The Long-Run Determinants of Indian Government Bond Yields

Tanweer Akram and Anupam Das*

This paper investigates the long-term determinants of the nominal yields of Indian government bonds (IGBs). It examines whether John Maynard Keynes' supposition that the short-term interest rate is the key driver of the long-term government bond yield holds over the long run, after controlling for key economic factors. It also appraises if the government fiscal variable has an adverse effect on government bond yields over the long run. The models estimated in this paper show that in India the short-term interest rate is the key driver of the long-term government bond yield over the long run. However, the government debt ratio does not have any discernible adverse effect on IGB yields over the long run. These findings will help policy makers to (i) use information on the current trend of the short-term interest rate and other key macro variables to form their long-term outlook about IGB yields, and (ii) understand the policy implications of the government's fiscal stance.

Keywords: government bond yields, India, interest rates, monetary policy
JEL codes: E43, E50, E60, G10, O16

I. Introduction

John Maynard Keynes (1930) contends that the central bank's monetary policy is the most important driver of the long-term interest rate. He believes that the central bank's actions influence the long-term interest rate primarily through the effect of policy rates on the short-term interest rate and other tools of monetary policy. In *The General Theory of Employment, Interest, and Money*, Keynes (2007 [1936]) reiterates the importance of the central bank's influence on the long-term interest rate, even though he acknowledges that interest rates have psychological, social, and conventional foundations, and arise from investors' liquidity preferences.

*Tanweer Akram (corresponding author): Director of Global Public Policy and Economics, Thrivent Financial, Minneapolis, United States. E-mail: tanweer.akram@thrivent.com; Anupam Das: Professor, Department of Economics, Justice, and Policy Studies at Mount Royal University, Alberta, Canada. E-mail: adas@mtroyal.ca. The authors' institutional affiliations are provided for identification purposes only. The views expressed are solely those of the authors and are not necessarily those of Thrivent Financial, Thrivent Asset Management, or any of its affiliates. This is for information purposes only and should not be construed as an offer to buy or sell any investment product or service. The authors would like to thank the managing editor and two anonymous referees for helpful comments and suggestions. The usual ADB disclaimer applies.

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This paper examines whether Keynes' supposition that the short-term interest rate is the key driver of the long-term government bond yield holds in India over the long run after controlling for various key economic factors, such as inflationary pressure and measures of economic activity. It also appraises if government fiscal variables, such as the ratio of government debt to nominal gross domestic product (GDP), have an adverse long-run effect on government bond yields in India. Akram and Das (2015a and 2015b) report that Keynes' conjectures hold in India for the short-run horizon. They also find that government fiscal variables do not appear to exert upward pressure on Indian government bond (IGB) yields. However, they do not examine if these results hold over a long-run horizon. This paper fills that critical lacunae.

Understanding the determinants of government bond yields in India over the long-run horizon is important not just for scholarly reasons but also for policy purposes and policy modeling, particularly for discerning the effects of fiscal and monetary policy on IGB yields. Understanding the drivers of government bond yields in emerging markets such as India has crucial implications for the government's fiscal and macroeconomic policy mix. It is also relevant for fixed income investment and portfolio allocation, as well as the management of government debt.

India's institutional features, its economic rise, and the evolution of its financial system make it worthwhile to examine the long-run trends in its government bond market. First, India's financial markets are in the development stage. While India has liberalized its economy and many aspects of its financial system, there are still various restrictions. Its bond market is not as deep as those of advanced capitalist economies such as Japan, the United Kingdom, and the United States (US). The country's banking system is dominated by state-owned or state-controlled financial institutions, and its fixed income investors in the local currency bond market are largely confined to investing in government securities since the depth and liquidity of corporate bonds and other fixed income securities are limited. It is, hence, appropriate to inquire whether Keynes' supposition regarding the link between the short-term interest rate and the long-term interest rate holds in the institutional and structural circumstances of emerging market economies such as India. Second, whether the central bank's setting of the policy rate(s) and other monetary policy actions influence the long-term interest rate over the long run in India has meaningful policy implications for monetary transmission mechanisms. If the evidence suggests that the central bank can decisively affect the long-term interest rate, not just in the short run but also over the long run, this would show that the Government of India has considerable policy space. If no such relationship can be established, then this would mean that its policy space is rather restrictive and narrow. Hence, it is important to examine what conjectures are empirically warranted in India and other emerging markets.

The paper is organized as follows. Section II sets the foundation for the empirical investigation. First, it discusses Keynes' view on interest rates and provides the theoretical framework. Second, it summarizes Keynes' stance on the loanable funds theory and explains why he rejects this theory. Third, it presents a simple two-period model of government bond yields. Fourth, it recounts the stylized facts about government bond yields and government debt ratios. Fifth, it briefly reviews the relevant literature on government bond yields in emerging market economies. Section III describes the data, the behavioral equations to be estimated, and the econometric methodology applied here. Section IV reports the empirical findings. Section V analyzes the policy implications of the results and concludes. Appendix 1 presents the details of the simple two-period model of government bond yields used in the paper. Appendix 2 presents additional regressions to examine the effects of credit growth, global investors' risk appetite, and the nominal effective exchange rate on government bond yields.

II. Theoretical Framework, Model, Institutional Background, Stylized Facts, and Brief Review of the Literature

A. The Keynesian Framework

This paper investigates the long-run determinants of IGB yields based on Keynes' (1930 and 2007 [1936]) views. Keynes holds that the central bank's actions play the decisive role in setting the long-term interest rate on government bonds (Kregel 2011). He argues against the classical view of interest rates based on the loanable funds theory as represented in Cassel (1903), Marshall (1890), Taussig (1918), and the classical economists.

The central bank's ability to influence the long-term interest rate arises from its ability to set the policy rate and anchor the short-term interest rate around the policy rates, and to use various other tools of monetary policy (Keynes 1930). He acknowledges that interest rates have a foundation based on human psychology, social conventions, herd mentality, and liquidity preferences (Keynes 2007 [1936]). Nevertheless, the most immediate and important driver of long-term government bond yields are the central bank's actions as manifested through its ability to (i) influence the short-term interest rate by setting the policy rate, and (ii) use a wide range of tools of monetary policy including expanding and contracting its balance sheet as it deems appropriate. Keynes relies on Riefler's (1930) pioneering empirical analysis of the behavior of interest rates on US government securities (Kregel 2011). He also observes that current conditions and the investor's near-term outlook affect the investor's long-term outlook. Keynes believes that since the investor does not have a firm basis for estimating the mathematical expectations of the unknown and uncertain future, the investor resorts to forming an outlook of the future based on past and current conditions. As a result, the factors that affect the short-term interest rate also affect the long-term interest rate.

Keynes' view on the drivers of long-term government bond yields is in contrast to that of conventional views in macroeconomics and finance. The conventional view is that government debts and deficits have a decisive effect on government bond yields. Other things held constant, if government debts and/or government deficits (both as a share of nominal GDP) increase (decrease), then government bond yields will rise (decline). This view relies on the loanable funds theory of interest rates. For Keynes, liquidity preferences and the central bank's actions are largely responsible for interest rates as manifested in the yield curve for gilt-edged (government) securities and other fixed income instruments in an economy.

Among others, Ardagna, Caselli, and Lane (2007); Baldacci and Kumar (2010); Gruber and Kamin (2012); Lam and Tokuoka (2013); Poghosysan (2014); and Tokuoka (2012) represent the conventional view. In contrast, Akram (2014); Akram and Das (2014a, 2014b, 2015a, 2015b, 2017a, 2017b, and 2017c); and Akram and Li (2016, 2017a, and 2017b) have argued that the short-term interest rate and pace of inflation are the key drivers of interest rates on government bonds. Moreover, they argue that if other things are held constant, the government fiscal variable has hardly any influence on government bond yields. This view is based on their interpretation of Keynes. It is supported with empirical work on the determinants of government bond yields in the eurozone, India, Japan, and the US. As mentioned earlier, Akram and Das' (2015a and 2015b) empirical work on India has merely explored the short-run dynamics. This paper examines whether the same hypothesis holds true for India in the long run.

B. Keynes' Stance on the Loanable Funds Theory of Interest Rates

Keynes rejected the loanable funds theory of interest rates. According to the proponents of this theory, the interest rate is primarily determined by the demand and supply of loanable funds. The loanable funds theory has a distinguished pedigree. It is endorsed in classical economics such as Cassel (1903), Böhm-Bawerk (1959), Hayek (1933 and 1935), Marshall (1890), Pigou (1927), Ricardo (1817), von Mises (1953), and Wicksell (1962 [1936]). Keynes rejects the loanable funds theory because he believes it is insufficient to determine interest rates solely on the basis of knowledge of the demand for investment and the supply of savings. He criticizes the loanable funds theory for neglecting the roles of national income, the marginal propensity to consume, and liquidity preference in the determination of interest rates. In his view, the "rate of interest is the reward for parting with liquidity for a specified time" (Keynes 2007 [1936], p. 167). It follows that the interest rate is "a measure of the unwillingness of those who possess money to part with their liquid control over it." Liquidity preference is quite central to Keynes' view on the interest rate. Liquidity preference arises from fundamental uncertainty about future economic and financial conditions, and the divergence among investors about their outlook for the future. Interest rates have institutional and behavioral foundations. Hence, for Keynes, institutions like the central bank and investors' psychology and social orientation, as manifested in herding and the formation of long-term expectations, play decisive roles in the determination of the interest rate, rather than just the demand and supply of loanable funds. The demand and the supply of loanable funds are outcomes of income, the propensity to consume, and liquidity preference, which occur within a context that consists of institutions, such as the central bank, and amid investors' psychology that is guided by animal spirits, instincts, and social conventions.

C. A Simple Two-Period Model of Government Bond Yields

A simple model, based on Akram and Das' (2014 and 2015) and Akram and Li's (2016 and 2017a) interpretations of Keynes' views, is presented here to show the connection between the current short-term interest rate and the long-term interest rate.

To simplify the exposition, a two-period horizon is used. There are two periods: $t = 1, 2$. The long-term interest rate on a government bond in period 1 is r_{LT}; the short-term interest rates on a Treasury bill in period 1 and period 2 are, respectively, r_1 and r_2; the expected short-term interest rate in period 2 is Er_2; the 1-year, 1-year forward rate is $f_{1,1}$; the term premium is z; the current rate of inflation in period 1 is π_1; the actual rate of inflation in period 2 is π_2; the expected rate of inflation in period 2 is $E\pi_2$; the current growth rate in period 1 is g_1; the actual growth rate in period 2 is g_2; the expected growth rate in period 2 is Eg_2; the government fiscal variable in period 1 is ν_1; the government fiscal variable in period 2 is ν_2; and the expected government fiscal variable in period 2 is $E\upsilon_2$.

It can be shown that the long-term interest rate is a function of either (i) the short-term interest rates in period 1 and period 2, and the growth rate and the rate of inflation in period 2; or (ii) the short-term interest rates in period 1 and period 2, and the growth rate, the rate of inflation, and the government fiscal variable in period 2. Hence, the models of the determinants of the long-term bond yields take the following forms:

$$r_{LT} = F^7 (r_1, r_2, g_2, \pi_2) \quad (1)$$

$$r_{LT} = F^8 (r_1, r_2, g_2, \pi_2, \nu_2) \quad (2)$$

A detailed derivation of the above models is presented in Appendix 1.

