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A Keynesian Exploration of the Determinants of Government Bond Yields for Brazil, Colombia, and Mexico

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PLAGIARISM STATEMENT

I have written this project using my own words and ideas, except otherwise indicated. I have subsequently attributed each word, idea, figure, and table which is not my own to their respective authors. I am aware that paraphrasing is plagiarism unless the source is duly acknowledged. I understand the incorporation of material from other works without acknowledgement will be treated as plagiarism. I have read and understand the Levy Economics Institute of Bard College statement on plagiarism and academic honesty as well as the relevant pages in the Student Handbook.

Simon Simoski 05/21/2019

ABSTRACT

This dissertation investigates the long-term determinants of the government bond nominal yields of Brazil, Colombia, and Mexico. It deploys vector error correction (VEC) model to assess whether John Maynard Keynes's view that the central bank's actions, mainly through short-term interest rates and various monetary policy measures, are the key drivers of long-term government bond yields over the long-run, after controlling for key economic variables such as the inflation rate, GDP growth rate, and government debt- and deficit-to-GDP ratios. The results from the models estimated indicate that short-term interest rates are the main drivers of long-term government bond yields for all three countries thus supporting Keynes's conjectures in the context of Latin American emerging markets. The results also demonstrate that higher government debt and deficit ratios do not exert upward pressures on the Brazilian government bond yields. Contrary to conventional wisdom, a rise in the Brazilian government debt- and deficit-to-GDP ratios lowers the government bond yields. For Colombia and Mexico, some of the results from the estimated models are in concordance with the conventional view, but many also suggest that the government finance variables do not have statistically significant effect on the government bond yields.

Keywords: Emerging Financial Markets; Government Bond Yields; John Maynard Keynes; Latin America; Long-Term Interest Rates; Monetary Policy; Short-Term Interest Rates; Time-Series Models

JEL Classifications: C32; E43; E50; E58; E60; G10; G12; O16

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INTRODUCTION

The Latin American debt trading markets started to develop in 1989 with the implementation of the Brady Plan. By the 1980s, many Latin American countries could not meet their debt servicing obligations – a period that has been referred to as the "Lost Decade." The Brady Plan, through debt restructuring i.e., reduction agreements, enabled the Latin American countries to get credit enhancement, allowing them a greater access to the international financial markets. But since then, the Latin American countries have been subject to structural adjustment programs proposed by the IMF and the World Bank. In the 1990s, the countries of Brazil, Colombia, and Mexico still continued to experience episodes of high inflation, currency volatility, and debt crises. However, following the turn of the 21st century, there has been a major development in the bond markets in most of the Latin American countries. As the external financing was declining, the domestic bond markets were developing at a high pace. Through the years, the average maturity of the domestic outstanding debt lengthened, the institutional collaboration between the Treasury departments and the central banks strengthened, and the financial structural framework improved.

This dissertation investigates as to whether central bank's actions mainly determine Latin American government bonds' nominal yields through the short-term interest rate. We try to answer this question by testing whether short-term interest rates, after controlling for other crucial variables, such as rate of inflation, rate of economic activity, and ratios of government debt-and deficit-to-GDP, take a lead role in driving long-term interest rates on a long run basis since the 2000s.

There is a substantial amount of literature on the determinants of government bond yields. One side of the literature corresponds to the conventional view that higher government debt-and deficit-to-GDP ratios exert upward pressure on government bond yields (Ardagna, Caselli, and Lane 2007; Baldacci and Kumar 2010; Cebula 2014; Grandes 2007; Gruber and Kamin 2012; Lam and Tokuoka 2011; Martinez, Tercenoa, and Teruelb 2013; Min et al. 2003; Paccagnini 2016; Perovic 2015; Poghosyan 2012). The other side of the literature represents the Keynesian view, which is that central bank's actions affect the government bond yields, primarily through the effect of the policy rates on short-term interest rates and other tools of monetary policy (Keynes 1930). Although in the *General Theory*, Keynes ([1936] 2007) addressed the idea that psychological, social and business incentives to investors' liquidity preferences are also significant factors in determining the interest rate, he still emphasized that there is a direct link between central bank's actions and interest rates. Following Keynes's notion of ontological uncertainty and his contention that investors extrapolate the future outlook from the present, several studies, such as Akram and Das (2014, 2015, 2017a, 2017b, 2018) and Akram and Li (2017a, 2017b, 2018) demonstrate that short-term interest rates are the key drivers of long-term government bond yields. This body of literature also addresses that the ratios of government debt-and deficit-to-GDP do not have adverse effect on the government bond yields.

This dissertation fills this literature gap by investigating whether Keynes's conjectures are valid in the Latin American emerging markets, specifically, for the countries of Brazil, Colombia, and Mexico. It implements vector error correction (VEC) modeling to assess the determinants of the long-term government bond yields. The results from the majority of the models demonstrate that the short-term interest rate are, in fact, the most important determinants of long-term interest rates for all three countries. In addition, some of the results from the models for Brazil suggest that, over the long term, an increase in the ratios of the government finance variables lowers the government bond yields. These findings align with modern monetary theory (Wray 2003, 2012), modern central bank's operational framework (Bindseil 2004; Fullwiler 2008), and recent developments in macroeconomic monetary theory (Sims 2013; Woodford 2001). For Colombia and Mexico, some of the estimations from the models are in concordance with the conventional view, but quite a few also suggest that government finance variables have hardly any influence on government bond yields.

This dissertation is organized as follows: chapter 1 presents a theoretical and an empirical overview of the literature with regards to government bond yields; chapter 2 describes important and recent stylized facts about the economies of Brazil, Colombia, and Mexico; chapter 3 gives the institutional background of their central banks and their government debt markets; chapter 4 describes the data and its sources, and provides a detailed analysis of the model of long-term interest rates according to Keynes's views; chapter 5 presents the econometric framework applied in this dissertation, reports the model estimations, and interprets the findings, and lastly, the conclusion provides a summary of the main findings and their implications for macroeconomic theory and policy along with a discussion of some policy remarks.

LITERATURE REVIEW

Theoretical Background

There are two major strands in the theoretical literature that lay out what explains and determines the interest rate. The framework of one strand has been referred to as the real theory of interest rate, which finds its roots in Irving Fisher. This framework operates in a so-called real exchange economy where a natural rate of interest establishes long-run neutrality of money (Fisher 1907, 1930). The other aligns with John Maynard Keynes and his monetary theory of interest rate (Keynes [1936] 2007). Since economies are based on monetary production, this framework puts an emphasis on liquidity preference, monetary conditions, and financial institutions.

