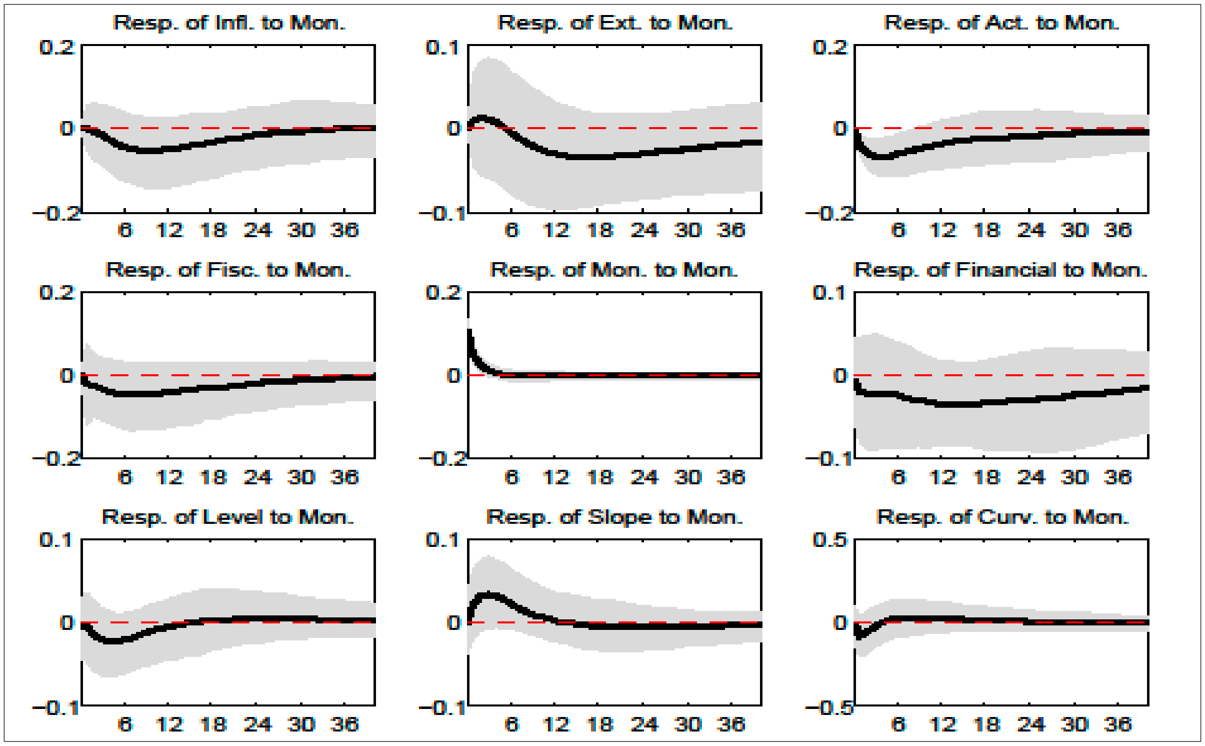
high level and vice versa. The same reasoning applies of the entire paper, in particular for impulse response analysis below.

[9] In Figure 7, infl=inflation, Ext=external sector, Act=economic activity (output), Fisc=fiscal policy, Mon=monetary policy. See Table 4 for detailed content of the variables.

Figure 7. Impulse Response Functions: Monetary Policy Tightening



While the impact of monetary policy tightening on the yield curve is not significant with 95 percent confidence, a non-negible impact on the slope is perceptible for the first 12 months. Over that period, the slope of the curve decreases, thereby flattening the yield curve, as the yields of short maturities increase. The level of the curve is also somewhat lower, which could reflect the anticipation of a significant decline in growth.

In short, the monetary shock has a short-lived impact on output, and leads to a perceptible (though not significant with 95 percent confidence) movement in short maturities. The effects on economic activity suggests that notwithstanding the peg of the Moroccan dirham to the euro and the U.S. dollar, monetary policy in Morocco is somewhat effective in part due to controls on capital outflows. A close look at the last two episodes of monetary policy rate adjustment by BAM shows that changes in the policy rate affect credit growth. Monetary policy loosening in September and December 2014 transmitted essentially through lower lending rates and deposit rates and the former resulted in higher credit growth (BAM, 2015a, 2015b). The impact on credit was small and seemed to subside after one quarter, except for consumer credit which was a little more persistent. The weakness of the transmission of lower lending rates to credit was mostly due to soft demand for credit.