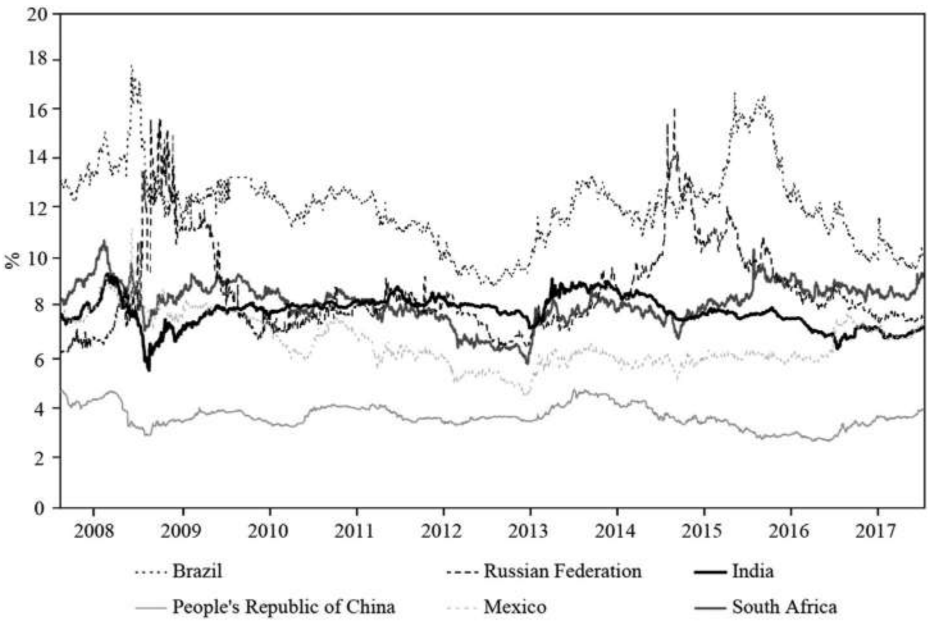
It is appropriate to incorporate the government fiscal variable in the model of the long-term interest rate for several reasons. First, government fiscal variables affect the long-term interest rate in the standard IS–LM Keynesian models. Second, it is also included in the standard theoretical and empirical literature, including Ardagna, Caselli, and Lane (2007); Baldacci and Kumar (2010); and other studies cited in section II.A. Third, since the paper assesses whether Keynes' conjecture regarding the importance of the short-term interest rate in driving the long-term interest rate is more warranted than that of the conventional view, it is necessary to empirically estimate the effect of government fiscal variables on the long-term interest rate. Ruling out, a priori, the role of the government fiscal variable on the long-term interest rate would be arbitrary and could be regarded as an ad hoc and unjustified maneuver. Undoubtedly, the empirical findings of this and other studies that find support for the Keynesian perspective can influence the choice of variables in the construction of models of the long-term interest rate in the future.

D. Institutional Background

Akram and Das (2015a and 2015b) provide the institutional background to the monetary policy framework, the government bond market, and monetary–fiscal coordination in India. Yanamandra (2014) gives additional perspective on monetary policy making in India in light of economic reforms, modernization, and recent developments, while Chakraborty (2016) provides a detailed description and analysis of the country's monetary–fiscal policy mix and monetary–fiscal coordination. Jácome et al.'s (2012) survey of global practices among central banks in extending credit and coordinating with the national Treasury includes a description of Indian laws, regulations, and practices related to its Treasury and central bank.

India enjoys monetary sovereignty as defined by Wray (2012). The Government of India issues its own currency, the rupee. The country's central bank, the Reserve Bank of India (RBI), sets the policy rates and can use a wide range of monetary policy tools. The RBI enjoys a wide range of authority and control over the country's financial system. The Government of India has the legal and political authority to collect taxes from households, businesses, financial institutions, and other organizations. The country's sovereign debt is predominantly issued in its own currency, the rupee. The multifaceted roles played by the RBI in the payment system, monetary policy, financial stability policy, and policy coordination with the Treasury gives it the operational ability to influence government bonds' nominal yields by setting and changing the short-term interest rate and using other tools of monetary policy as it deems appropriate. RBI (2014) provides a detailed institutional description of the IGB market, while RBI (various years) *Annual Reports* give useful summaries of the central bank's monetary policy and background. The 2009 report presents a valuable perspective on the operational aspects of monetary–fiscal coordination in India.

Figure 1. **The Evolution of 10-Year Government Bond Yields in Selected Emerging Market Economies**



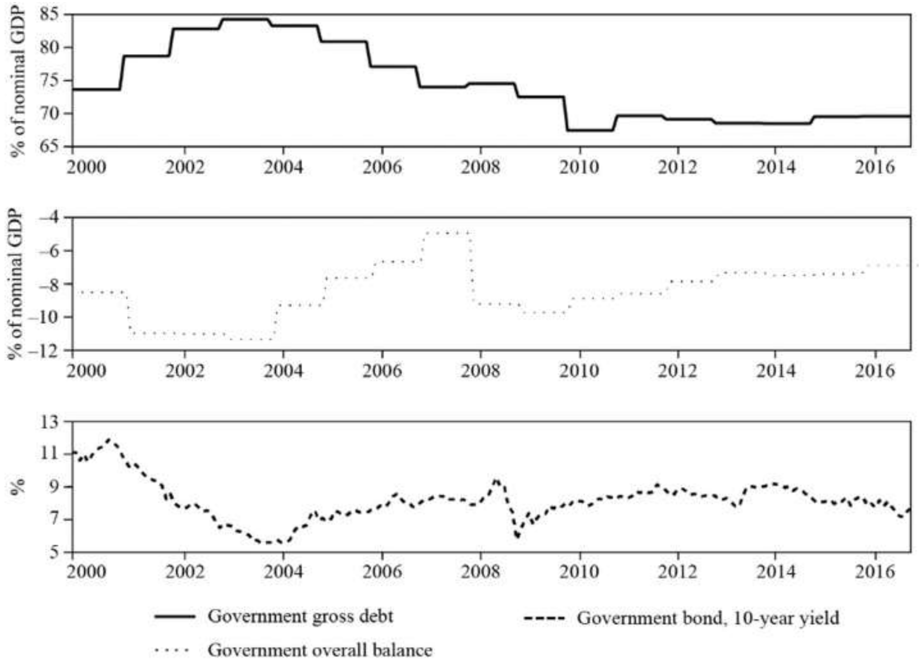
Source: Macrobond. Various years. Macrobond subscription services (accessed September 13, 2017).

E. Stylized Facts

A set of figures are presented in this section to highlight important stylized facts related to IGBs and government finance. Figure 1 compares the evolution of 10-year government bond yields in India with that of other major emerging markets, such as Brazil, Mexico, the People's Republic of China, the Russian Federation, and South Africa. It shows that since the global financial crisis, government bond yields in India have been generally higher than in the People's Republic of China and Mexico, but lower than in Brazil. Government bond yields in the Russian Federation and South Africa have been more volatile than those in India. In recent years, as commodity prices tumbled, financial flows to emerging markets weakened, and their central bank policy rates increased, and government bond yields in the Russian Federation and South Africa rose.

Figure 2 shows the evolution of key government fiscal variables in India such as the (i) ratio of gross government debt to nominal GDP, (ii) ratio of government fiscal balance to GDP, and (iii) 10-year government bond yield. It shows that the government debt-to-GDP ratio rose from 70% to nearly 85% in the early 2000s, but subsequently declined to around 70% as the country's annual fiscal

Figure 2. **The Evolution of Key Government Fiscal Variables in India**



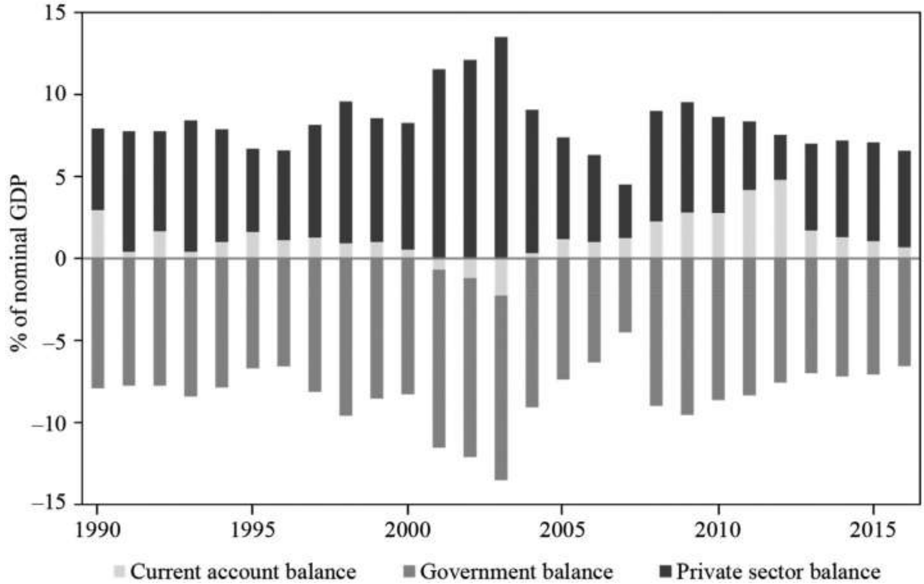
GDP = gross domestic product.
Source: Macrobond. Various years. Macrobond subscription services (accessed September 13, 2017).

balance improved from a deficit of around 11% of GDP in the early 2000s to a deficit of just 4% of GDP in the 2010s. Since the beginning of the 2010s, India's government debt ratio has been stable at around 70%, while its fiscal deficit has hovered around 7% of GDP. The figure also suggests that, prima facie, the evolution of government bonds yields in India is not directly affected by government fiscal conditions.

Figure 3 shows the evolution of the sector balances as a share of nominal GDP in India. It uses annual flow data to display (i) the government balance, (ii) the private sector balance, and (iii) the current account balance. It visually shows that the flow of government dissaving is equal to private sector saving and the rest of the world's saving in Indian rupees.

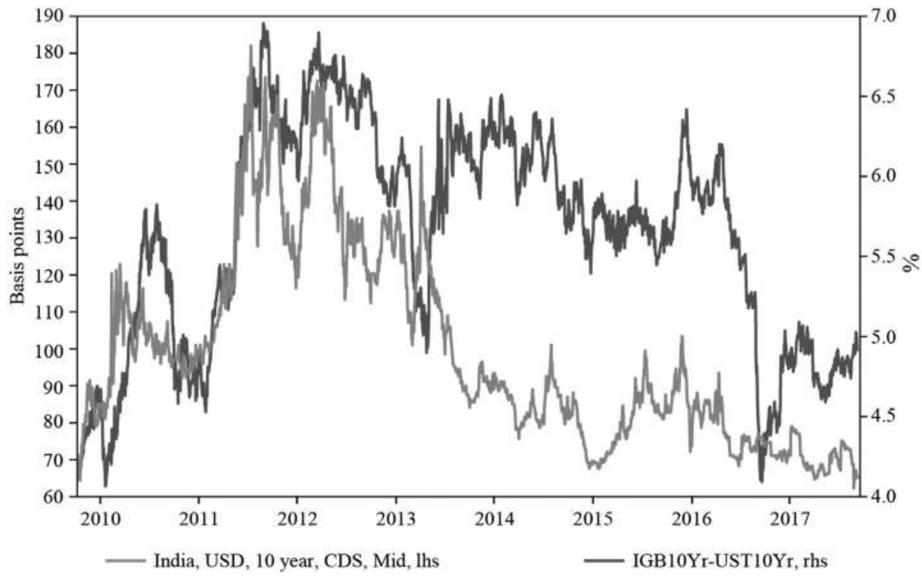
Figure 4 displays that the changing relationship between the credit default swap (CDS) premium on IGBs and the spread between the nominal yields of 10-year IGBs and 10-year US Treasury notes since 2010. It shows that the correlation can change drastically. Between 2010 and 2013, the CDS premium and the yield spread were tightly correlated. However, since 2014, the correlation between the CDS premium and the yield spread has been quite weak.

Figure 3. **The Evolution of Sector Balances in India**



GDP = gross domestic product.
Source: Macrobond. Various years. Macrobond subscription services (accessed September 12, 2017).

Figure 4. **The Evolution of Credit Default Swap Premiums and Yield Spreads**



CDS = credit default swap, IGB10Yr = 10-year Indian government bond yield, lhs = left-hand side, rhs = right-hand side, USD = United States (US) dollar, UST10Yr = 10-year US Treasury note yield.
Source: Macrobond. Various years. Macrobond subscription services (accessed September 12, 2017).

F. A Brief Review of the Literature on Government Bond Yields

There is a substantial literature on government bonds yields, including on the determinants of government bond yields in emerging markets such as India. Nevertheless, the debate on the determinants of bond yields and the relative importance of the key drivers is still unsettled.