Fisher And The New Monetary Consensus

The central banks of Brazil, Colombia, and Mexico abide by the principle of inflation targeting – a policy strategy based upon the New Monetary Consensus (NMC) in which the main goal is to achieve a stable and low rate of inflation. NMC has its roots in Monetarism and in the economic debates of the 1970s that led to the rejection of counter-cyclical policies as a way to establish stable economic growth. The basic underlying framework of the NMC is to stabilize the so-called "natural interest rate" by managing inflation and inflation expectations (Smithin [1994] 2003, 108-17; Tymoigne 2009, 7-13; Wicksell [1898] 1965). The understanding is that the natural interest rate is an equilibrium real interest rate that is set in the loanable funds market. In this market, savers on the supply side are rewarded by giving up present consumption and investors on the demand side borrow funds from the savers.

This is, in fact, the real exchange economy, which brings us to Fisher's theory of the rate of interest. Fisher's theory centers on intertemporal consumption preferences by rational economic individuals who, given their time preference, decide on what assets to buy (lend) or to sell (borrow) that would eventually provide them with the highest rate of return (Fisher 1907, 36; Fisher 1930, 131). This arbitrage between present and future incomes can be extended in the aggregate with regards to a monetary asset and commodity called the real aggregate income, with the assumption that there is a representative rate that allows us to compare the rates of return (Fisher 1907, 328; Fisher 1930, 45; Kregel 1998, 126-8; Robertson 1940, 84). The arbitrage stops when the rate of return in terms of the monetary asset becomes equal to the rate of return on real income:

$$i_t = r_t + p_t \tag{1.1}$$

In this equation, i_t is the nominal interest rate, r_t denotes the rate of return on real income and is often referred to as the natural rate of interest, and p_t stands for the rate of inflation. When $i_t < r_t + p_t$, the investors have an incentive to borrow because the cost of credit is lower than the rate of return on non-monetary assets corrected for the rate of inflation. As a result, there is an increase in investment and spending, which leads to higher inflation and, with that higher inflation expectations. In order to make sure that inflation is on target and that expectations of inflation are realized, central banks would tighten their policy by increasing the nominal interest rate (Tymoigne 2009, 12-3). Conversely, when $i_t > r_t + p_t$, the cost of credit is greater than the rate of return on non-monetary assets adjusted for the rate of inflation. As a result, borrowing falls and inflation declines. Thus, central banks would loosen their policy by lowering the nominal interest to manage their inflation targets.

Before NMC, the central bank's inflation targeting approach was dominated by Monetarism, which proposes targeting of monetary aggregates in order to manage the money supply and keep inflation stable (Arestis and Sawyer 2003; Wray 2006). This relates back to the loanable funds framework in which monetary conditions cannot influence the natural rate of interest. In standard loanable funds market, the interest rate provides an extra return for the foregone consumption. This means that the return for savings increases as the interest rate increases, which increases the supply of funds in the market. On the other side of the market are the investors who make investment decisions based on the marginal product of capital vis-à-vis the cost of investing (i.e., the interest rate). Thus, individuals must have lower preference for present consumption so that the interest rate can fall, which would make the investments more profitable. Consequently, the interest rate is determined in the market through arbitrage by economic units adjusting their intertemporal consumption patterns, thus, ensuring that savings equals investment. However, Fisher actually believed that the central bank should focus on minimizing the "discrepancy between real interest rate and money rate" by managing inflation expectations (Fisher 1932, 127). Even before Fisher, Wicksell ([1898] 1965) argued that central banks should react to the inflationary/deflationary pressures by adjusting their nominal rate in order to control the natural rate. Unlike the Monetarists, both Fisher and Wicksell favored central bank management of interest rates – setting the nominal interest rate to be consistent with the interest rate of non-monetary assets. Moving to the present, this associates with the current policy objectives of inflation targeting by the central banks. Operating the interest rate target to manage inflation expectations has become the dominant goal of monetary policy making (Agenor 2002; Bernanke and Mishkin 1997; King 2005; Svensson 1999).

New Monetary Consensus Criticism

Despite its prevalence, the policy approach of the NMC has been under some criticism. Arestis and Sawyer (2003) address the margins of error in forecasting inflation. They also raise doubts on central banks adjusting the interest rate with the purpose of achieving zero output gap and securing equilibrium between planned savings and planned investment. Palley (2003) points out that inflation targeting policy cannot control asset price bubbles. Furthermore, Goodhart (2005) and Woodford (2007) question the availability and formulation of the forecasts regarding inflation expectations. The harshest criticism comes from Chari, Kehoe, and McGrattan (2008) who state that models adhering to the NMC are not realistic and should not be used for policy analysis.

Central banks need to put more emphasis on the management of financial imbalances. Since central banks can closely target the interest rate, they can promote interest rate stability. Large variations in the interest rate operation targets raise uncertainty with regards to the short-term rate and the long-term rate (Kaldor 1982). Namely, with different maturity terms, financing activity can be susceptible to interest rate changes. Moreover, a volatile interest rate environment could trigger changes in the long-term rates that eventually impact the values of assets and liabilities – causing insolvency problems (Kregel 1998, 130-2; Tymoigne 2009, 45). It is very difficult for a central bank to manage inflation since it cannot control the endogenous nature of money supply creation. Instead of low inflation, the central bank's main role should be to promote financial stability and a stable yield curve (Hannsgen 2005; Kregel 1998, 2003). This dissertation does not argue that monetary policy should be favored over fiscal policy, but that a stable term structure can help reinforce a more robust financial structure. This is a paramount necessity before implementing any kind of full-employment policy by the government (Minsky 1975).

The Keynesian Approach

All of these functions, objectives, and operations of the central bank had been put forward by Keynes, who has laid a monetary theory of interest rates. Keynes's framework puts an emphasis on monetary conditions and financial institutions. Keynes was completely against the classical views on the rate of interest held by Marshall (1890), Cassel (1903), and Taussig (1918) that the marginal productivity of capital and the marginal installment of saving tend to converge toward an equilibrium meeting at a common rate of interest. According to Keynes, "the rate of interest cannot be a return to saving" since it "is the reward for parting with liquidity for a specified period." (Keynes [1936] 2007, 166-7). Keynes went on to argue that the classical theory of interest is a "nonsense theory" since it neglects "the relevance of changes in the level of income or the possibility of the level of income being actually a function of the rate of investment." (Keynes [1936] 2007, 180). Keynes also diverges from the neoclassical theory by claiming that investment is not only a function of interest rates and that we cannot keep the state of investor expectations constant. Investment is affected by fundamental uncertainty, so expected profitability of investors and lending institutions play a key role for investment to take place.[1]

In a monetary theory production economy, there are no perfect foresight rational economic units. Instead, there is uncertainty and the economy is driven by the expected future proceeds. While assets were perfect substitutes in Fisher's framework, liquidity preference is a concern in Keynes's theory. Namely, the spread between the short-term and the long-term rates of interest is actually determined by the preferences of investors toward liquid or illiquid positions (Lavoie 1992, 195; Wells 1983, 533). Money is not neutral, acting as a "lubricant that oils the wheels of production and exchange" (Davidson 1994, 14). Money is actually a "real factor determining production decisions in a modern economy" (Kregel 1998, 111). Contrary to Fisher's real rate of interest, Keynes has an own rate of interest. In both theories, the interest rate is a spot-forward relationship. However, Keynes' own rate of interest is a relation between the spot-forward quantities of an asset (Kregel 1998; Tymoigne 2009, 255-8).

