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The Indonesian macroeconomy and the yield curve: A dynamic latent factor approach

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ABSTRACT

We develop a fine representation of the term structure of interest rates in Indonesia and create a link between the yield curve and macroeconomic fundamentals. We construct a state-space representation of the yield curve as a function of three time-varying parameters: level, slope, and curvature factors. The model is then expanded to include three macroeconomic variables: real activity, inflation, and interest rates. We find that the dynamic latent factor model provides a very good fit to characterise the Indonesian yield curve in terms of the statistical properties for each maturity, and in terms of the properties of three latent yield-curve factors. With regards to the relationship to the macroeconomy, we find that there is a large amount of idiosyncratic variation in the yield curve movements. Therefore, macroeconomic variables can only explain small dynamics in the yield curve.

1. Introduction

This paper is the first to study the modelling of the term structure of the yield curve for Indonesian government securities and has two related purposes. First, we wish to develop a fine representation of the term structure of interest rates in Indonesia. Second, we are interested in investigating whether the underlying movements of the yield curve are related to macroeconomic fundamentals and vice versa. Most existing studies have generally focused on developed countries such as the US and UK, and little is known about the term structure of interest rates in emerging markets, especially those of Asian countries.

We are inclined to adopt the most recent tool in econometric modelling to capture the behaviour in the yield curve, rather than utilise a traditional approach, such as fitting the yield curve at a point in time with simple functional forms. For an example, see McCulloch (1971) and Nelson and Siegel (1987). An extension of the later approach was recently developed by Diebold and Li (2006), who specify the term structure of interest rates as a function of unobservable components. A further extension is continued by Diebold, Rudebusch, and Aruoba (2006) by complementing the unobserved factors in the yield curve with macroeconomic variables. We would like to test this latest methodology's ability to fit the Indonesian yield curve and capture the dynamics between the yield curve and macroeconomic fundamentals.

Our paper contributes to academic literature in three ways. First, the paper focuses on an emerging market case, in which it models and characterises the Indonesian government securities yield curve using one of the most modern and advanced

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tools. Second, it explores the dynamics of the bond market by investigating the role of macroeconomic variables in explaining movements in the yield curve factors. Third, it analyses whether the information contained in the yield curve can influence macroeconomic variables, especially in the context of monetary policy in Indonesia. Further, the originality of this paper lies to the fact that no previous study examines Indonesia employing the same methodology.

We first construct a dynamic Nelson–Siegel representation of the yield curve as a function of three time-varying parameters. The three parameters are able to capture the short-, medium-, and long-term factors that influence yield curve dynamics. The yield curve specification is then formulated in terms of state-space representation, which can produce a good dynamic forecast for complete term structure of interest rates, as reflected in the yield curve. To link the yield curve dynamics with the macroeconomic variables, the state-space representation is expanded to include three important macroeconomic variables: real activity, inflation, and interest rates. We then assess the causality between the macroeconomic variables and the bond market by examining impulse response functions and variance decompositions of transition equations in the state-space representation.

We find that the dynamic latent factor model provides a very good fit for characterising the yield curve in terms of the statistical properties for each maturity and in terms of the properties of the three latent yield-curve factors (level, slope, and curvature). Regarding the yield curve behaviour, macroeconomic variables can only explain small dynamics of the variations in the yield curve. We also find that long run inflation expectations, as measured by the level factor, tend to behave in a backward-looking manner. On the other hand, macroeconomic variables (monetary policy implemented by the central bank in particular) are significantly impacted by information from the bond market. The causality from yield factors to macro factors is primarily driven by the fact that changes in level of the yield curve impacts inflation through changes in monetary policy. This finding suggests that monetary policy plays a key role in driving this causality.

The remainder of this paper is organised as follows. The following section briefly outlines the state-space representation of the Nelson–Siegel factor model and its macroeconomic extension. Section 3 discusses the data on Indonesian government securities and the estimation results for the dynamic latent-factor model of the yield curve. The estimation results, impulse response functions, and variance decompositions for an extended yield-curve model with macroeconomic factors are discussed in Section 4. The final section concludes the paper and provides a policy recommendation.

2. Methodology

2.1. Nelson–Siegel yield curve representation

The foundation for the dynamic latent factor model used in this study is the Nelson and Siegel (1987) functional form, which is a parsimonious 3-component exponential algorithm. Diebold and Li (2006) reformulate the original Nelson–Siegel exponential expression for the yield curve as

$$y_t(\tau) = \beta_{1t} + \beta_{2t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + \beta_{3t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right), \quad (1)$$

where $y_t(\tau)$ is the continuously compounded nominal yield at maturity τ. The β_{1t}, β_{2t} and β_{3t} are time-varying parameters, and the parameter λ controls the exponential decay rate. Small values of the decay parameter λ, produce slower decay that better fit the longer term maturities, while large values produce faster decay that better fit the shorter maturities. The decay parameter also governs where the loading on β_{3t} reaches a maximum.

The three time-varying parameters can be interpreted as dynamic latent factors. The loading on β_{1t} is 1, a constant that does not decay to zero in the limit. An increase in β_{1t} increases all yields equally since the loading is identical on all maturities. Consequently, it is viewed as a *long-term factor* and is typically interpreted as the level (L_t) factor. The loading on β_{2t} is $(1-e^{-\lambda\tau})/(\lambda\tau)$, a function that starts at 1 and decays monotonically to zero. An increase in β_{2t} increases short yields more than long yields since the short rates load more heavily on β_{2t}, resulting in a change in the slope of the yield curve, defined as short-minus long-term yield. It is viewed as a *short-term factor* and is interpreted as the slope (S_t) factor. The loading on β_{3t} is $(1-e^{-\lambda\tau})/(\lambda\tau) - e^{-\lambda\tau}$, which starts at zero, increases, and then decays to zero. An increase in β_{3t} will have little effect on the very short and long yields, but will increase medium-term yields since they load more heavily on it. It may be viewed as a *medium-term factor* and interpreted as the curvature (C_t) factor. Thus, the interpretations of the three time-varying parameters allow us to respecify Eq. (1) to be as follows:

$$y_t(\tau) = L_t + S_t\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + C_t\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right). \quad (2)$$

The three time-varying latent factors L_t, S_t, and Ct, and the decay parameter λ are able to capture a variety of shapes of the yield curve through time, such as upward sloping, downward sloping, and inversely humped. The factor representation has the advantage of aggregating information from a large set of yields so that the representation does not depend on the set of yields chosen. L_t and S_t factors have intuitive interpretations and explanations, which relate their association to macroeconomic variables: the level has been typically associated with the long-run inflation expectations; the slope has been associated with changes in the risk-free interest rate and thus, the reaction of monetary policy to the cyclical state of the