We examine the findings of recent studies on government bond yields to ascertain how relevant these are to the question that this paper addresses. Andritzky (2012) provides a useful database on the investor base for government securities and investigates the effect of the composition of the investor base on government bond yields. Even though the study relies on G20 advanced economies and the eurozone, a key finding appears to be relevant for emerging markets. An increase in the share of bonds held by institutional or nonresidents by 10 percentage points is correlated with a decline in bond yields by about 25–40 basis points (bps). Asonuma, Bakhache, and Hesse (2015) find that an increase in domestic bank holdings of government bonds reduces bond yields and provides fiscal space for the sovereign authorities. Ebeke and Lu (2014) argue that the rise in foreign holdings of local currency government bonds in emerging markets has led to a decline in bond yields but a rise in their volatility, particularly since the global financial crisis. Acharya and Steffen (2015) provide an insightful analysis of the cause of the divergence of bond yields between the core of the eurozone and its periphery. They also discuss the vital role played by the "carry trade" of eurozone banks in causing the widening of the spread. The results of Ardagna, Caselli, and Lane (2007) are in line with the conventional wisdom cited earlier in the introduction. They claim that an increase of 1 percentage point in the ratio of the primary deficit leads to (i) an increase in the current long-term interest rate by 10 bps and (ii) cumulative increases in the long-term interest rate by 150 bps after 10 years. These and other results in the conventional literature on government bond yields are interesting. However, the conventional literature does not probe sufficiently the key role of the central bank in influencing government bond yields in emerging markets. Hence, a Keynesian perspective may provide a more insightful analysis of the decisive factors and may be more pertinent for understanding government bond yields in India.

This view is reinforced by the empirical literature on IGBs, which largely refutes the conventional view that higher (lower) government debt or government deficits induce higher (lower) government bond yields. Chakraborty's (2016) detailed and careful institutional and empirical study finds that there is no evidence of any link between fiscal deficit and interest rates in India. Vinod, Chakraborty, and Karun (2014) use the maximum entropy bootstrap method and report that the government fiscal deficit ratio is not significant for interest rate determination in India. Chakraborty (2012), applying asymmetrical vector autoregressive models, finds that an increase in the fiscal deficit ratio does not lead to a rise in interest rates. Akram and Das (2015a and 2015b) show that changes in the short-term interest rate, after controlling for other crucial variables such as changes in the rates of inflation and economic activity, take a lead role in driving the changes of the nominal yields of IGBs. Additional results show that higher fiscal deficits do not appear to exert upward pressures on government bond yields. Findings from Akram and Das (2015a and 2015b) are, however, valid solely for the short run. One of the important goals of the current paper is to examine if the findings from Akram and Das (2015a and 2015b) hold over the long-run horizon.

The next section introduces behavioral equations, time series data, and econometric methods to examine the role of the short-term interest rate, the rate of inflation, the government fiscal variable, and other key macroeconomics variables to determine the nominal yields on IGBs over the long-run horizon.

III. Data, Behavioral Equations, and Methods

A. Data[1]

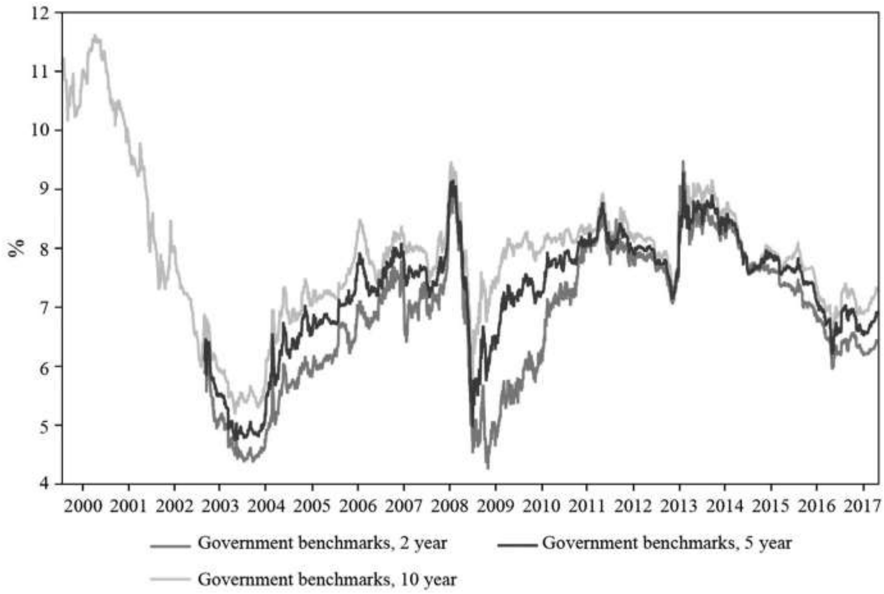
For the purpose of econometric estimations, time series data on the nominal yields of long-term IGBs, the short-term interest rate, the rate of inflation, the growth of industrial production, and government fiscal variables are used.

Nominal yields on Indian Treasury bills with 3-month maturities are used for the short-term interest rate, while the nominal yields on IGBs of various tenors—including 2-year, 3-year, 5-year, 7-year, and 10-year maturities—are used to represent long-term government bond yields. The RBI (2014) classifies government securities with a maturity of less than 1 year as short-term securities, and those with a maturity of 1 year or more as long-term securities.

Figure 5 shows the evolution of nominal yields of IGBs. Figure 6 shows the evolution of the short-term interest rate along with the RBI's policy rates (repo rates and reverse repo rates). The rate of inflation is defined as the year-on-year percentage change in the total consumer price index for all items. Growth in industrial production is the year-on-year percentage change in the index of industrial activity in India. The ratio of government debt to nominal GDP is used here as the government fiscal variable. The ratio of private sector credit (from all sectors) to nominal GDP is used to measure credit growth. The Institute for International Monetary Affairs' index of the volatility in global bond markets is a proxy for global investors' risk appetite. An increase (decrease) in volatility in global bond markets means that investors' perception of and appetite for risk has risen (declined). The nominal effective exchange rate, calculated by the Bank for International Settlements, is the exchange rate used here. The data of all the variables are collected from Macrobond's (various years) data services. Table 1 provides a

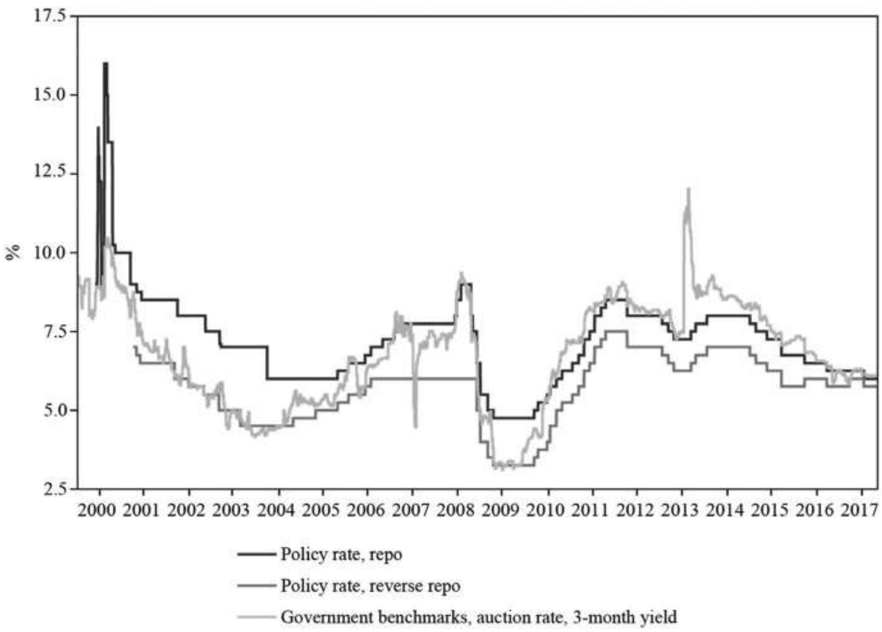
[1]The dataset used in the empirical part of this paper is available upon request to bona fide researchers for the replication and verification of the results.

Figure 5. **The Evolution of Indian Government Bond Yields of Selected Tenors**



Source: Macrobond. Various years. Macrobond subscription services (accessed July 12, 2017).

Figure 6. **The Evolution of Policy Rates and Short-Term Interest Rates in India**



Source: Macrobond. Various years. Macrobond subscription services (accessed July 12, 2017).

Table 1. **Summary of the Data and Variables**

Variable Labels	Data Description, Date Range	Frequency	Sources
Indian Short-Term Interest Rates			
TB3M; TB3M_Q	Government benchmarks, auction rate, 3-month % yield; Jan 1999–Oct 2015; Q1 1999–Q3 2015	Daily; converted to monthly	Reserve Bank of India; Macrobond converted to quarterly
Indian Government Bond Yields			
IGB2YR; IGB2YR_Q	Government bond, 2-year % yield; Mar 2003–Oct 2015; Q2 2003–Q3 2015	Daily; converted to monthly	Clearing Corporation of India; Macrobond converted to quarterly
IGB3YR; IGB3YR_Q	Government bond, 3-year % yield; Mar 2003–Oct 2015; Q2 2003–Q3 2015	Daily; converted to monthly	Clearing Corporation of India; Macrobond converted to quarterly
IGB5YR; IGB5YR_Q	Government bond, 5-year % yield; Mar 2003–Oct 2015; Q2 2003–Q3 2015	Daily; converted to monthly; converted to quarterly	Clearing Corporation of India; Macrobond
IGB7YR; IGB7YR_Q	Government bond, 7-year % yield; Mar 2003–Oct 2015; Q2 2003–Q2 2015	Daily; converted to monthly; converted to quarterly	Clearing Corporation of India; Macrobond
IGB10YR; IGB10YR_Q	Government bonds, 10-year % yield; Jan 1999–Oct 2015; Q1 1999–Q2 2015	Daily; converted to monthly; converted to quarterly	Clearing Corporation of India; Macrobond
Inflation			
TCPIYOY; TCPIYOY_Q	India, consumer price index, total, % change, year on year; Jan 2007–Oct 2015; Q1 2007–Q2 2015	Monthly; converted to quarterly	*The Economist*; Macrobond
Economic Activity			
IPIYOY; IPIYOY_Q	Industrial production, % change, year on year; Jan 1999–Oct 2015; Q1 1999–Q2 2015	Monthly; converted to quarterly	Central Statistical Organisation, India; Macrobond
Government Fiscal Variable			
DRATIO_Q	Government debt, % of nominal GDP; Q1 1999–Q2 2015	Quarterly	Indian Ministry of Commerce and Industry; Macrobond
Credit Growth			
CREDIT	Credit from all sectors to the private sector, % of nominal GDP; Jan 1999–Dec 2015	Quarterly; converted to monthly using cubic interpolation	Bank for International Settlements; Macrobond
Investors' Risk Appetite			
RISK	Global bond market volatility index; Jan 1999–Dec 2015	Daily; converted to monthly	Institute for International Monetary Affairs; Macrobond
Exchange Rate			
NEER	Nominal effective exchange rate index, broad; Jan 1999–Dec 2015	Monthly	Bank for International Settlements; Macrobond

GDP = gross domestic product, Q = quarter.
Source: Authors' compilation.

summary of the data and detailed descriptions of the variables. The monthly time series dataset runs from March 1999 to October 2015, while the quarterly dataset includes time series variables from the third quarter of 2003 to the second quarter of 2015.

Both monthly and quarterly data are used to examine the determinants of nominal yields of long-term government bonds. Indian government fiscal data is available only in quarterly form. Hence, the debt-to-GDP ratio is included only in the quarterly equations.