With respect to the yield curve, the current accepted explanation of the interest rates can be found in Fisher's conjectures regarding "expectations of future goods prices relative to present goods prices." (Kregel 1998, 125). Thus, the expected future inflation rate is the main

[1] A more detailed analysis of Keynes's view on the drivers of long-term interest rates with regards to investment decisions is covered in the Data and Methodology chapter.

determinant of the yield curve. However, the perfectly foreseen rate of inflation neglects the impact of interest rates on the price of securities because bondholders, for instance, in anticipation of higher inflation, will eventually end up with a lower total real return on the investment. The reasoning here is that the higher interest rate, to compensate for the increased inflation, erodes the principal value of the bond. Kregel lays out Keynes's argument against Fisher by stating that, "Fisher's relation goes in the wrong direction since the higher yields required to preserve real yields causes capital losses that more than offset the increased interest earnings." (128). For Keynes, the shape of the yield curve depends on the "expectation of changes in prices of longer-term bonds" (131). This is different from the Hicksian expectation hypothesis, which argues that long-term rates reflect expected future short-term rates, which are further determined by future inflation rates. This essentially means that the long rates are in fact averages of short-term rates without any reference to potential changes in the assets' capital values due to short-term changes (Hicks [1939] 1946). This would be true if investors were only income-risk sensitive and happy to hold securities for a long time because "the fear of income loss more than offsets a mild change of capital loss." (Kahn 1972, 83).

However, an economy is primarily dominated by financial institutions that have asset liability mismatches, which means that changes in capital values play a significant role in the structure of the balance sheets (Kahn 1972, 74-5; Kregel 1998, 131; Rezende 2015). Thus, there are also capital-risk investors who participate in bond trading, making capital gains and so are afraid of interest rate changes (Tymoigne 2009, 65). Fisher's relation thus portrays an economy with economic units, waiting for their real asset returns to be realized that they perfectly foresaw. On the other hand, by emphasizing that it was not legitimate to hold the state of investor expectations constant due to the notion of uncertainty, Keynes explicitly states that the expected rate of return on an asset depends on the expected gains from holding the asset, the expected carrying costs in taking a position in the asset, the expected capital gain if the asset is sold, and the liquidity premium, which is the reward for "walking away" from a liquid asset to an illiquid asset (Keynes [1936] 2007, 222-44). Hence, changes in liquidity preference accompany changes in investment decisions. In a Keynesian framework, investors assess their expected investment horizon rate of return based on "subjective evaluations about future movements of short and long-term rates, holding period, risk preferences, and the degree of conviction of those assessments (Rezende 2015, 74). The Keynesian approach, therefore, describes the yield curve as the interplay between the expected future long rates relative to the short-term borrowing rate, which properly portrays modern capital markets where the expected capital gains of the investors' levered portfolios are always measured against the cost of financing (Kregel 1998, 132).

Keynes ([1936] 2007), however, was adamant about monetary authorities being successful in exerting direct control on the "determinate rate of interest, or more strictly, a determinate rate of interest for debts of different maturities" (204). In the *Treatise* Keynes (1930) argued that, "the influence of the short-term rate of interest on the long-term rate is much greater than anyone would have expected," and, that, we should have no doubts in the central bank's ability to "make its short-term rate of interest effective in the market." (315-24). And even though, in Keynes-Kahn it is the expected future long rates that affect the demand for short-term debt, as Kregel puts it:

> "The shape of the yield curve is determined by expectation of changes in long rates relative to the short borrowing rate. Monetary policy, which can only influence short rates, can influence the shape of the yield curve and thus long rates, to the extent that it is capable of influencing expectations of changes in long rates. That is, by influencing the estimates of the future that determine present prices." (Kregel 1998, 132).

To support his views, Keynes drew upon the writings of Riefler (1930), who demonstrated in numerous Federal Reserve statistical studies that the actual range of fluctuations in the long-term interest rates in the United States closely followed the fluctuations in the short-term interest rates, and that this similarity is "more than just a merest chance" (115). Riefler argued that "monetary forces cause banks and other investors to change their participation in the investment markets," and, as a result, "bond prices and bond yields are influenced directly in some measure by the same monetary forces which account for changes in short-term money rates." (116).

Although Keynes in the *General Theory* pointed to other factors such as liquidity preference, social norms, and business and psychological motives that could affect interest rates, he still suggested that there is a strong direct relation between monetary authorities and interest rates "if the monetary authority were prepared to deal both ways on specified term in debts of all maturities and even more so if it were prepared to deal in debt of varying degrees of risk" (Keynes [1936] 2007, 205). Keynes went on to further argue that "a complex offer by the central bank to buy and sell at stated prices gilt-edged bonds of all maturities, in place of the single bank rate for short-term bills, is the most important practical improvement which can be made in the technique of monetary management." (206).

The Crowding Out Argument

The loanable funds market explored earlier also has implications with regards to fiscal policy since the "government's fundamental objective is to borrow a given amount of real resources, not a given amount of money." (U.S. Congress 1952, 690, statement of Milton Friedman). When the government decides that it wants to spend, it enters into competition with investors to get access to the available pool of savings in order to finance the deficit spending. This means that there is a higher demand for the accumulated stock of savings in the loanable funds market, which pushes up the natural interest rate thereby discouraging private investment. Therefore, it is argued that government spending "crowds out" private investment. This analysis has been reinforced with the NMC as monetary policy was given a larger role in influencing demand growth (Arestis and Sawyer 2003; Wray 2006). With monetary policy being more favored, it was argued that fiscal policy should focus on balancing the government budget (Arestis 2009).

However, in a monetary production economy, savings and investment are not necessarily independent as they are in the loanable funds market. Savings cannot occur before income, and banks do not need any prior deposits to finance loans. In fact, savings are a passive residual determined by disposable income and the marginal propensity to consume. Here we see that in a monetary production economy, the demand conditions and the level of economic activity play a central role. According to Kalecki's profit equation[2], when the government spends, there is an injection of income into the private sector. This improves the state of confidence among investors boosting their profit expectations from investment. Kalecki also made a similar argument with respect to the national debt, namely, that:

> "In the first place, interest on an increasing national debt…cannot be a burden to society as a whole because in essence it constitutes an internal transfer… Secondly, in an expanding economy this transfer need not necessarily rise out of proportion with the tax revenue at the existing rate of taxes. The standard rate of income tax necessary to finance the

[2] $\Pi = I + DEF + NX$, where Π is aggregate profit, I is private investment, DEF is government deficit, and NX is the net exports. The equation is just a simplified version without the workers' and capitalists' consumption. Kalecki (1954) derived the profit equation in order to explain economic growth and business cycle fluctuations through the lenses of income distribution, market structure, and pricing.