This information, coupled with the fact that financial inclusion is limited in Morocco (Sahay et al 2015), suggests that greater financial sector development and access to credit could provide conditions for better monetary policy transmission. In addition, more exchange rate flexibility, as envisaged by the Moroccan authorities, will also reinforce the capacity of monetary policy to impact the economic cycle. Bulir and Vlcek (2016) show that long maturities in inflation-targeting advanced economies are anchored by credible inflation targets and do not react to policy shocks. They also show that exchange rate or money targeters in their sample (including Morocco) may not have complete control over the short end of their yield curve. This suggests that if Morocco introduces a more flexible exchange rate and an inflation forecast targeting (IFT) regime, its long maturities may be better anchored by a credible inflation target, while the short end of the yield curve could become more sensitive to the monetary policy rate.

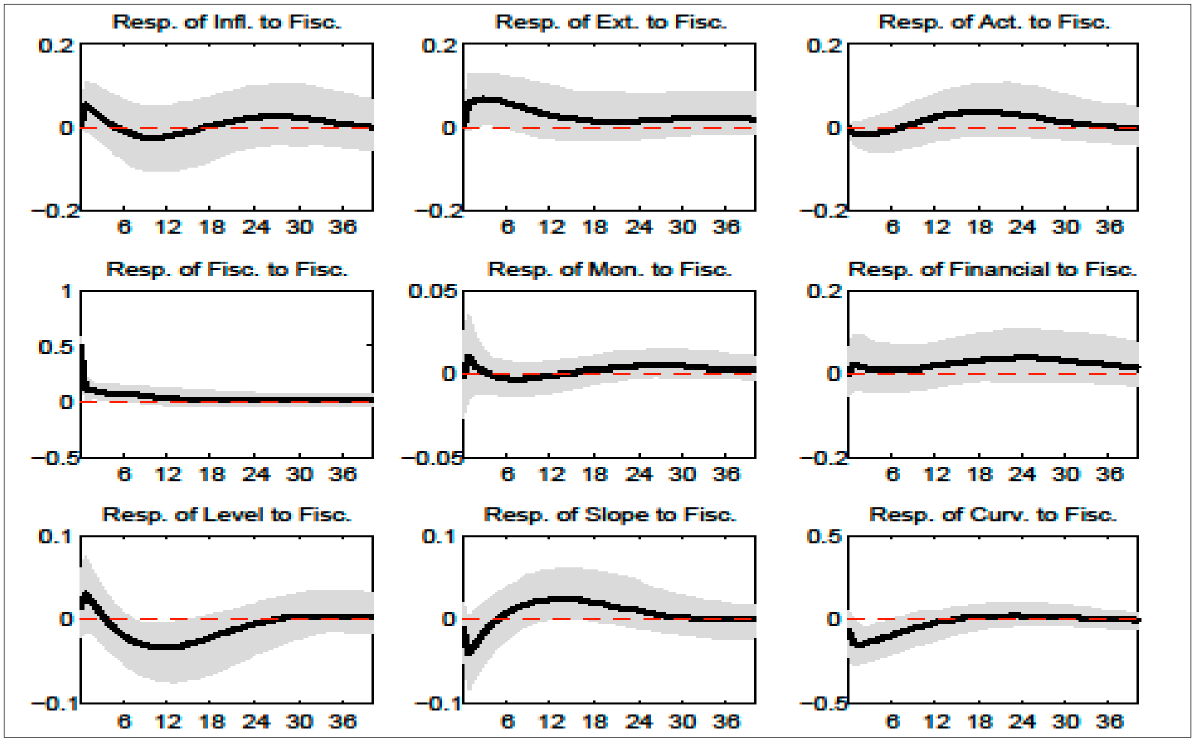
Fiscal shock

A non-permanent fiscal shock (lower deficit, less fanincing needs or lower default risk) affects the level, slope and curvature of the yield curve. The impact can also be analyzed in three phases. During the first phase (up to 6 months), it is not possible to reject with 95 percent confidence the hypothesis that the level of the curve is unchanged relative to the baseline. At the same time the slope and the curvature rise. The dynamic of the level and the slope implies yields at the shortest maturities fall and long-end yields increase. The fact that the curvature is increased (at 95 percent confidence) further supports the conclusion that long-end maturities increase during the first phase. In the second phase (6–18 months), the level and the slope fall below their baseline values, implying that average maturities are lower and long-end maturities fall more than the shortest maturities, which remain below their original values. In the last phase (beyond 18 months), it is not possible to reject the hypothesis that the yield curve has returned to its initial shape, i.e, the original level, slope and curvature. Overall, an improvement in the fiscal position leads to a fall in short-maturity yields, then to lower long-end maturity yields. Beyond 18 months the yield curve seems to return to its pre-shock shape. The dynamic of the yield curve is broadly consistent with the cross-correlograms (Figure 8), indicating that fiscal policy leads the slope and level by 8-10 months. No significant impact on other macroeconomic variables is observed, even though there are perceptible improvements in the financial sector (perhaps reflecting a crowding in of the private sector) and in growth 6 to 24 months after the shocks.