B. Behavioral Equations

A set of behavioral equations for monthly data and for quarterly data are constructed in concordance with the model based on the Keynesian framework presented earlier. These behavioral equations readily lend themselves to empirical testing. The specific-to-general approach is deployed here. For the monthly dataset, the long-term government bond yields are first regressed individually with the short-term interest rate, inflation, and the growth rate of industrial production. The dependent variables are then regressed with the short-term interest rate and inflation, and the short-term interest rate and growth rate. In the general form of the behavioral equation, the long-term interest rate is determined by all three explanatory variables including the short-term interest rate, rate of inflation, and growth rate. The general equation takes the following form:

$$r_{LT} = \alpha_1 + \alpha_2 r_1 + \alpha_3 \pi_1 + \alpha_4 g_1 \qquad (3)$$

The same approach is used when the quarterly dataset is employed to examine the determinants of long-term bond yields in India. However, to understand the effects of the government fiscal variable on government bond yields, the ratio of government debt to nominal GDP is included in the general equation of the quarterly dataset. Hence, the behavioral equation can be written in the following manner:

$$r_{LT} = z_1 + z_2 r_1 + z_3 \pi_1 + z_4 g_1 + z_5 v_1 \qquad (4)$$

C. Econometric Methodology

The first step is to examine the nature of the data. The presence of unit roots in most macroeconomic variables is fairly common (Nelson and Plosser 1982). Hence, estimating the long-run relationships of stationary variables using standard cointegration techniques (e.g., Johansen cointegration) is inconsistent. Therefore, unit root tests on the variables used in this paper are imperative. Conventional research has used both the Augmented Dickey–Fuller (ADF) (Dickey and Fuller 1979, 1981) and the Phillips–Perron (PP) (Phillips and Perron 1988) tests to

Table 2. **Unit Root Tests for Monthly Variables**

Variable	DFGLS	ADF	PP
IGB2YR	−1.29	−1.72	−1.86
ΔIGB2YR	−1.76*	−11.57***	−11.57***
IGB3YR	−1.26	−1.81	−1.97
ΔIGB3YR	−2.01**	−7.60***	−11.54***
IGB5YR	−1.26	−1.95	−2.03
ΔIGB5YR	−2.44**	−7.87***	−11.38***
IGB7YR	−1.27	−2.06	−2.06
ΔIGB7YR	−2.74***	−7.96***	−11.18***
TB3M	−1.57	−2.57	−2.58
ΔTB3M	−2.15**	−17.09***	−17.13***
TCPIYOY	−1.63*	−1.89	−1.99
ΔTCPIYOY	−9.47***	−9.51***	−9.48***
IPIYOY	−1.92*	−4.67***	−13.66***
ΔIPIYOY	−0.97	−9.73***	−47.57***
CREDIT	0.30	−1.54	−1.64
ΔCREDIT	−0.98	−2.48	−6.99***
NEER	0.48	−0.52	−0.27
ΔNEER	−0.79*	−11.21***	−11.04***
RISK	−4.93***	−4.93***	−4.86***
ΔRISK	−0.97	−17.18***	−19.01***

ADF = Augmented Dickey–Fuller, CREDIT = credit to the private sector as percentage of GDP, DFGLS = Dickey–Fuller Generalized Least Squares, IGB2YR = 2-year government bond yield, IGB3YR = 3-year government bond yield, IGB5YR = 5-year government bond yield, IGB7YR = 7-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, NEER = nominal effective exchange rate, PP = Phillips–Perron, RISK = global bond market volatility index, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.
Notes: ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively. The null hypothesis of all three tests is that the series contains unit roots.
Source: Authors' calculations.

identify the existence of unit roots. Elliott, Rothenberg, and Stock (1996) proposed the Dickey–Fuller Generalized Least Square (DFGLS) test, which is a modified version of the standard ADF test. According to the DFGLS procedure, the data are detrended before testing for stationarity. Different versions of the ADF, PP (with no constant and trend, constant and no trend, and constant and trend), and DFGLS tests (with constant but without trend, and constant and trend) are applied in this paper. All of these versions produce similar results. Due to space constraints, only the results with constant but without trend are presented here. All remaining results are available upon request.[2] Unit root results for monthly variables are displayed in Table 2 and the results for quarterly variables are displayed in Table 3. For the monthly dataset, most variables are nonstationary at levels and stationary at the first difference. The year-on-year percentage change in consumer price index is found to be nonstationary at levels and stationary at the first difference by two out of three

[2]For additional results, the interested reader may want to consult the working paper version (Akram and Das 2017a) of this study and/or contact the authors.

Table 3. **Unit Root Tests for Quarterly Variables**

Variable	DFGLS	ADF	PP
IGB2YR_Q	−1.51	−2.05	−2.05
ΔIGB2YR_Q	−6.10***	−7.47***	−7.48***
IGB3YR_Q	−1.60	−2.27	−2.14
ΔIGB3YR_Q	−6.36***	−8.06***	−8.36***
IGB5YR_Q	−1.72*	−2.54	−2.30
ΔIGB5YR_Q	−6.58***	−8.51***	−9.59***
IGB7YR_Q	−1.81*	−2.72	−2.47
ΔIGB7YR_Q	−6.77***	−6.81***	−10.14***
TB3M_Q	−1.59	−2.16	−2.57
ΔTB3M_Q	−1.87*	−8.52***	−8.60***
TCPIYOY_Q	−1.93*	−2.36	−2.44
ΔTCPIYOY_Q	−6.46***	−6.56***	−6.65***
IPIYOY_Q	−1.70*	−4.64***	−4.58***
ΔIPIYOY_Q	−6.55***	−6.53***	−14.18***
DRATIO_Q	−1.27	−2.21	−4.00***
ΔDRATIO_Q	−0.87	−2.60*	−11.21***

ADF = Augmented Dickey–Fuller, DFGLS = Dickey–Fuller Generalized Least Squares, DRATIO_Q = government debt as percentage of nominal gross domestic product, IGB2YR_Q = 2-year government bond yield, IGB3YR_Q = 3-year government bond yield, IGB5YR_Q = 5-year government bond yield, IGB7YR_Q = 7-year government bond yield, IPIYOY_Q = year-on-year percentage change in industrial production, PP = Phillips–Perron, TB3M_Q = 3-month government auction rate, TCPIYOY_Q = year-on-year percentage change in consumer price index.

Notes: ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively. The null hypothesis of all three tests is that the series contains unit roots.

Source: Authors' calculations.

tests. The year-on-year percentage change in industrial production (IPIYOY) and the global bond market volatility index are stationary at levels. Thus, most variables are integrated of order one, I(1). All three tests suggest that IPIYOY is stationary at levels; that is, I(0). Similar results are found for the quarterly variables. Government bond as a percentage of GDP is found to be stationary at levels by the PP test, and nonstationary at levels by the ADF and DFGLS tests. Therefore, all quarterly variables are either I(0) or I(1).

Given the results from the unit root tests, it is appropriate to estimate the long-run cointegrating relationships using the autoregressive distributive lag (ARDL) proposed by Pesaran and Shin (1998) and Pesaran, Shin, and Smith (2001). The ARDL bounds test approach is based on the ordinary least squares estimation of a conditional unrestricted error correction model for cointegration analysis. The ARDL technique is more appealing than the Johansen cointegration technique (Johansen and Juselius 1990) because the latter requires that the variables are integrated of the same order of I(1). However, the ARDL approach is not constrained by the outcomes of unit root tests. It is applicable irrespective of whether the regressors in the model are purely I(0), purely I(1), or mutually cointegrated. In the present case, most variables are I(1) with the exception of IPIYOY and DRATIO_Q (i.e., government debt as percentage of nominal

Table 4. **Autoregressive Distributive Lag Bounds Test Results for IGB2YR** (monthly data)

Equation		**F-statistic**
4.1) IGB2YR $= \beta_0 + \beta_1$TB3M		3.93
4.2) IGB2YR $= \beta_2 + \beta_3$TCPIYOY		2.97
4.3) IGB2YR $= \beta_4 + \beta_5$IPIYOY		1.46
4.4) IGB2YR $= \beta_6 + \beta_7$TB3M $+ \beta_8$TCPIYOY		**6.52****
4.5) IGB2YR $= \beta_9 + \beta_{10}$TB3M $+ \beta_{11}$IPIYOY		2.99
4.6) IGB2YR $= \beta_{12} + \beta_{13}$TB3M $+ \beta_{14}$TCPIYOY $+ \beta_{15}$IPIYOY		**4.81***
Long-Run Relationships		
Variable	**Equation 4.4**	**Equation 4.6**
TB3M	0.51***	0.51***
	(0.04)	(0.05)
TCPIYOY	−0.01	−0.00
	(0.04)	(0.04)
IPIYOY	—	−0.00
		(0.01)
Constant	3.60***	3.60***
	(0.48)	(0.54)
Time period	Dec 2006–Oct 2015	Feb 2007–Oct 2015
Number of observations	107	105

IGB2YR = 2-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.

Notes: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 6.84, 4.94, and 4.04 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 7.84, 5.73, and 4.78 for 1%, 5%, and 10% levels of significance, respectively.

Source: Authors' calculations.

GDP), which are I(0). Moreover, the ARDL technique allows different variables to take different optimal numbers of lags, while this is not permitted in the Johansen cointegration approach. Therefore, the ARDL technique, which will accommodate both I(0) and I(1) variables, is used in this paper to estimate the long-run relationships between long-term government bond yields and other control variables.

IV. Empirical Results

A. Monthly Results

The ARDL bounds test results generated from monthly variables are presented in Tables 4–8. When the short-term interest rate is included with inflation, in most cases the computed F-statistic based on a Wald test exceeds the upper bound value at the 5% level. In the case of the 2-year government bond yield, the computed F-statistic exceeds the upper bound value at the 10% level when the

Table 5. **Autoregressive Distributive Lag Bounds Test Results for IGB3YR** (monthly data)

Equation		F-statistic
5.1) IGB3YR = $\beta_{16} + \beta_{17}$TB3M		4.60
5.2) IGB3YR = $\beta_{18} + \beta_{19}$TCPIYOY		2.64
5.3) IGB3YR = $\beta_{20} + \beta_{21}$IPIYOY		2.03
5.4) IGB3YR = $\beta_{22} + \beta_{23}$TB3M + β_{24}TCPIYOY		**8.37*****
5.5) IGB3YR = $\beta_{25} + \beta_{26}$TB3M + β_{27}IPIYOY		3.70
5.6) IGB3YR = $\beta_{28} + \beta_{29}$TB3M + β_{30}TCPIYOY + β_{31}IPIYOY		**6.20****
Long-Run Relationships		
Variable	**Equation 5.4**	**Equation 5.6**
TB3M	0.39***	0.38***
	(0.04)	(0.05)
TCPIYOY	−0.01	−0.01
	(0.04)	(0.04)
IPIYOY	—	−0.01
		(0.01)
Constant	4.74***	4.81***
	(0.47)	(0.55)
Time period	Dec 2006–Oct 2015	Feb 2007–Oct 2015
Number of observations	107	105

IGB3YR = 3-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.

Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 6.84, 4.94, and 4.04 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 7.84, 5.73, and 4.78 for 1%, 5%, and 10% levels of significance, respectively.

Source: Authors' calculations.

short-term rate is included in the equation with both inflation and the industrial production index (equation 4.6). The null hypothesis of no cointegration is rejected whenever the F-statistic value is higher than the upper bound value. This analysis confirms the presence of a long-run relationship among long-term government bond yields, the short-term interest rate, the rate of inflation, and the growth of industrial production. It enables the estimation of the long-run coefficients of the short-term interest rate and other control variables. The coefficients of the short-term interest rate are always positive and statistically significant at the 1% level. The size of this coefficient tends to be smaller as the tenor of the government bond rises. These results suggest that in the long run the short-term interest rate strongly influences long-term government bond yields in India.