> increasing amount of interest on the national debt need not rise if the rate of expansion of the national income is sufficiently high." (Kalecki [1944] 1990, 363).

Kalecki's first point aligns with the arguments put forward by modern monetary theory, that, government spends by crediting bank reserves into the system. The second point indicates that government spending increases the growth rate as well as the tax receipts. As long as the growth rate is above the interest rate, the growth of the debt ratio cannot become unsustainable (Wray 2012).

But before the New Monetary Consensus started to put its stamp on economic policy, the Washington Consensus[3] in the 1980s had already established an agenda characterized by fiscal conservatism in which the central policy goal of the government was balancing the budget and achieving a sustainable debt level. In regards to current literature, one of the most well-known is the work of Reinhart and Rogoff (2009), who have constructed a case study for a set of 20 developed countries and concluded that when the government debt-to-GDP increases by more than 90 percent, the mean and median growth rates fall by 1 percentage point, and in some cases, even more than that. There are, however, all sorts of problems with these findings, and their whole case study has been dismantled by Herndon, Ash, and Pollin (2014), who demonstrate a number of inconsistencies and methodological errors. The relationship between national debt and economic growth rates vary significantly by period and country. For example, it could very well be the case that one or two larger-economy countries drive the results for the whole set of countries. In addition, Herndon, Ash, and Pollin (2014) criticize Reinhart and Rogoff on the basis of non-linearity of their data findings since they separate the countries in four data categories in terms of debt-to-GDP ratios (0-30, 30-60, 60-90, >90) across time. The fact that they find correlation between higher debt-to-GDP ratio and lower growth rates does not imply causation, especially after taking into account that government budget deficits increase following a recession which leads to accumulation of public debt. Herndon, Ash, and Pollin (2014) demonstrate that countries with debt-to-GDP ratios greater than 90 percent actually have positive real average GDP growth rates, which is contrary to what Reinhart and Rogoff claim. Herndon, Ash, and Pollin (2014) go on to show that Reinhart and Rogoff's empirical case study

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[3] A discourse of ideas and policy recommendations that was established following conventional economic orthodoxy in the late 1970s in which neoclassical economists adopted neoliberal ideology and were making market-oriented development prescriptions to the emerging countries (especially Latin America). Deficit reduction and inflation stabilization were at the cornerstone of the policy agenda (Bresser-Perreira 2008, 145-74).

suffers from coding errors, improper weighting of summary statistics, and selective exclusion of available data (258). But despite the serious drawbacks and wrong conclusions, Reinhart and Rogoff's work has generated interest among the mainstream economists who have picked up on it and started to implement government fiscal balance and debt ratios to empirically investigate their effects on government bond yields.

Empirical Background

There is substantial amount of empirical literature written on the determinants of government bond yields. One portion of the literature does not consider the Keynesian perspective and reinforces the conventional view that higher ratios of fiscal balance and government debt-to-GDP increases government bond yields. The other portion supports the Keynesian perspective. This empirical work emphasizes the important role of the short-term interest rates as major drivers of long-term bond yields, and provides some evidence that raise doubts about the crowding out arguments put forward by the conventional literature.

The Conventional View

Elmendorf and Mankiw (1998) provide an overview of the standard neoclassical loanable funds model as they survey the literature on the macroeconomic effects of government debt for the United States and 18 additional advanced countries. Supplemented with analyses on historical time trends, they come to the conclusion that fiscal deficits decrease national savings and increase aggregate demand. But this eventually has an impact on the long-term interest rates as there is an excess supply of government debt which leads to a higher real interest rates. Gale and Orszag (2003) also summarize the literature by exploring approximately 60 studies and find that half of them demonstrate evidence of crowding out, while the other half of the studies shows either no evidence and/or mixed results regarding the effects of government fiscal stance on government bond yields.

There have also been numerous panel data studies. This topic, for example, Ardagna, Caselli, and Lane (2007) explore the impact of public debt ratios on long-term government bond yields for 16 countries that are in the Organization for Economic Co-operation and Development (OECD) during 1960-2002. They find mixed effects because in the non-linear specification, the effect of a 1 percentage point increase in the debt-to-GDP ratio on the long-term bond yields varies from a decrease of 2.4 basis points to an increase of 3.8 basis points.

Gruber and Kamin (2012) also analyze the effect of government debt and fiscal balance on long-term government bond yields for the OECD countries. They implement a panel regression during the period 1988-2007 and find that an increase in the fiscal deficit-to -GDP ratio of 1 percentage point leads to an increase in the bond yields of approximately 7 basis points. Similarly, an increase in the net debt-to-GDP ratio exerts upward pressure on the bond yields by 1 basis point. They also conduct an analysis just for the G-7 countries and find that the fiscal effects on yields are approximately double relative to those estimated for the full OECD panel. Furthermore, Poghosyan (2012) analyzes the determinants of sovereign bond yields for 22 advanced countries during 1980-2010 period using panel cointegration techniques. The results suggest that in the long run, a 1 percentage point increase in government debt-to-GDP ratio leads to an increase in the government bond yields of about 2 basis points. The other most relevant determinant according to this study is the potential growth rate as a 1 percentage point increase in it leads to a 45 basis points rise in government bond yields.