The results are supported by the Moroccan Ministry of Finance's report on debt (Ministère des Finances, 2015), which attributed the lower rates paid on treasury securities in 2014 in part to the improvement in the fiscal deficit, which lowered the government financing needs.

Overall, the lack of persistent reaction to a one-time fiscal shock could be due to anticipation by agents that the impact of the shock will be short-lived. If the shock is due to a structural change (such as measures to reduce subsidies) that will keep expenditure low in the future, agents will anticipate a long-term decline in government financing needs. This would bring the yield curve down durably.

Figure 8. Impulse Response Functions: Fiscal Shock



Interaction of fiscal and monetary policy

The results above (Figure 7)[10] show that fiscal policy does not trigger a significant reaction of monetary policy in Morocco, in line with the absence of significant concerns about fiscal dominance. However, fiscal developments have bigger impacts on the yield curve. This is supported by evidence during 2012–13, when the fiscal position substantially deteriorated and growth slowed at the same time. The deterioration of the fiscal position pushed the yield curve higher, the slowdown of growth prompted the central bank to lower its policy rate, which in turn lowered somewhat the shortest maturity yields. Maturities as a whole came down substantial only after the improvement in the fiscal sector (Figure 1b). The fiscal deterioration in 2012-13 was mainly due to a subsidy system which could not be sustained with unexpected oil price increases, and also to weaknesses in the fiscal framework. The energy subsidy reform and the approval of the new organic law helped contain fiscal concerns by reducing vulnerabilities and improving public budgetary management.

[10] In Figure 7, infl=inflation, Ext=external sector, Act=economic activity (output), Fisc=fiscal policy, Mon=monetary policy. See Table 4 for detailed content of the variables.

VI. Conclusions and Policy Lessons

Improvements in the monetary policy framework as well as in the fiscal/debt management over the last decade have helped improve the functioning of the government security market, as demonstrated by the tighter range of interest rates at short and long maturities. The Dynamic Nelson-Siegel model provides a very good fit of the yield curve for Morocco and reflects the changes in the policy framework described above.

A VAR estimation suggests that policy transmission channels are effective, however, the impacts of monetary policy on the yield curve and economic activity are short-lived. The degree of monetary policy autonomy provided by the existence of capital controls was enhanced by the improved credibility of the central bank since the mid-2000s, and monetary policy tightening results in lower output and short-end maturity yields. Also, fiscal improvements lead to lower yields (first at short maturities, and then on long-end maturities).

Sustained improvements in the fiscal sector (such as the elimination of public subsidies and other reforms aimed at reducing fiscal vulnerability) have been and should continue to be important in order to strengthen macroeconomic policy transmission and effectiveness. The monetary policy framework should also keep improving so as to reinforce the credibility of the central bank, the anchoring of inflation expectations, and long-term yield stability. Such progress should be supported by a possible move to a flexible exchange rate and inflation targeting. Inflation targeting with clearly communicated objectives can help reinforce the credibility of the central bank, particularly when Morocco moves to a flexible exchange rate and inflation pressures possibly emerge. Finally, further financial sector development and soundness, including improved financial inclusion, could also help strengthen the transmission of monetary policy to the economy and the yield curve.

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APPENDIX. TABLES

Table 1. Descriptive Statistics, Actual Yield Curve

Maturity (Months)	Mean	Std. dev.	Coef. of var.	Min.	Max.	ρ(1)	ρ (12)	ρ (30)
3	3.149	0.436	0.139	2.284	3.977	0.911	0.334	0.078
6	3.212	0.430	0.134	2.377	4.118	0.917	0.346	0.058
12	3.358	0.429	0.128	2.529	4.278	0.946	0.268	0.062
24	3.557	0.443	0.125	2.580	4.574	0.974	0.188	0.005
60	4.101	0.498	0.121	2.923	5.140	0.925	-0.063	-0.074
120	4.577	0.672	0.147	3.221	5.996	0.957	0.159	-0.163
180	4.817	0.665	0.138	3.674	5.999	0.959	0.271	-0.286
240(Level)	4.929	0.685	0.139	3.791	6.526	0.952	0.430	-0.322
Slope	-1.780	0.928	-0.522	-3.813	-0.498	0.958	0.626	-0.185
Curvature	-0.419	0.579	-1.383	-1.912	1.158	0.839	-0.053	-0.002