B. Quarterly Results

Estimated results using quarterly data are presented in Tables 9–13. When the short-term 3-month interest rate is included with inflation and the ratio of

Table 6. **Autoregressive Distributive Lag Bounds Test Results for IGB5YR** (monthly data)

Equation	**F-statistic**
6.1) $IGB5YR = \beta_{32} + \beta_{33}TB3M$	3.84
6.2) $IGB5YR = \beta_{34} + \beta_{35}TCPIYOY$	3.65
6.3) $IGB5YR = \beta_{36} + \beta_{37}IPIYOY$	2.37
6.4) $IGB5YR = \beta_{38} + \beta_{39}TB3M + \beta_{40}TCPIYOY$	**10.56*****
6.5) $IGB5YR = \beta_{41} + \beta_{42}TB3M + \beta_{43}IPIYOY$	4.08
6.6) $IGB5YR = \beta_{44} + \beta_{45}TB3M + \beta_{46}TCPIYOY + \beta_{47}IPIYOY$	**7.74****

Long-Run Relationships

Variable	**Equation 6.4**	**Equation 6.6**
TB3M	0.26***	0.25***
	(0.04)	(0.04)
TCPIYOY	−0.00	−0.00
	(0.04)	(0.04)
IPIYOY	—	−0.01
		(0.01)
Constant	5.86***	5.98***
	(0.43)	(0.53)
Time period	Dec 2006–Oct 2015	Feb 2007–Oct 2015
Number of observations	107	105

IGB5YR = 5-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 6.84, 4.94, and 4.04 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 7.84, 5.73, and 4.78 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

government debt to nominal GDP, the computed F-statistic value is mostly higher than the upper bound value. Long-run coefficients of the short-term interest rate are positive when significant. The magnitude of this coefficient lies between 0.13 and 0.53. The coefficient of the ratio of government debt to nominal GDP is mostly negative and significant at the 1% level, suggesting that in the long run a higher debt ratio tends to reduce the nominal yields of IGBs. This is contrary to the conventional wisdom. Quarterly data allow the use of government fiscal variables but a clear limitation is that these results are based on a smaller number of observations.

C. The Main Finding and Its Relevance

The main finding is that the short-term interest rate is a key driver of the long-term interest rate on IGBs in both the short run and the long run. This finding has important policy implications. For example, it suggests that the RBI's monetary policy decisions not only have an immediate effect on the long-term interest rate and the Treasury yield curve, but also on the direction and the level of the

Table 7. **Autoregressive Distributive Lag Bounds Test Results for IGB7YR** (monthly data)

Equation	***F*-statistic**
7.1) IGB7YR $= \beta_{48} + \beta_{49}$TB3M	4.02
7.2) IGB7YR $= \beta_{50} + \beta_{51}$TCPIYOY	**5.63**
7.3) IGB7YR $= \beta_{52} + \beta_{53}$IPIYOY	2.59
7.4) IGB7YR $= \beta_{54} + \beta_{55}$TB3M $+ \beta_{56}$TCPIYOY	**10.60*****
7.5) IGB7YR $= \beta_{57} + \beta_{58}$TB3M $+ \beta_{59}$IPIYOY	4.09
7.6) IGB7YR $= \beta_{60} + \beta_{61}$TB3M $+ \beta_{62}$TCPIYOY $+ \beta_{63}$IPIYOY	**7.70****

Long-Run Relationships

Variable	**Equation 7.2**	**Equation 7.4**	**Equation 7.6**
TB3M	—	0.19***	0.18***
		(0.03)	(0.04)
TCPIYOY	0.03	0.02	0.01
	(0.08)	(0.04)	(0.04)
IPIYOY	—	—	−0.01
			(0.01)
Constant	7.71***	6.40***	6.53***
	(0.62)	(0.43)	(0.52)
Time period	Dec 2006–Oct 2015	Dec 2006–Oct 2015	Feb 2007–Oct 2015
Number of observations	107	107	105

IGB7YR = 7-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 6.84, 4.94, and 4.04 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 7.84, 5.73, and 4.78 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

long-term interest rate over a longer horizon. The results obtained are robust. Additional regressions estimated in Appendix 2 show that the coefficient of the short-term interest rate is positive and statistically significant, at least at the 5% level, even after controlling for variables such as credit growth, global investors' risk appetite, and the nominal effective exchange rate. Therefore, the main finding that the short-term interest rate is the most important determinant of long-term bond yields does not change with adjustments to the specifications.

These results reinforce the findings in Akram and Das' (2015a and 2015b) recent studies on IGBs in which they report that changes in the short-term interest rate are important determinants of changes in long-term government bond yields in India. Whereas Akram and Das (2015a and 2015b) established the results for the short run, the current study extends this for the long run.

V. Policy Implications and Conclusion

The empirical results reported here support Keynes' conjecture that the central bank's actions, through its influence on the short-term interest rate and its use

Table 8. **Autoregressive Distributive Lag Bounds Test Results for IGB10YR** (monthly data)

Equation	***F*-statistic**
8.1) IGB10YR = $\beta_{64} + \beta_{65}$TB3M	4.73
8.2) IGB10YR = $\beta_{66} + \beta_{67}$TCPIYOY	**7.51****
8.3) IGB10YR = $\beta_{68} + \beta_{69}$IPIYOY	3.60
8.4) IGB10YR = $\beta_{70} + \beta_{71}$TB3M + β_{72}TCPIYOY	**9.42*****
8.5) IGB10YR = $\beta_{73} + \beta_{74}$TB3M + β_{75}IPIYOY	3.07
8.6) IGB10YR = $\beta_{76} + \beta_{77}$TB3M + β_{78}TCPIYOY + β_{79}IPIYOY	**6.83****

Long-Run Relationships

Variable	**Equation 8.2**	**Equation 8.4**	**Equation 8.6**
TB3M	—	0.14***	0.13***
		(0.04)	(0.04)
TCPIYOY	0.04	0.03	0.02
	(0.05)	(0.04)	(0.04)
IPIYOY	—	—	−0.01
			(0.01)
Constant	7.74***	6.87***	6.99***
	(0.45)	(0.44)	(0.53)
Time period	Dec 2006–Oct 2015	Dec 2006–Oct 2015	Feb 2007–Oct 2015
Number of observations	107	107	105

IGB10YR = 10-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 6.84, 4.94, and 4.04 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 7.84, 5.73, and 4.78 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

Table 9. **Autoregressive Distributive Lag Bounds Test Results for IGB2YR_Q** (quarterly data)

Equation	***F*-statistic**
9.1) IGB2YR_Q = $\gamma_0 + \gamma_1$TB3M_Q + γ_2DRATIO_Q	2.67
9.2) IGB2YR_Q = $\gamma_3 + \gamma_4$TCPIYOY_Q + γ_5DRATIO_Q	1.68
9.3) IGB2YR_Q = $\gamma_6 + \gamma_7$IPIYOY_Q + γ_8DRATIO_Q	2.21
9.4) IGB2YR_Q = $\gamma_9 + \gamma_{10}$TB3M_Q + γ_{11}TCPIYOY_Q + γ_{12}DRATIO_Q	1.16
9.5) IGB2YR_Q = $\gamma_{13} + \gamma_{14}$TB3M_Q + γ_{15}IPIYOY_Q + γ_{16}DRATIO_Q	2.03
9.6) IGB2YR_Q = $\gamma_{17} + \gamma_{18}$TB3M_Q + γ_{19}TCPIYOY_Q + γ_{20}IPIYOY_Q + γ_{21}DRATIO_Q	1.01

DRATIO_Q = government debt as percentage of nominal gross domestic product, IGB2YR_Q = 2-year government bond yield, IPIYOY_Q = year-on-year percentage change in industrial production, TB3M_Q = 3-month government auction rate, TCPIYOY_Q = year-on-year percentage change in consumer price index.
Note: Lower bound values are 6.84, 4.94, and 4.04 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 7.84, 5.73, and 4.78 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

Table 10. **Autoregressive Distributive Lag Bounds Test Results for IGB3YR_Q** (quarterly data)

Equation	***F*-statistic**
10.1) $IGB3YR\_Q = \gamma_{22} + \gamma_{23}TB3M\_Q + \gamma_{24}DRATIO\_Q$	**5.51****
10.2) $IGB3YR\_Q = \gamma_{25} + \gamma_{26}TCPIYOY\_Q + \gamma_{27}DRATIO\_Q$	2.19
10.3) $IGB3YR\_Q = \gamma_{28} + \gamma_{29}IPIYOY\_Q + \gamma_{30}DRATIO\_Q$	2.51
10.4) $IGB3YR\_Q = \gamma_{31} + \gamma_{32}TB3M\_Q + \gamma_{33}TCPIYOY\_Q + \gamma_{34}DRATIO\_Q$	**6.17****
10.5) $IGB3YR\_Q = \gamma_{35} + \gamma_{36}TB3M\_Q + \gamma_{37}IPIYOY\_Q + \gamma_{38}DRATIO\_Q$	2.21
10.6) $IGB3YR\_Q = \gamma_{39} + \gamma_{40}TB3M\_Q + \gamma_{41}TCPIYOY\_Q + \gamma_{42}IPIYOY\_Q + \gamma_{43}DRATIO\_Q$	1.09

Long-Run Relationships

Variable	**Equation 10.1**	**Equation 10.4**
TB3M_Q	0.53***	0.44***
	(0.07)	(0.03)
TCPIYOY_Q	—	0.00
		(0.03)
IPIYOY_Q	—	—
DRATIO_Q	−2.39***	0.69
	(0.82)	(0.61)
Constant	7.36***	3.21***
	(1.55)	(0.85)
Time period	Q3 2003–Q2 2015	Q1 2007–Q2 2015
Number of observations	48	34

DRATIO_Q = government debt as percentage of nominal gross domestic product, IGB3YR_Q = 3-year government bond yield, IPIYOY_Q = year-on-year percentage change in industrial production, TB3M_Q = 3-month government auction rate, TCPIYOY_Q = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 5.15, 3.79, and 3.17 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 6.36, 5.52, and 4.14 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

of the tools of monetary policy, are the main drivers of the long-term interest rate. In the case of India, the actions of the RBI affect the long-term interest rate. The long-term interest rate on IGBs is positively associated with the short-term interest rate on Indian Treasury bills after controlling for the relevant variables such as the rate of inflation, growth of industrial production, and debt ratio. A higher (lower) long-term interest rate on IGBs is associated with a higher (lower) short-term interest rate, higher (lower) rate of inflation, and faster (slower) pace of industrial production. The results show that a higher level of government indebtedness does not have an adverse effect on IGBs' nominal yields, contrary to the conventional view. These findings concur with the results obtained in Akram and Das' (2015a and 2015b) studies of the short-term dynamics of IGBs. The findings also align with those obtained in studies by Chakraborty (2012 and 2016) and Vinod, Chakraborty, and Karun (2014), which use quite different econometric and statistical methods.

Table 11. **Autoregressive Distributive Lag Bounds Test Results for IGB5YR_Q** (quarterly data)

Equation	***F*-statistic**
11.1) IGB5YR_Q = $\gamma_{44} + \gamma_{45}$TB3M_Q + γ_{46}DRATIO_Q	**5.13****
11.2) IGB5YR_Q = $\gamma_{47} + \gamma_{48}$TCPIYOY_Q + γ_{49}DRATIO_Q	3.45
11.3) IGB5YR_Q = $\gamma_{50} + \gamma_{51}$IPIYOY_Q + γ_{52}DRATIO_Q	3.81
11.4) IGB5YR_Q = $\gamma_{53} + \gamma_{54}$TB3M_Q + γ_{55}TCPIYOY_Q + γ_{56}DRATIO_Q	**9.00*****
11.5) IGB5YR_Q = $\gamma_{57} + \gamma_{58}$TB3M_Q + γ_{59}IPIYOY_Q + γ_{60}DRATIO_Q	3.97
11.6) IGB5YR_Q = $\gamma_{61} + \gamma_{62}$TB3M_Q + γ_{63}TCPIYOY_Q + γ_{64}IPIYOY + γ_{65}DRATIO_Q	**6.63*****

Long-Run Relationships

Variable	**Equation 11.1**	**Equation 11.4**	**Equation 11.6**
TB3M_Q	0.41***	0.26***	0.21***
	(0.09)	(0.04)	(0.07)
TCPIYOY_Q	—	−0.03	−0.11
		(0.05)	(0.08)
IPIYOY_Q	—	—	−0.03
			(0.02)
DRATIO_Q	−3.06***	1.54	1.67
	(1.04)	(0.92)	(1.08)
Constant	9.52***	3.73**	4.67**
	(1.98)	(1.36)	(1.83)
Time period	Q3 2003–Q2 2015	Q1 2007–Q2 2015	Q1 2007–Q2 2015
Number of observations	48	34	34

DRATIO_Q = government debt as percentage of nominal gross domestic product, IGB5YR_Q = 5-year government bond yield, IPIYOY_Q = year-on-year percentage change in industrial production, TB3M_Q = 3-month government auction rate, TCPIYOY_Q = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 5.15, 3.79, and 3.17 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 6.36, 5.52, and 4.14 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