There is also a considerable body of literature that includes emerging economies in evaluating the macroeconomic determinants of government bond yields and sovereign bond spreads. Namely, Baldacci and Kumar (2010) examine the impact of fiscal deficits and public debt on long-term interest rates in panel data that includes 31 advanced and emerging market economies from 1980-2008 using a Generalized Method of Moments (GMM). They find that an increase of 5 percentage points in the fiscal deficit-to-GDP ratio a country could experience its long-term interest rate increasing by 100 basis points. By applying country-specific factors, they also discover that large fiscal deficits and public debts in countries, with unfavorable fiscal conditions, weak institutions, and global risk factors such as limited access to global capital, put more substantial upward pressures on sovereign bond yields. Moreover, Perovic (2015) studied the impact of government debt and primary balances on long-term government bond yields for a panel of 10 Central and Eastern European countries during the period 2000-2013. The results indicate a 1 percentage point increase in the government debt-to-GDP ratio (primary deficit-to-GDP ratio) is associated with a 2.7-4 (12.9-24.3) basis points increase in the government bond yields. Min et al. (2003) investigated the determinants of government bond spreads for 11 emerging economies from Latin America and Asia for the period 1991-1999. Due to the nature of the sovereign debt, they put an emphasis on the international channel. Hence, besides using inflation rate, GDP growth rate, debt-to-GDP ratio, etc, they also used real exchange rates, country's terms of trade, international reserves-to-GDP ratio, real oil prices, export/import growth rates, debt service to export ratios, current account deficits, and United States Federal Reserve funds rates. Min et al. (2003) find that most of the spread is explained by variations in liquidity and solvency variables (with the expected signs, for instance, a higher debt-to-GDP ratio increases the yield spread), but also that the macroeconomic variables together with the Federal funds rate also play a significant role in the determination of the bond spreads. Martinez, Tercenoa, and Teruelb (2013) is a more recent paper that has very similar methodology and approach to Min et al. (2003) in its investigation of the determinants of the sovereign bond spreads for a set of Latin American countries. From the panel framework, Martinez, Tercenoa, and Teruelb (2013) discover that terms of trade, inflation, external debt, and international reserves are the key drivers of sovereign bond spreads. Additionally, Grandes (2007) explores the main macroeconomic determinants of the sovereign bond spreads for Argentina, Brazil, and Mexico over the period 1993-2001. He uses monthly and quarterly data for the Emerging Market Bond Index plus the sovereign spread adjusted for consumer price index, gross capital inflows, debt servicing ratios, economic activity index, as well as, data for real Federal funds rate, US 30-year Treasury bond yields, and global risk aversion index (credit-rated BB US corporate bond yield as proxy). After implementing feasible GMM least squares method, Grandes finds that higher capital inflows (e.g., FIDs) and higher GDP growth reduce the sovereign bond spreads, whereas higher debt service to GDP ratios increase the sovereign bond spreads. Grandes's explanation for the last finding is that higher debt servicing ratios force the countries to use their domestic resources to meet the outstanding debt thereby having less resources for consumption and investment.

There have also been one-country case studies on the determinants of government bond yields. For instance, Lam and Tokuoka (2011) have conducted a detailed overview of the worrying limits of the Japanese debt-to-GDP ratio by comparing this ratio relative to other developed countries. They propose that the Japanese nominal bond yields are low due to low currency risk and high private savings. In addition, Cebula (2014) conducts a more specific empirical investigation on the impact of the US federal budget deficit on the real interest rate yields on 3-year US Treasury notes and 7-year US Treasury notes. The two-stage least squares estimations indicate that, for the period 1972 to 2012 using yearly data, a 1 percent increase in the budget deficit (as percentage of GDP) increases the yield on the 3-year US Treasury notes and the 7-year US Treasury notes between 7 and 10 basis points, and between 9 and 11 basis points, respectively.

Some Discussion Regarding The Conventional View Literature

The structure and composition of the emerging market bonds has changed dramatically since the early 2000s. Back then they were considered sovereign debt, even though those bonds were issued in foreign currency. Nowadays, the Latin American countries issue most of the domestic debt in their own currency. Herein lays the problem with the studies conducted by Grandes (2007), Martinez, Tercenoa, and Teruelb (2013), and Min et al. (2003) since they place all the emphasis on external data and the spread relative to United States securities. Moreover, a lot of the empirical studies mentioned above, namely, Ardagna, Caselli, and Lane (2007), Baldacci and Kumar (2010), Cebula (2014), Gruber and Kamin (2012), Min et al. (2003), and Poghosyan (2012), use yearly data and annual averages of the macroeconomic variables, which implies a big loss in variation. Another problem with these studies, including Gruber and Kamin (2012), is that these are panel data studies with a mix of developed and developing countries; every country has a unique monetary and exchange rate regime, as well as different governing institutions. Perovic (2015) uses data on tax rates and numerous stock market indices as control variables that raises questions on their economic significance. Lastly, Baldacci and Kumar's (2010) choice of using forecasted deficit and debt data following Blanchard (1984) and Poghosyan's (2012) implementation of potential GDP growth rates cast doubts of the reliability of those predictive measures.

Medeiros (2008) was one of the first papers to critically assess external indebtedness. He laid out the problems of the financial-export model that led to financial integration, but also contributed to high interest rate variability (and dependency on the US interest rate), fiscal contraction, and higher default-rate risk due to the external debt, which was necessary in order to sustain the continued capital inflows. More recently Caldentey and Vernengo (2016) suggested that fiscal restraints in Central and Latin America do not have a significant impact on reducing the risks of a crisis, and that excessive fiscal conservatism actually could lead to lower growth rates.

Papers like Eichler and Maltritz (2013) and Jaramillo and Weber (2013) have added to the contemporary policy issues surrounding government bonds. Eichler and Maltritz (2013) apply a fixed effects model for the Economic Monetary Union member states and, besides finding that GDP growth and country's degree of openness are the main drivers, results also indicate that high public indebtedness is not a problem in the long run when the other variables are in good condition. This provides some evidence that high public debt does not necessarily cause higher default risk. Jaramillo and Weber (2013) also use a fixed effects model and allow their explanatory variables to have various regression slopes based on whether their global aversion index is above or below a certain threshold. They find that during tranquil times, bond yields are mainly determined by inflation and GDP growth rates, whereas, during higher market volatility, bond yields are influenced strongly by the country's fiscal fundamentals.

The Keynesian View

Akram and Das (2014, 2015, 2017a, 2017b, 2018), Akram and Li (2017a, 2017b, 2018) have constructed models that consider the Keynesian perspective of long-term interest rate on government bonds. Akram and Li (2017a, 2017b) conduct an empirical inquiry for the US regarding the determinants of long-term interest rates on US Treasury securities. Akram and Li (2017a) employ a bounds testing approach to cointegration and error correction models within autoregressive distributive lag (ARDL) framework in order to dynamically calibrate the relationship between the macroeconomic variables. They find that short-term interest rates are the main drivers of long-term interest rates. The results also indicate that higher federal fiscal balance ratios reduce the yields on long-term Treasury securities. This finding is also present in Akram and Li's (2017b) paper in which they show that government indebtedness in the US has a negative effect on long-term interest rates. They implement vector error correction (VEC) modeling and detect that a 1 percentage point increase in the short-term interest rate causes a 64 basis points increase in the long-term interest rates. This supports Keynes's views that short-term interest rates are the primary drivers of long-term interest rates on a long run basis.

Akram and Das (2014) and Akram and Li (2018) investigate the dynamics of the long-term Japanese sovereign debt. Akram and Das (2014) use a two-step feasible and efficient GMM technique and find that the Japanese government bond nominal yields are extremely sensitive to short-term interest rates. They also discover that while the coefficient for the inflation rate is positive and significant, it is moderate in magnitude, and that the coefficient of the growth of industrial production is positive, but low and statistically insignificant. Akram and Li (2018) deploy VEC framework to estimate the dynamics of the long-term government bond yields. They discover that an increase in the short-term interest rate by 1 percentage point increases the long-term interest rate by 66.8 basis points – therefore, showing that the Bank of Japan's accommodative monetary policy with low short-term policy rates is responsible for keeping the long-term government bond nominal yields low. In addition, the results indicate that an increase in the government debt and deficit ratios reduce the long-term interest rates.