Table 2. Descriptive Statistics, Yield Curve Residuals

Maturity (Months)	Mean	Std. dev.	Coef. of var.	Min.	Max.	ρ(1)	ρ (12)	ρ (30)
3	-0.012	0.087	-7.131	-0.166	0.682	0.408	-0.032	-0.101
6	-0.005	0.058	-10.956	-0.496	0.121	-0.004	-0.015	0.062
12	0.026	0.065	2.472	-0.231	0.227	0.373	-0.164	-0.082
24	-0.001	0.144	-111.267	-0.569	0.229	0.828	0.167	0.137
60	-0.007	0.118	-16.942	-0.175	0.471	0.651	0.178	0.194
120	-0.016	0.191	-12.153	-0.441	0.548	0.804	-0.021	-0.233
180	0.008	0.140	17.952	-0.492	0.492	0.682	-0.012	0.084
240	0.007	0.205	28.816	-0.539	0.681	0.776	-0.144	-0.135

Table 3. Correlations Between Factors

	Estimated Level	Estimated Slope	Estimated Curvature	Empirical Level	Empirical Slope	Empirical Curvature
Estimated level	1	-	-	-	-	-
Estimated Slope	-0.94	1	-	-	-	-
Estimated Curvature	-0.5	0.53	1	-	-	-
Empirical level	0.97	-0.89	-0.52	1	-	-
Empirical Slope	-0.9	0.97	0.63	-0.90	1	-
Empirical Curvature	-0.4	0.42	0.98	-0.44	0.55	1

Table 4. Sectoral Indicators: First Principal Components (PC)*

	Indicators Used	**% of Total Variance Explained by the 1st PC**
Inflation	Core CPI inflation (+)	-
Activity	GDP growth (+), credit to the economy (+)	89.08
External	REER(+) and Reserves in months of imports(+)	93.34
Fiscal	Primary fiscal balance (+), Financing needs (-), and 10-years government bonds spread over the US (-).	67.49
Monetary	Money market rate	-
Financial	Non-performing loans(-), return on assets (+), and liquid assets to total assets(+)	66.71

* An increase corresponds to an improvement, except for inflation for which it corresponds to a higher inflationary environment. Signs in parenthesis describe how the 1st principal component loads of the indicators.

Table 5. Correlation Between Macroeconomic Factors and Latent Factors

	Infl	**Act**	**Ext**	**Fisc**	**Mon**	**Fin**	**Level**	**Slope**	**Curv**
Infl	1.00								
Act	0.25	1.00							
Ext	0.37	0.69	1.00						
Fisc	0.38	0.79	0.72	1.00					
Mon	0.24	0.41	0.43	0.22	1.00				
Fin	0.50	0.79	0.77	0.63	0.57	1.00			
Level	-0.04	-0.52	-0.55	-0.41	-0.26	-0.53	1.00		
Slope	0.15	0.52	0.52	0.29	0.46	0.65	-0.90	1.00	
Curv	0.03	-0.22	0.08	-0.42	0.10	0.06	-0.20	0.29	1.00