The findings reported in this paper have implications for policy debates in India and other emerging markets with monetary sovereignty that issue government debt mostly in their own currencies. The findings are also relevant for ongoing debates over fiscal policy, the sustainability of government debt, monetary policy, monetary–fiscal coordination and the policy mix during economic fluctuations, and macroeconomic and monetary theory (Bindseil 2004, Fullwiler 2008 and 2016, Kregel 2011, Sims 2013a and 2013b, Tcherneva 2011, Woodford 2001, and Wray 2003 [1998] and 2012). First, the results show that the RBI can exert a strong influence on IGB yields by affecting the short-term interest rates. The RBI can affect the short-term interest rates on Indian Treasury bills through setting the repo rate and the reverse repo rate (Figure 6). These findings support Keynes' conjecture about the influence of a sovereign central bank on long-term interest rates. Second, the results also suggest that, contrary to the conventional wisdom, higher government indebtedness does not raise IGBs' nominal yields. While this

Table 12. **Autoregressive Distributive Lag Bounds Test Results for IGB7YR_Q (quarterly data)**

Equation	***F*-statistic**
12.1) IGB7YR_Q = $\gamma_{66} + \gamma_{67}$TB3M_Q + γ_{68}DRATIO_Q	**4.89****
12.2) IGB7YR_Q = $\gamma_{69} + \gamma_{70}$TCPIYOY_Q + γ_{71}DRATIO_Q	**4.50****
12.3) IGB7YR_Q = $\gamma_{72} + \gamma_{73}$IPIYOY_Q + γ_{74}DRATIO_Q	**4.62****
12.4) IGB7YR_Q = $\gamma_{75} + \gamma_{76}$TB3M_Q + γ_{77}TCPIYOY_Q + γ_{78}DRATIO_Q	**10.04*****
12.5) IGB7YR_Q = $\gamma_{79} + \gamma_{80}$TB3M_Q + γ_{81}IPIYOY_Q + γ_{82}DRATIO_Q	3.81
12.6) IGB7YR_Q = $\gamma_{83} + \gamma_{84}$TB3M_Q + γ_{85}TCPIYOY_Q + γ_{86}IPIYOY_Q + γ_{87}DRATIO_Q	2.44

Long-Run Relationships

Variable	**Equation 12.1**	**Equation 12.2**	**Equation 12.3**	**Equation 12.4**
TB3M_Q	0.35***	—	—	0.18***
	(0.10)			(0.05)
TCPIYOY_Q	—	0.02	—	−0.04
		(0.10)		(0.05)
IPIYOY_Q	—	—	−0.02	—
			(0.04)	
DRATIO_Q	−3.22***	1.67	−4.97***	1.71*
	(1.14)	(2.16)	(1.57)	(0.98)
Constant	10.40***	5.18	15.71***	4.27***
	(2.17)	(3.51)	(2.53)	(1.43)
Time period	Q3 2003–Q2 2015	Q1 2007–Q2 2015	Q3 2003–Q2 2015	Q1 2007–Q2 2015
Number of observations	48	34	48	34

DRATIO_Q = government debt as percentage of nominal gross domestic product, IGB7YR_Q = 7-year government bond yield, IPIYOY_Q = year-on-year percentage change in industrial production, TB3M_Q = 3-month government auction rate, TCPIYOY_Q = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 5.15, 3.79, and 3.17 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 6.36, 5.52, and 4.14 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

finding is contrary to the conventional view, which is derived from the loanable funds perspective, it is fully in concordance with Keynes' views and modern money theory (Fullwiler 2008 and 2016, Kregel 2011, and Wray 2003 [1998] and 2012), which holds that increased government expenditures result in rising central bank reserves and banking deposits in the financial system because the central bank credits the banks in order to facilitate the government's borrowing and expenditures. Third, the results suggest that Indian policy makers can use appropriate models—based on information on the current trend of short-term interest rates, government debt ratios, and other key macro variables—to form their long-term outlook about IGBs' nominal yields and understand the implications of the government's fiscal stance on the government bond market. Of course, the use of such models requires judgment and prudence, and carries with it model risks and limitations.

Keynes claims that the central bank has a decisive influence on long-term interest rates. He believes that short-term interest rates and other monetary policy

Table 13. **Autoregressive Distributive Lag Bounds Test Results for IGB10YR_Q (quarterly data)**

Equation	*F*-statistic
13.1) IGB10YR_Q = $\gamma_{88} + \gamma_{89}$TB3M_Q + γ_{90}DRATIO_Q	**6.82*****
13.2) IGB10YR_Q = $\gamma_{91} + \gamma_{92}$TCPIYOY_Q + γ_{93}DRATIO_Q	**5.51****
13.3) IGB10YR_Q = $\gamma_{94} + \gamma_{95}$IPIYOY_Q + γ_{96}DRATIO_Q	**7.88*****
13.4) IGB10YR_Q = $\gamma_{97} + \gamma_{98}$TB3M_Q + γ_{99}TCPIYOY + γ_{100}DRATIO_Q	**10.66*****
13.5) IGB10YR_Q = $\gamma_{101} + \gamma_{102}$TB3M_Q + γ_{103}IPIYOY_Q + γ_{104}DRATIO_Q	4.14
13.6) IGB10YR_Q = $\gamma_{105} + \gamma_{106}$TB3M_Q + γ_{107}TCPIYOY_Q + γ_{108}IPIYOY_Q + γ_{109}DRATIO_Q	3.93

Long-Run Relationships

Variable	Equation 13.1	Equation 13.2	Equation 13.3	Equation 13.4
TB3M_Q	0.29	—	—	0.13**
	(0.20)			(0.05)
TCPIYOY_Q	—	0.03	—	−0.05
		(0.08)		(0.06)
IPIYOY_Q	—	—	0.04	—
			(0.07)	
DRATIO_Q	−5.41***	1.53	−7.52***	1.75*
	(2.18)	(1.78)	(2.16)	(1.02)
Constant	14.67***	5.48*	19.90***	4.85***
	(4.42)	(2.90)	(3.56)	(1.48)
Time period	Q3 1999–Q2 2015	Q1 2007–Q2 2015	Q3 1999–Q2 2015	Q1 2007–Q2 2015
Number of observations	64	34	64	34

DRATIO_Q = government debt as percentage of nominal gross domestic product, IGB10YR_Q = 10-year government bond yield, IPIYOY_Q = year-on-year percentage change in industrial production, TB3M_Q = 3-month government auction rate, TCPIYOY_Q = year-on-year percentage change in consumer price index.
Notes: *** and ** represent 1% and 5% levels of significance, respectively. Standard errors are in parentheses. Lower bound values are 5.15, 3.79, and 3.17 for 1%, 5%, and 10% levels of significance, respectively. Upper bound values are 6.36, 5.52, and 4.14 for 1%, 5%, and 10% levels of significance, respectively.
Source: Authors' calculations.

actions drive long-term interest rates and that an investor's long-term outlook is mostly shaped by the investor's near-term outlook and assessment of current conditions. This paper shows that Keynes' conjecture has empirical support in India over the long-run horizon by extending Akram and Das' (2015a and 2015b) findings for the short-run horizon to the long-run horizon for the case of India. It contributes to the nascent literature—such as Akram (2014) and Akram and Das (2014a and 2014b) on Japan; Akram and Das (2017b and 2017c) on the eurozone; and Akram and Li (2016, 2017a, and 2017b) on the US—on this topic of examining whether Keynes' conjecture holds in various countries. Further research should extend this to a wider range of countries—both advanced capitalist economies and emerging markets and other developing areas—and apply a broad spectrum of suitable econometric methods to establish whether these findings can be generalized and determine under which institutional contexts they are warranted.

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Appendix 1. Derivation of the Two-Period Model of Government Bond Yields

The long-term interest rate on the 2-year government bond depends on the short-term interest rate on Treasury securities in period 1 and the 1-year, 1-year forward rate (equation A1). The 1-year, 1-year forward rate is based on an investor's expectation of the short-term interest rate on Treasury securities in period 2 and the term premium (equation A2). However, the expected short-term interest rate on Treasury securities in period 2 and the term premium is a function of the investor's expectation of growth and inflation in period 2 (equation A3). Hence, the 1-year, 1-year forward rate is merely the sum of the expected short-term interest rate on the Treasury bill in period 2 and a function of the expected growth rate and expected inflation in the same period (equation A4). This implies that the forward rate is a function of expected short-term interest rates on Treasury securities, the expected growth rate, and expected rate of inflation in period 2 (equation A5). Since the long-term interest rate is a function of the short-term interest rate on the Treasury securities in period 1 and the 1-year, 1-year forward rate (equation A6), it follows that the long-term interest rate is a function of the short-term interest rate in period 1, and a function of the expected short-term interest rate, expected growth rate, and expected rate of inflation in period 2 (equation A7).

Keynes' view is that the investor resorts to the present and the past. The investor relies on his view of the near-term future to form his conception of the long-term future since it is not really possible to have a proper mathematical expectation of the unknown and uncertain future. Hence, for the investor, the expected short-term interest rate in period 2 is based on the actual short-term interest rate in period 1 (equation A8), the expected growth rate in period 2 is based on the actual growth rate in period 1 (equation A9), and the expected rate of inflation in period 2 is based on the actual rate of inflation in period 1 (equation A10). Similarly, the expected government fiscal variable in period 2 is based on the government fiscal variable in period 1 (equation A11). These Keynesian assumptions results in a model (equation A12) where the long-term interest rate is a function of either (i) the current short-term interest rate, the current growth rate, and current inflation (equation A13); or (ii) the current short-term interest rate, the current growth rate, current inflation, and the current government fiscal variable (equation A14).

The Keynesian view that an investor's expectation of key economic variables depends largely on current conditions or the investor's assessment of current conditions may appear intriguing and counterintuitive. But if key economic variables follow a Markov process (equation A15, equation A16, equation A17, and equation A18), then the Keynesian view of the trajectory of expected values of these variables is entirely reasonable. Empirical and behavioral studies of the investor's expectations of the interest rate and the rate of inflation show that Keynes' conjectures have considerable support (Clark and Davig 2008; Faust and Wright 2013; Mavroedis, Plagborg-Møller, and Stock 2014).

In contrast, under rational expectations where Lucasian assumptions of perfect foresight hold, the investor's expected short-term interest rates, expected growth rate, expected inflation, and expected government fiscal variable would equal, respectively, the actual short-term interest rates, growth rate, rate of inflation, and government fiscal variable in period 2 (equation A19, equation A20, equation A21, and equation A22). This would result in the long-term interest rate being a function of either (i) the current short-term interest rate, growth rate, and rate of inflation in period 2 (equation A23); or (ii) the current short-term interest rate, growth rate, rate of inflation, and government fiscal variable in period 2 (equation A24).

The model is represented in the following system of equations:

$$(1 + r_{LT})^2 = (1 + r_1)(1 + f_{1,1}) \tag{A1}$$

$$f_{1,1} = Er_2 + z \tag{A2}$$

$$Er_2 + z = F^1(Eg_2, E\pi_2) \tag{A3}$$

$$f_{1,1} = Er_2 + F^2(Eg_2, E\pi_2) \tag{A4}$$

$$f_{1,1} = F^3(Er_2, Eg_2, E\pi_2) \tag{A5}$$

$$r_{LT} = F^4(r_1, f_{1,1}) \tag{A6}$$

$$r_{LT} = F^4\left(r_1, F^3(Er_2, Eg_2, E\pi_2)\right) \tag{A7}$$

The Keynesian assumptions imply that the following hold:

$$Er_2 = r_1 \tag{A8}$$

$$Eg_2 = g_1 \tag{A9}$$

$$E\pi_2 = \pi_1 \tag{A10}$$

$$E\nu_2 = \nu_1 \tag{A11}$$

Incorporating Keynesian assumptions into the model leads to the following:

$$r_{LT} = F^4\left(r_1, F^3(r_1, g_1, \pi_1)\right) \tag{A12}$$

$$r_{LT} = F^5(r_1, g_1, \pi_1) \tag{A13}$$

Extending the model to include the government fiscal variable results in the following:

$$r_{LT} = F^6(r_1, g_1, \pi_1, \upsilon_1) \tag{A14}$$

If the variables in period 2 are to follow a simple Markov process, these variables can be modeled in the following terms:

$$r_2 = \Lambda_1 + \Lambda_2 r_1 \tag{A15}$$

$$g_2 = \Lambda_3 + \Lambda_4 g_1 \tag{A16}$$

$$\pi_2 = \Lambda_5 + \Lambda_6 \pi_1 \tag{A17}$$

$$\upsilon_2 = \Lambda_7 + \Lambda_8 \upsilon_1 \tag{A18}$$

In the above equations, the restrictions on the parameters are as follows: $0 < \Lambda_2 < 1, 0 < \Lambda_4 < 1, 0 < \Lambda_6 < 1$, and $0 < \Lambda_8 < 1$.