Furthermore, Akram and Das (2018) implement an ARDL approach to explore the determinants of the Commonwealth of Australia government bond nominal yields. The results from the models reveal that the short-term interest rate is by far the most important determinant of the long-term interest rate. In terms of the government finance variables, the estimated models indicate some ambiguity; the coefficient of the fiscal balance ratio is small but statistically significant, whereas the debt ratio does not manifest any notable effect.

Additionally, Akram and Das (2017b) implement Keynesian methodology using a pooled mean group (PMG) cointgration technique for a set of 11 Eurozone countries. Hence, they try to detect what the main determinants of long-term government bond yields are within the context of monetary non-sovereign countries. The Eurozone countries have one common European Central Bank (ECB) and are forced to issue debt through the international bond markets in the euro currency in order to fund their government spending activities. The results still demonstrate that the most important drivers of the countries' government bond yields are the short-term interest rates. What is more interesting is that for the mean group, the government debt ratio has a negative and significant relation with the government bond yields. An ARDL approach is also used to investigate the dynamics between the variables for individual countries. The results, overall, reinforce the findings from the PMG panel analysis. This gives credence to Keynes's insights even more because of the fact that the Eurozone countries cannot exert monetary sovereignty.

Akram and Das (2015, 2017a) try to detect whether Keynes's conjectures about the determinants of government bond yields are valid in emerging markets, such as India. Akram and Das (2015) employ a two-step feasible and efficient GMM technique and find that changes in short-term interest rates, after controlling for changes in inflation rate and growth rate, are always positive and statistically significant at the 1 percent level. This provides evidence that the Indian central bank's actions, through the effect of the policy rates on short-term interest rates and other monetary policy tools, take a lead role in driving the changes of the Indian government bond nominal yields. They also observe mixed results with regards to changes in fiscal balance, as some of the models imply a positive relationship while some demonstrate a negative one between fiscal deficits and long-term interest rates. Akram and Das (2017a) apply an ARDL method in order to examine whether Keynes's conjectures about India hold over the long-term. The coefficients of the short-term interest seem to be always positive and significant, which suggests that, in the long run, short-term interest rates are the main drivers of long-term government bond yields in India. Another very interesting finding is that higher debt ratios exert downward pressure on the Indian government bond nominal yields. This goes against the conventional argument that higher government debt and deficit ratios increase the nominal yields of the government bonds. Along these lines, Pham (2014) adopts the empirical methodology by Pogoshyan (2012) and studies the determinants of sovereign bond yields with regards to 9 emerging Asian countries over the period 1994-2012. Even though it ignores the Keynesian framework, Pham (2014) still finds a negative relationship between public debt and sovereign bond yields, which does not support the conventional literature.

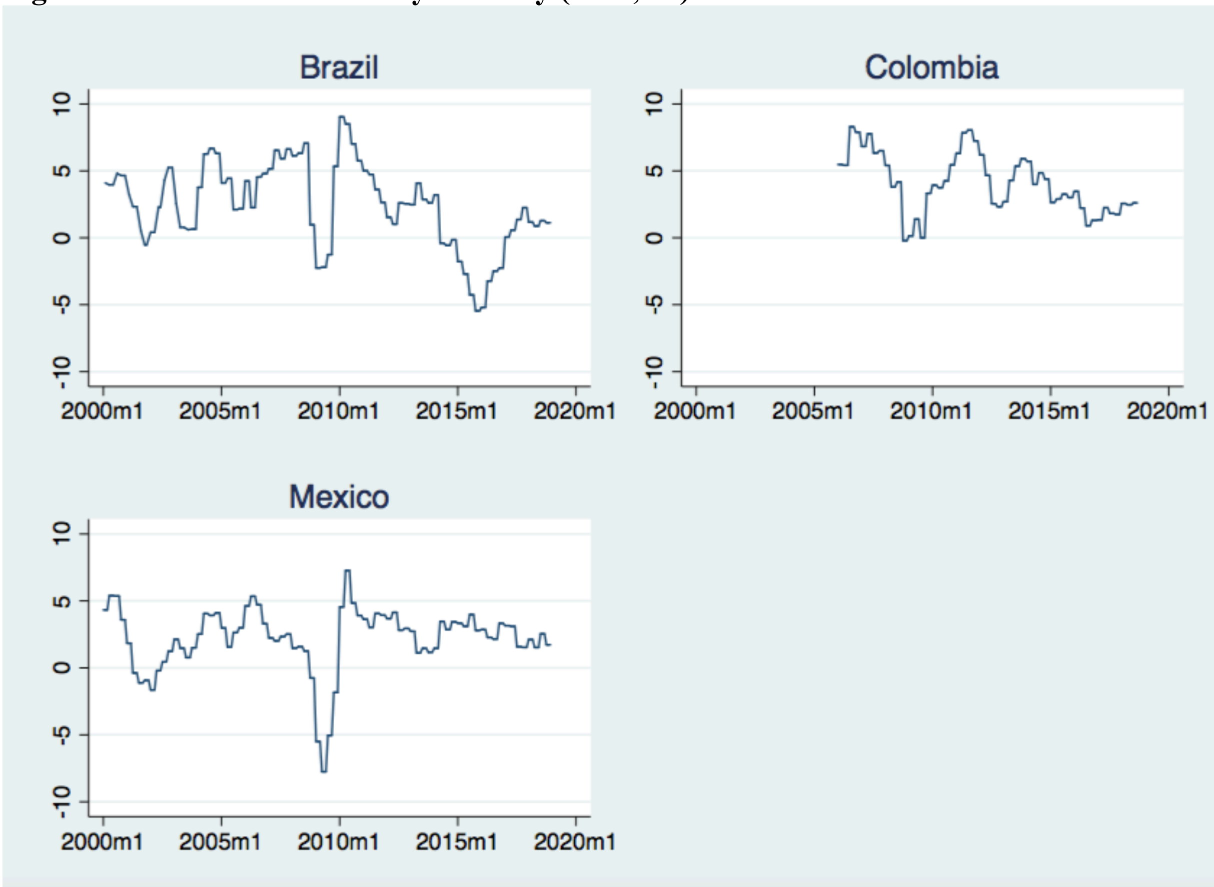
Despite Akram and Das (2015, 2017a) conducting an empirical investigation for India, an emerging market economy, there has not been a case study that explores the government bond nominal yields using Keynes's insights for the emerging economies in Latin America. By applying Keynesian methodology, this dissertation fills the gap in the literature by providing empirical evidence that the main determinants of the long-term interest rates for a set of Latin American countries are the short-term interest rates.