Table 6. VAR Parameter Estimates

	Infl	Ext	Act	Fisc	Mon	Fin	Level	Slope	Curv
Infl(-1)	0.89***	-0.01	-0.01	0.15**	-0.01	0.00	0.00	0.00	-0.02
	(0.04)	(0.04)	(0.02)	(0.06)	(0.01)	(0.03)	(0.02)	(0.02)	(0.07)
Ext(-1)	-0.23***	0.82***	0.06**	0.35***	0.00	-0.02	-0.02	0.00	-0.10
	(0.06)	(0.06)	(0.02)	(0.10)	(0.02)	(0.04)	(0.03)	(0.03)	(0.11)
Act(-1)	0.08	-0.03	0.98***	0.29***	0.01	0.08*	-0.03	0.04	0.19*
	(0.05)	(0.06)	(0.02)	(0.09)	(0.02)	(0.04)	(0.03)	(0.03)	(0.10)
Fisc(-1)	0.11*	0.11	-0.03	0.28*	0.02	0.05	0.06	-0.08**	-0.21*
	(0.06)	(0.07)	(0.03)	(0.11)	(0.02)	(0.05)	(0.04)	(0.03)	(0.12)
Mon(-1)	0.03	0.12	-0.37***	-0.22	0.55***	-0.14	-0.01	0.18	-0.60
	(0.22)	(0.24)	(0.09)	(0.38)	(0.08)	(0.17)	(0.12)	(0.12)	(0.42)
Fin(-1)	0.08	0.09	-0.01	-0.03	0.02	0.90***	0.01	0.03	0.03
	(0.06)	(0.07)	(0.03)	(0.11)	(0.02)	(0.05)	(0.04)	(0.03)	(0.12)
Level(-1)	0.13	0.21	-0.21**	-0.79*	0.12	0.17	0.90***	-0.20**	0.70**
	(0.21)	(0.23)	(0.09)	(0.38)	(0.08)	(0.17)	(0.12)	(0.12)	(0.41)
Slope(-1)	0.16	0.14	-0.16*	-0.97**	0.12	0.28	-0.06	0.74***	1.15**
	(0.22)	(0.24)	(0.09)	(0.39)	(0.09)	(0.18)	(0.13)	(0.12)	(0.43)
Curv(-1)	0.00	-0.01	0.01	-0.22***	0.02	0.00	0.10***	-0.09***	0.64***
	(0.04)	(0.04)	(0.02)	(0.07)	(0.02)	(0.03)	(0.02)	(0.02)	(0.08)
C	-0.33	-1.17	1.96***	2.59*	1.05***	0.00	0.50	-0.11	-0.01
	(0.87)	(0.95)	(0.37)	(1.53)	(0.34)	(0.69)	(0.50)	(0.48)	(1.69)
R^2	0.94	0.94	0.99	0.85	0.65	0.97	0.88	0.90	0.77

Numbers in parentheses are robust standard errors.

*p < 10%. **p < 5%. *** p < 1%.