It is useful to contrast the Keynesian model with a Lucasian (rational expectations) model. Under rational expectations:

$$Er_2 = r_2 \tag{A19}$$

$$Eg_2 = g_2 \tag{A20}$$

$$E\pi_2 = \pi_2 \tag{A21}$$

$$E\upsilon_2 = \upsilon_2 \tag{A22}$$

Under Lucasian assumptions, the long-term rates are modeled, respectively, without and with government fiscal variable, as follows:

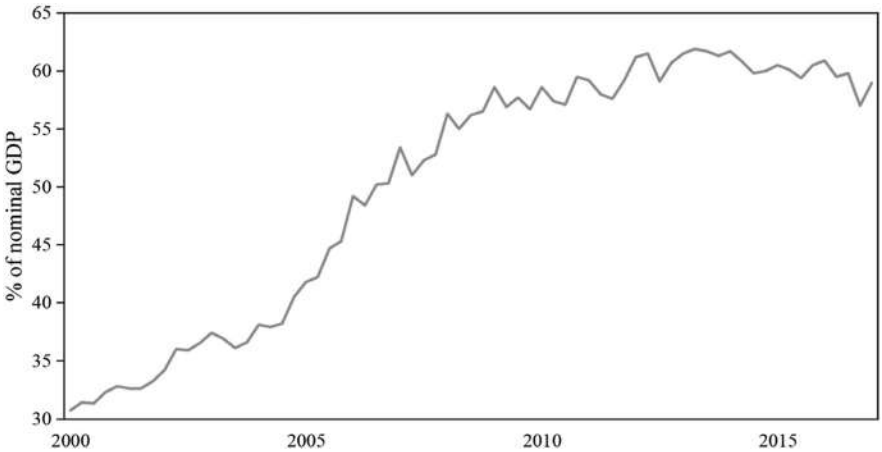
$$r_{LT} = F^7 (r_1, r_2, g_2, \pi_2) \tag{A23}$$

$$r_{LT} = F^8 (r_1, r_2, g_2, \pi_2, \upsilon_2) \tag{A24}$$

Appendix 2. The Effects of Credit Growth, Global Risk Appetite, and the Nominal Effective Exchange Rate on Indian Government Bond Yields

While this paper is based on a Keynesian perspective on government bond yields, it can be worthwhile to examine the view that a number of other macroeconomic variables—such as credit growth, global investors' risk appetite, the index of the nominal effective exchange rate, and financial flows—could have marked effects on government bond yields. Increased (decreased) access to credit should lead to higher (lower) demand for government bonds and hence would cause bond prices to rise (fall) and bond yields to decline (increase). The appreciation (depreciation) of the Indian rupee should lead to lower (higher) bond yields because investors, particularly foreign investors, are compensated for the increase

Figure A2.1. **The Evolution of Credit to the Private Sector in India**



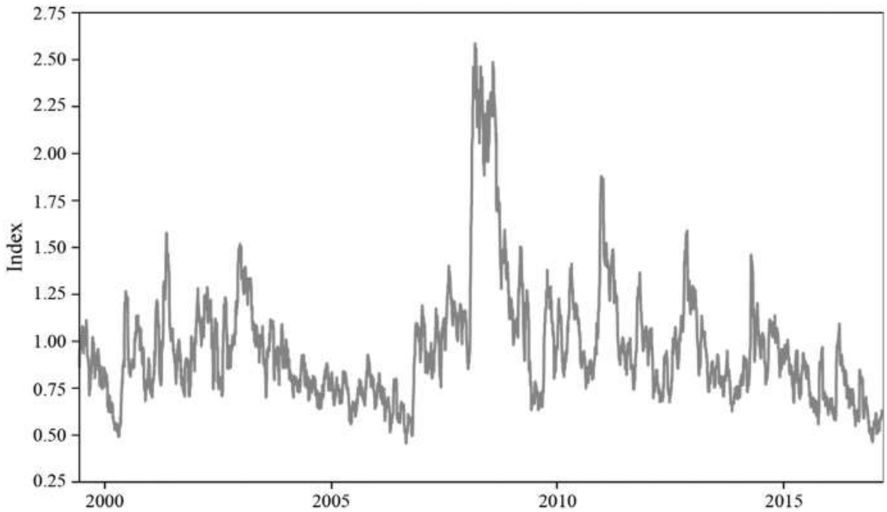
GDP = gross domestic product.
Source: Macrobond. Various years. Macrobond subscription services (accessed September 13, 2018).

(reduction) in the value of the currency. Increased (decreased) perception of risk, as measured by higher (lower) volatility in global bond markets, should lead to higher (lower) government bond yields in India. This appendix examines whether any of these variables have a discernable influence on government bond yields as posited.

The hypothesis that credit growth, global investors' risk appetite, and the exchange rate matter is supported in some of the findings reported in the recent empirical literature on the determinants of government bond yields. Arslanalp and Poghosyan (2014) show that an increase in the share of government debt held by foreign investors can explain a reduction in long-term government bond yields. Ebeke and Lu (2014) report that foreign holdings of local currency government bonds in emerging markets exert downward pressure on government bond yields, though they note that an increase in such holdings is associated with somewhat increased yield volatility in the post-Lehman period. Other researchers have explored the effects of overall credit growth and the exchange rate on government bond yields in emerging markets.

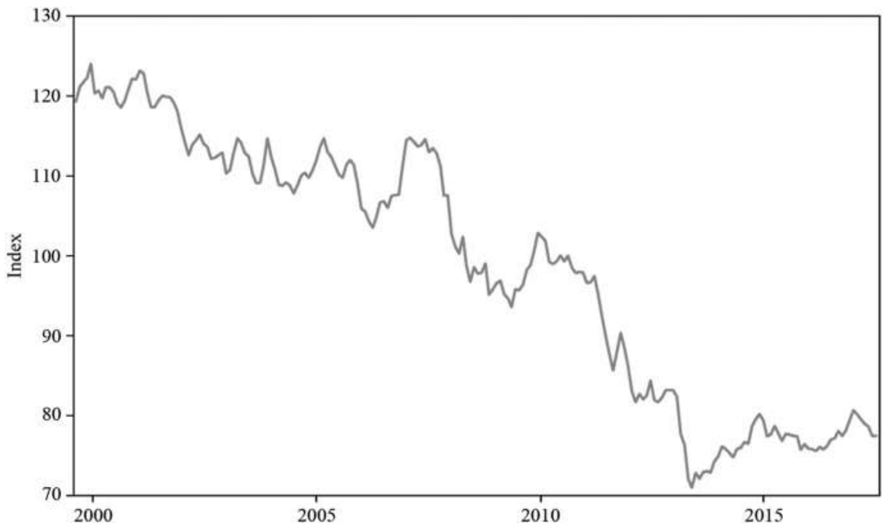
The evolution of some of these additional variables for India is shown in the figures below. Figure A2.1 shows that the ratio of overall credit to nominal gross domestic product steadily increased for many years before stabilizing in recent years. Figure A2.2 depicts the evolution of volatility in global bond markets. Volatility in government bond markets rose sharply during both the global financial crisis and the eurozone debt crisis. Such volatility is a good proxy for global investors' risk appetite. Figure A2.3 displays the evolution of the nominal effective exchange rate for the Indian rupee. The Indian rupee depreciated steadily versus

Figure A2.2. **The Evolution of Risk as Measured by the Global Market Volatility Index**



Source: Macrobond. Various years. Macrobond subscription services (accessed September 13, 2018).

Figure A2.3. **The Evolution of the Nominal Effective Exchange Rate of the Indian Rupee**



Source: Macrobond. Various years. Macrobond subscription services (accessed September 13, 2018).

the United States dollar between 2000 and 2014. Since 2014, it has appreciated modestly and has been fairly stable.

After controlling for the short-term interest rate, rate of inflation, growth of industrial production, and debt ratio, the effects of credit growth, global risk

Table A2.1. **Autoregressive Distributive Lag Bounds Test Results for IGB2YR (monthly data)**

Equation	*F*-statistic
B1.1) IGB2YR = $\beta_0 + \beta_1$TB3M + β_2CREDIT + β_3NEER + β_4RISK	**9.86**
B1.2) IGB2YR = $\beta_5 + \beta_6$TCPIYOY + β_7CREDIT + β_8NEER + β_9RISK	**5.79**
B1.3) IGB2YR = $\beta_{10} + \beta_{11}$IPIYOY + β_{12}CREDIT + β_{13}NEER + β_{14}RISK	**8.03**
B1.4) IGB2YR = $\beta_{15} + \beta_{16}$TB3M + β_{17}TCPIYOY + β_{18}CREDIT + β_{19}NEER + β_{20}RISK	**7.58**
B1.5) IGB2YR = $\beta_{21} + \beta_{22}$TB3M + β_{23}IPIYOY + β_{24}CREDIT + β_{24}NEER + β_{27}RISK	**8.58**
B1.6) IGB2YR = $\beta_{28} + \beta_{29}$TB3M + β_{30}TCPIYOY + β_{31}IPIYOY + β_{32}CREDIT + β_{33}NEER + β_{34}RISK	**5.99**

Long-Run Relationships

Variable	Equation B1.1	Equation B1.2	Equation B1.3	Equation B1.4	Equation B1.5	Equation B1.6
TB3M	0.46^{***}	—	—	0.47^{***}	0.47^{***}	0.45^{***}
	(0.04)			(0.03)	(0.04)	(0.04)
TCPIYOY	—	0.05	—	−0.20	—	−0.04
		(0.15)		(0.03)		(0.04)
IPIYOY	—	—	0.00	—	−0.02	−0.01
			(0.05)		(0.02)	(0.02)
CREDIT	0.07^{***}	0.10	0.16^{***}	0.06	0.08^{***}	0.07
	(0.01)	(0.27)	(0.04)	(0.05)	(0.01)	(0.06)
NEER	0.01^{***}	0.02	0.03	0.01	0.02^{**}	0.01
	(0.01)	(0.06)	(0.03)	(0.01)	(0.01)	(0.01)
RISK	-1.07^{***}	-3.26^{***}	-4.07^{***}	-0.89^{***}	-1.28^{***}	-1.04^{***}
	(0.19)	(0.75)	(1.11)	(0.18)	(0.26)	(0.27)
Constant	−0.28	2.82	−0.61	0.30	−1.44	0.08
	(0.99)	(19.83)	(4.49)	(3.54)	(1.24)	(4.14)
Time period	May 2003–Oct 2015	Mar 2007–Oct 2015	Aug 2009–Oct 2015	Mar 2007–Oct 2015	Jul 2003–Oct 2015	Feb 2007–Oct 2015
Number of observations	150	104	147	107	148	105

CREDIT = credit to the private sector as percentage of gross domestic product, IGB2YR = 2-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, NEER = nominal effective exchange rate, RISK = global bond market volatility index, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.

Notes: *** represents 1% level of significance. Standard errors are in parentheses.

Source: Authors' calculations.

appetite, and the nominal effective exchange rate on the nominal yields of Indian government bonds (IGBs) of various tenors are examined using monthly data. Autoregressive distributive lag bounds test results are obtained. When the computed *F*-statistic value is higher than the upper bound value, the long-run relationships are estimated.