STYLIZED FACTS FOR BRAZIL, COLOMBIA, AND MEXICO

Economic Outlook

In the last two years growth in Latin America and the Caribbean (LAC) has gained momentum following a contraction in 2016 (IMF 2018a, 17). Figure 1 illustrates that Brazil's growth rate turned positive, as the severe recession has come to an end. The growth rate has been boosted by the higher commodity prices. Similarly, Mexico has experienced positive growth rates due to the buoyant economic growth present in the United States in the current business cycle. Colombia, as a smaller country both in terms of size and overall economic capacity, has performed relatively well over the years despite the large oil price shock in 2015 that temporarily muted the healthy, sustained growth.

Figure 1. Real GDP Growth by Country (YoY, %)



Source: OECD Main Economic Indicators, National Accounts Statistics.

Mexico has the largest GDP per capita in LAC with GDP per capita in constant prices of 18,339.07 US dollars (USD) when adjusted by purchasing power parity (PPP). In 2018, Mexico registered an unemployment rate of approximately 3.49%. The average GDP growth rate of Mexico between 2000 and 2018 had been 3.02% (Table 1).

Brazil has the 2nd largest GDP per capita in LAC with GDP per capita of 14,312.03 USD. Nevertheless, the unemployment rate in 2018 was estimated to be 11.8% and between 2000 and 2018, it recorded one of the lowest average GDP and GDP per capita growth rates in the LAC region – 1.38% and 0.51%, respectively. Brazil had been experiencing high growth rates until 2010 when the industrial output started to stagnate as a result of overvaluation in the exchange rate and reduction in the profit margins (Oreiro and D'Agostini 2017, 27-8). This led to a loss of external competitiveness and a decline of investment for the Brazilian manufacturing sector.

Colombia's GDP per capita is the lowest of all three (13,343.53 USD). In 2018, the unemployment rate was approximately 9.2%, which is slightly lower than that of Brazil but still fairly high in relation to the LAC region. In terms of economic performance, Colombia has performed better than most LAC countries – generating an average GDP growth rate of 3.93% and an average GDP per capita growth rate of 2.74%.

Table 1. Average Economic Growth Between 2000 and 2018

Country	Average GDP Growth	Average GDP Per Capita Growth
Brazil	1.38%	0.51%
Colombia	3.93%	2.74%
Mexico	3.02%	1.86%

Sources: IMF World Economic Outlook Database; and author's calculations.

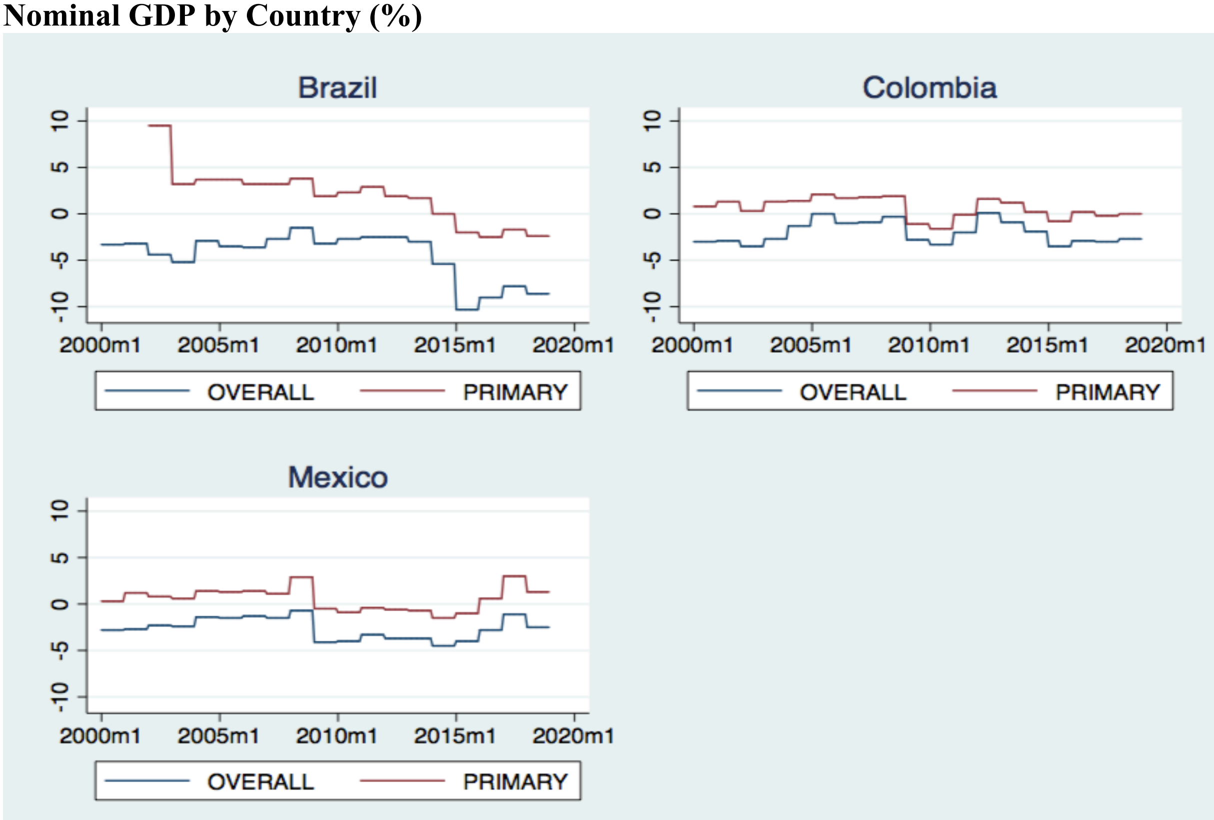
Fiscal Stance

As a result of the severe downturn, the Brazilian Federal Government in 2015 implemented a regime called the New Macroeconomic Matrix that was supposed to stimulate aggregate demand via fiscal policy. However, as the government increased expenditures to alleviate the economy, worries regarding the potential increase in the public debt instigated fears within the Ministry of Finance, as well as international institutions like the IMF. The fiscal stimulus lasted only until 2015 when the Brazilian Federal Government decided to pursue fiscal adjustment and set a target for budget surpluses. This led to economic uncertainty, which was exacerbated with the political corruption scandal inside Petrobras, Brazil's national oil company. Public expenditures were cut and GDP growth decelerated even further. However, this led to decrease in the government receipts, which eventually meant larger fiscal deficits.