Sample period: 2007M01-2012M12

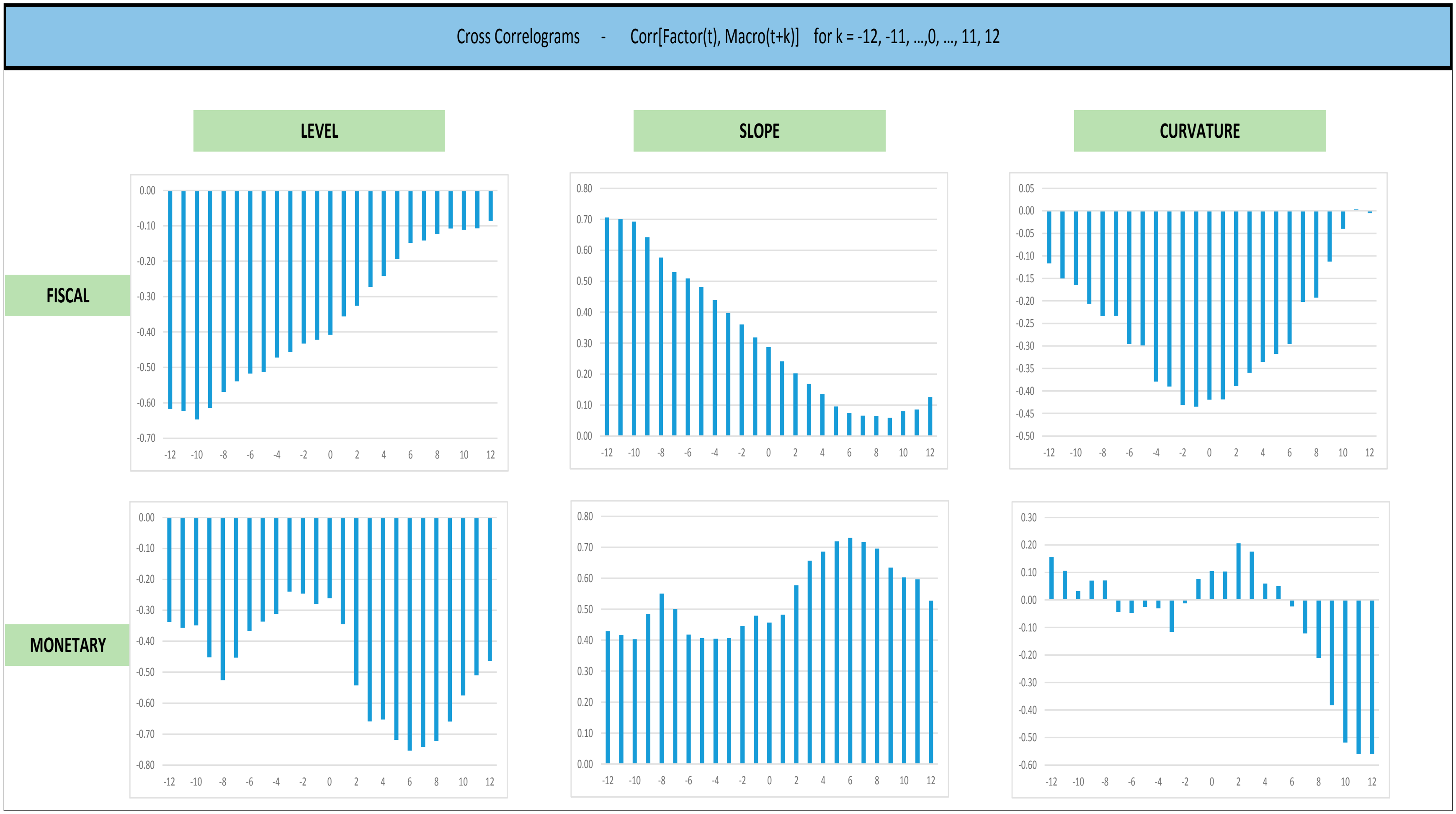
Number of observations: 96

Table 7. Supplemental Table: Data Definitions and Sources

	Indicators and definitions	**Sources***
Inflation	Core inflation Consumer Price Index (CPIX)	BAM
	GDP growth	IFS
Activity	Credit to the economy	FSI
	Real Effective Exchange Rate (REER)	Haver Analytics
External	Reserves in months of imports	IFS and DOT
	Primary fiscal balance	GFS
Fiscal	Financing needs	GFS
	10-years government bonds spread over the US	IFS
Monetary	Money market rate	BAM
	Non-performing loans (NPL)	FSI
	Return on assets	Bloomberg
Financial	Liquid assets to total assets	FSI

* IFS, FSI, GFS, DOT, and BAM respectively stand for: International Financial Statistics, Financial Soundness Indicators, Government Finance Indicators, Direction of trades, and Bank Al-Maghrib.

Figure 9. Cross Correlograms



ANNEX. FUNCTIONING OF THE DOMESTIC BOND MARKET IN MOROCCO

The Treasury conducts multiple price auctions on an electronic auction system according the following issuance calendar :

1st Thursday	2nd Thursday	3rd Thursday	Last Thursday
13 week	26 week	13 week	26 week
52 week	52 week	52 week	2 year
2 year	5 year	2 year	10 year
	15 year		20 year
			30 year (end of each quarter)

Source: Moroccan Authorities.

Since 1996, a Treasury Securities Intermediary (IVT) (primary dealership) system has been established to enhance participation in the primary market and ensure the liquidity of the secondary market. There are currently seven such intermediaries who have specific responsibilities that are also balanced with some privileges.

In October 2015, a new Treasury-Primary Dealers convention entered into force with the aim to foster the commitment of the Treasury Securities Intermediary (IVT) to contribute to the development of both primary and secondary markets. They are required to: i) achieve a minimum share of 8 percent in the quarterly issuances of the Treasury in each maturity segment (short, medium and long terms)); ii) participate in the secondary market as a counterparty for a minimum share of 8 percent of outright transactions; iii) firmly quote daily bid/offer prices on an electronic trading platform of at least five Treasury securities covering the three types of maturities (short, medium and long term); and iv) advise the Treasury on issues relating to market trends and development. In return for accepting these responsibilities, the IVTs are the privileged partners of the Treasury, have exclusive access to primary market and participate in monthly meetings. They are also allowed to make two kinds of non-competitive bids (NCB): NCB 1 (simultaneously with competitive bids auction), based on their performance in primary market for up to 10 percent of the securities awarded in competitive bids by type of maturity, 50 percent of which they can buy at the weighted average rate of price and 50 percent at the stop limit rate of price and NCB 2 (post-competitive bids auction) based on their performance in secondary market for up to 15 percent of the securities awarded in competitive bids by type of maturity which they can buy at the weighted average rate of price The secondary market for government bonds is developing, but market liquidity is relatively limited[11].

[11] For more details see African Central Government Debt 2014; The Statistical Yearbook or Morocco Debt Reporting 2014; and Documents Accompanying the Finance Bill 2016.