The results of the empirical investigation are presented in Tables A2.1–A2.5. An increase in the ratio of credit to nominal GDP leads to slightly higher IGB yields rather than lower yields. The coefficient for the index of the nominal

Table A2.2. **Autoregressive Distributive Lag Bounds Test Results for IGB3YR (monthly data)**

Equation	***F*–statistic**
B2.1) IGB3YR = $\beta_{35} + \beta_{36}$TB3M + β_{37}CREDIT + β_{38}NEER + β_{39}RISK	**8.73**
B2.2) IGB3YR = $\beta_{40} + \beta_{41}$TCPIYOY + β_{42}CREDIT + β_{43}NEER + β_{44}RISK	**5.96**
B2.3) IGB3YR = $\beta_{45} + \beta_{46}$IPIYOY + β_{47}CREDIT + β_{48}NEER + β_{49}RISK	**8.04**
B2.4) IGB3YR = $\beta_{50} + \beta_{51}$TB3M + β_{52}TCPIYOY + β_{53}CREDIT + β_{54}NEER + β_{55}RISK	**6.35**
B2.5) IGB3YR = $\beta_{56} + \beta_{57}$TB3M + β_{58}IPIYOY + β_{59}CREDIT + β_{60}NEER + β_{61}RISK	**7.82**
B2.6) IGB3YR = $\beta_{62} + \beta_{63}$TB3M + β_{64}TCPIYOY + β_{65}IPIYOY + β_{66}CREDIT + β_{67}NEER + β_{68}RISK	**5.02**

Long-Run Relationships

Variable	**Equation B2.1**	**Equation B2.2**	**Equation B2.3**	**Equation B2.4**	**Equation B2.5**	**Equation B2.6**
TB3M	0.35***	—	—	0.36***	0.35***	0.34***
	(0.04)			(0.04)	(0.04)	(0.04)
TCPIYOY	—	0.06	—	−0.02	–	−0.01
		(0.09)		(0.03)		(0.04)
IPIYOY	—	—	−0.01	—	–0.01	−0.01
			(0.04)		(0.02)	(0.02)
CREDIT	0.09***	−0.06	0.14***	0.04	0.09***	−0.02
	(0.01)	(0.14)	(0.03)	(0.05)	(0.01)	(0.05)
NEER	0.01***	−0.02	0.03	0.01	0.02**	−0.01
	(0.01)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)
RISK	−0.97***	−2.78***	−3.06***	−0.66***	–1.07***	−0.73***
	(0.18)	(0.64)	(0.75)	(0.17)	(0.22)	(0.23)
Constant	−0.58	15.39	−0.24	2.46	–1.02	7.35*
	(0.99)	(1.014)	(3.27)	(4.00)	(1.22)	(3.92)
Time period	May 2003–Oct 2015	Jan 2007–Oct 2015	Aug 2003–Oct 2015	Dec 2006–Oct 2015	Jul 2003–Oct 2015	Feb 2007–Oct 2015
Number of Observations	150	106	147	107	148	105

CREDIT = credit to the private sector as percentage of gross domestic product, IGB3YR = 3-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, NEER = nominal effective exchange rate, RISK = global bond market volatility index, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.
Notes: *** represents 1% level of significance. Standard errors are in parentheses.
Source: Authors' calculations.

effective exchange rate is positive. This implies that as the Indian rupee appreciates (depreciates), IGB yields rise (fall). The estimated coefficient on risk shows that as risk (as measured by global bond market volatility) rises (falls), IGB yields decline (increase).

The results from the additional regressions estimated in this Appendix suggest that the ratio of credit to nominal GDP, nominal effective exchange rate, and investors' risk appetite (volatility) in global bond markets are not important drivers of IGB yields in India. However, the short-term interest rate is always found to be

Table A2.3. **Autoregressive Distributive Lag Bounds Test Results for IGB5YR (monthly data)**

Equation	***F*–statistic**
B3.1) IGB5YR = $\beta_{69} + \beta_{70}$TB3M + β_{71}CREDIT + β_{72}NEER + β_{73}RISK	**6.60**
B3.2) IGB5YR = $\beta_{74} + \beta_{75}$TCPIYOY + β_{76}CREDIT + β_{77}NEER + β_{78}RISK	**5.60**
B3.3) IGB5YR = $\beta_{79} + \beta_{80}$IPIYOY + β_{81}CREDIT + β_{82}NEER + β_{83}RISK	**6.51**
B3.4) IGB5YR = $\beta_{84} + \beta_{85}$TB3M + β_{86}TCPIYOY + β_{87}CREDIT + β_{88}NEER + β_{89}RISK	**4.02**
B3.5) IGB5YR = $\beta_{90} + \beta_{91}$TB3M + β_{92}IPIYOY + β_{93}CREDIT + β_{94}NEER + β_{95}RISK	**5.88**
B3.6) IGB5YR = $\beta_{96} + \beta_{97}$TB3M + β_{98}TCPIYOY + β_{99}IPIYOY + β_{100}CREDIT + β_{101}NEER + β_{102}RISK	**5.23**

Long-Run Relationships

Variable	**Equation B3.1**	**Equation B3.2**	**Equation B3.3**	**Equation B3.4**	**Equation B3.5**	**Equation B3.6**
TB3M	0.21***	—	—	0.23***	0.21***	0.21***
	(0.05)			(0.05)	(0.05)	(0.04)
TCPIYOY	—	0.02	—	0.01	—	0.01
		(0.06)		(0.04)		(0.04)
IPIYOY	—	—	−0.01	—	−0.02	−0.02
			(0.03)		(0.02)	(0.02)
CREDIT	0.09***	−0.02	0.13***	−0.05	0.10	−0.03
	(0.01)	(0.09)	(0.02)	(0.06)	(0.01)	(0.05)
NEER	0.01*	−0.01	0.02	−0.01	0.02*	−0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
RISK	−0.78***	−1.79***	−2.05***	−0.34	−0.89***	−0.73***
	(0.22)	(0.40)	(0.51)	(0.22)	(0.27)	(0.23)
Constant	0.31	11.65*	0.20	10.30**	−0.68	9.54**
	(1.36)	(6.85)	(2.45)	(4.22)	(1.70)	(3.91)
Time period	Jan 2007–Oct 2015	Dec 2006–Oct 2015	Aug 2003–Oct 2015	Dec 2006–Oct 2015	Jul 2003–Oct 2015	Feb 2007–Oct 2015
Number of observations	150	107	147	107	148	105

CREDIT = credit to the private sector as percentage of gross domestic product, IGB5YR = 5-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, NEER = nominal effective exchange rate, RISK = global bond market volatility index, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.

Notes: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. Standard errors are in parentheses.

Source: Authors' calculations.

positive and statistically significant, irrespective of the equations used to estimate the determinants of long-term government bond yields. This particular result is robust and insensitive to any changes in the specification. This result supports Keynes' contention in the case of India.

Table A2.4. **Autoregressive Distributive Lag Bounds Test Results for IGB7YR (monthly data)**

Equation	***F*–statistic**
B4.1) IGB7YR = $\beta_{103} + \beta_{104}$TB3M + β_{105}CREDIT + β_{106}NEER + β_{107}RISK	**3.17**
B4.2) IGB7YR = $\beta_{108} + \beta_{109}$TCPIYOY + β_{110}CREDIT + β_{111}NEER + β_{112}RISK	**2.90**
B4.3) IGB7YR = $\beta_{113} + \beta_{114}$IPIYOY + β_{115}CREDIT + β_{116}NEER + β_{117}RISK	**5.91**
B4.4) IGB7YR = $\beta_{118} + \beta_{119}$TB3M + β_{120}TCPIYOY + β_{121}CREDIT + β_{122}NEER + β_{123}RISK	**4.28**
B4.5) IGB7YR = $\beta_{124} + \beta_{125}$TB3M + β_{126}IPIYOY + β_{127}CREDIT + β_{128}NEER + β_{129}RISK	**4.97**
B4.6) IGB7YR = $\beta_{130} + \beta_{131}$TB3M + β_{132}TCPIYOY + β_{133}IPIYOY + β_{134}CREDIT + β_{135}NEER + β_{136}RISK	**3.69**

Long-Run Relationships

Variable	**Equation B4.1**	**Equation B4.3**	**Equation B4.4**	**Equation B4.5**	**Equation B4.6**
TB3M	0.22***	—	0.18***	0.15**	0.18***
	(0.08)		(0.05)	(0.06)	(0.05)
TCPIYOY	—	—	0.03	–	0.03
			(0.04)		(0.05)
IPIYOY	—	−0.02	—	–0.02	−0.02
		(2.28)		(0.02)	(0.02)
CREDIT	0.09***	0.13***	−0.07	0.10***	−0.08
	(0.02)	(0.02)	(0.06)	(0.02)	(0.06)
NEER	0.02*	0.02	−0.02	0.02*	−0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
RISK	−0.19	−1.69***	−0.15	–0.83***	−0.28
	(0.41)	(0.45)	(0.24)	(0.30)	(0.31)
Constant	−0.17	−0.02	11.89***	–0.40	12.39***
	(1.90)	(0.03)	(4.41)	(1.86)	(4.59)
Time period	Jan 2007–Oct 2015	Aug 2003–Oct 2015	Dec 2006–Oct 2015	Jul 2003–Oct 2015	Feb 2007–Oct 2015
Number of Observations	150	147	107	148	105

CREDIT = credit to the private sector as percentage of gross domestic product, IGB7YR = 7-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, NEER = nominal effective exchange rate, RISK = global bond market volatility index, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.

Notes: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. Standard errors are in parentheses.

Source: Authors' calculations.

Table A2.5. **Autoregressive Distributive Lag Bounds Test Results for IGB10YR (monthly data)**

Equation	***F*-statistic**
B5.1) IGB10YR = $\beta_{137} + \beta_{138}$TB3M + β_{139}CREDIT + β_{140}NEER + β_{141}RISK	**3.51**
B5.2) IGB10YR = $\beta_{142} + \beta_{143}$TCPIYOY + β_{144}CREDIT + β_{145}NEER + β_{146}RISK	**2.89**
B5.3) IGB10YR = $\beta_{147} + \beta_{148}$IPIYOY + β_{149}CREDIT + β_{150}NEER + β_{151}RISK	**2.83**
B5.4) IGB10YR = $\beta_{152} + \beta_{153}$TB3M + β_{154}TCPIYOY + β_{155}CREDIT + β_{156}NEER + β_{157}RISK	**4.19**
B5.5) IGB10YR = $\beta_{158} + \beta_{159}$TB3M + β_{160}IPIYOY + β_{161}CREDIT + β_{162}NEER + β_{163}RISK	**3.08**
B5.6) IGB10YR = $\beta_{164} + \beta_{165}$TB3M + β_{166}TCPIYOY + β_{167}IPIYOY + β_{168}CREDIT + β_{169}NEER + β_{170}RISK	**3.59**

Long-Run Relationships

Variable	**Equation B5.1**	**Equation B5.4**	**Equation B5.5**	**Equation B5.6**
TB3M	0.66***	0.17***	0.66***	0.17***
	(0.15)	(0.05)	(0.15)	(0.05)
TCPIYOY	—	0.07*	—	0.07
		(0.04)		(0.04)
IPIYOY	—	—	−0.05	−0.01
			(0.07)	(0.02)
CREDIT	0.04	−0.09	0.05	−0.10
	(0.04)	(0.06)	(0.05)	(0.06)
NEER	0.04	−0.01	0.06	−0.01
	(0.03)	(0.01)	(0.04)	(0.01)
RISK	2.04*	−0.00	1.72	0.08
	(1.08)	(0.24)	(1.17)	(0.31)
Constant	−4.69	12.88***	−6.74	13.17***
	(4.83)	(4.51)	(6.36)	(4.66)
Time period	Mar 1999–Oct 2015	Dec 2006–Oct 2015	Jun 1999–Oct 2015	Feb 2007–Oct 2015
Number of observations	199	107	197	105

CREDIT = credit to the private sector as percentage of gross domestic product, IGB10YR = 10-year government bond yield, IPIYOY = year-on-year percentage change in industrial production, NEER = nominal effective exchange rate, RISK = global bond market volatility index, TB3M = 3-month government auction rate, TCPIYOY = year-on-year percentage change in consumer price index.

Notes: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. Standard errors are in parentheses.

Source: Authors' calculations.