In Colombia, fiscal expansion depends largely on revenues from the oil sector (Ocampo, Malagon, and Ruiz 2017). This is problematic due to the temporary nature of this revenue, as it is mostly led by commodity-price-boom periods. Besides the income taxes generated by the state-oil company, Ecopertol, revenues from the agricultural and mining production sectors also influence the government's budget plans. There seems to be a perception that these revenues are the sole source for the increase in government expenditures. Mexico, which is also an oil-exporting country, implemented a fiscal economic reform in 2013 that intended to increase its tax revenues by 2.5% of GDP, which, by 2015, was supplemented by fiscal deficit limit of 0.3% of GDP (Ros 2017, 137-8). Putting a break on fiscal spending led to a dip in GDP growth rates post-2015 both for Mexico and Colombia (see Figure 1).

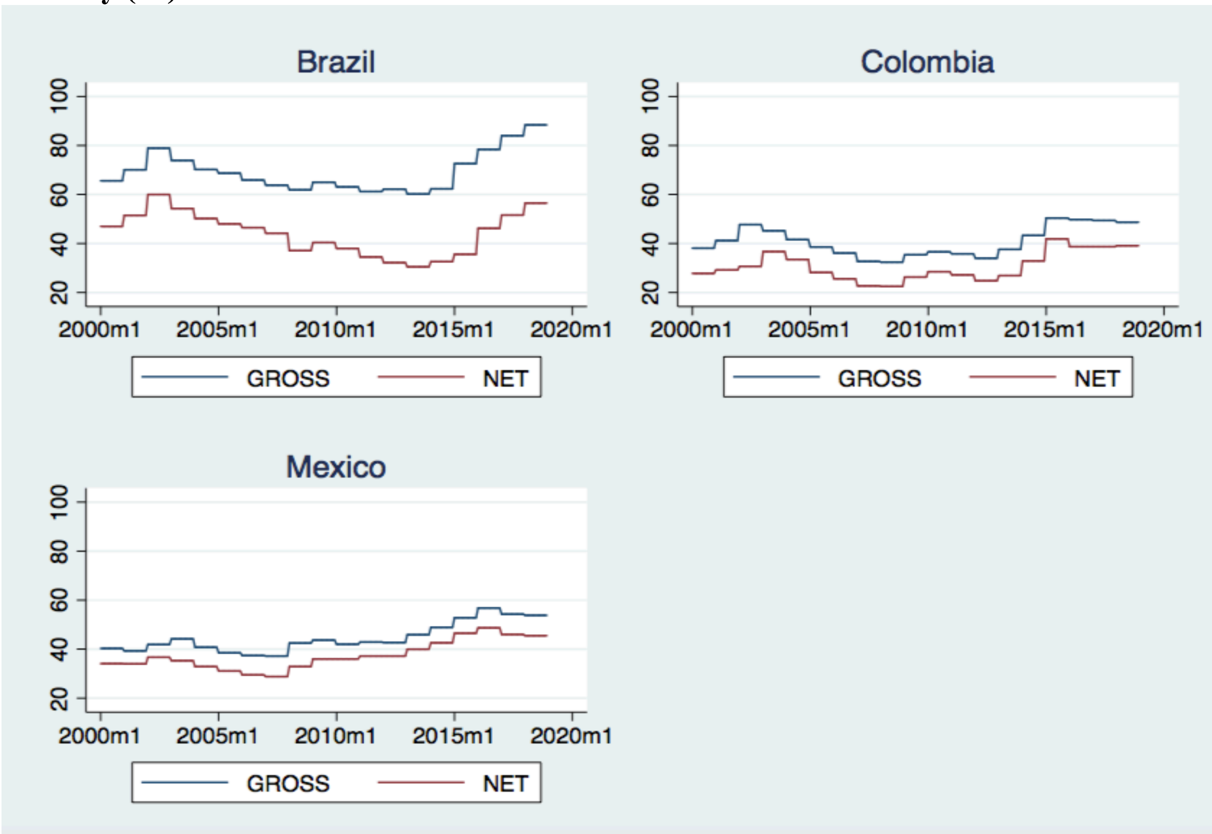
The overall fiscal deficit in 2018 had increased for Brazil and Mexico but decreased for Colombia. However, large sections of these deficits is driven by net interest payments. The main difference between overall and primary balances is that primary balance excludes interest payments from expenditure. For countries with a large outstanding government debt that abide to the prescriptions set by the Washington Consensus agenda, achieving primary budget surpluses is a major policy objective that needs to be enacted. Figure 3 shows the gross and net government debt and we can observe that Mexico and, especially Brazil, have larger government debt-to-GDP ratios than Colombia, which is considered to have moderate ratios according to international standards (Ocampo, Malagon, and Ruiz 2017, 109). Brazil's gross debt as a percent of GDP has reached 88.4% in 2018 and it has seen its overall fiscal deficits increase from 7.8% to 8.6% of GDP. Colombia's gross debt as a percent of GDP saw a slight decrease from the year before – totaling 48.7%. Its overall fiscal balance also improved from 3.0% to 2.7%. Mexico's gross debt as a percent of GDP in 2018 equaled 53.8% with the overall fiscal balance deteriorating by 1.4% - amounting to a 2.5% deficit (see Figures 2 and 3).

Figure 2. Ratios of Government Overall and Primary Fiscal Balance as a Share of Nominal GDP by Country (%)



Source: IMF Fiscal Monitor.

Figure 3. Ratios of Government Gross and Net Debt as a Share of Nominal GDP by Country (%)



Source: IMF Fiscal Monitor.

The agenda to aim and reduce government spending boils down to concerns of the crowding out effects, which were already explored earlier in the dissertation. In fact, the Federal Public Debt Annual Report for Brazil stated that structural reforms aimed at fiscal balance are in urgently need in order to "revert the growth of mandatory spending and to reduce budget rigidity, and thus, assure a sustainable debt trajectory." (Secretaria do Tesouro Nacional 2019b, slide 24). Moreover, in its Medium Term Fiscal Plan 2018 – Investor Presentation, the Colombian Ministry of Finance persists in trying to lower fiscal deficits with adjustments to the expenditure and tax revenue mechanism with the aim of lowering the projected net debt (Ministerio de Hacienda y Credito Publico 2018, slides 19-23). Similarly, the Mexican Ministry of Finance wants to maintain the public debt as a proportion of GDP on a downward trend (Secretaria de Hacienda 2019a). The terms fiscal discipline, fiscal consolidation, fiscal sustainability, and sound public finances, dominate these quarterly and yearly presentations on the country's economic activity, borrowing plan, and public debt. The mainstream understanding is that high levels of public debt expose possible recession shocks – hence, keeping public debt on a downward path remains an appropriate strategy. Governments have adhered to these fiscal consolidation plans characterized by expenditure contraction and public investment cuts, however, the absence of fiscal stimulus programs could actually become counterproductive for the future public debt's trend (Ros 2017). Slower growth rates could also sometimes be the reason why the public debt to GDP has been on a rising trend.

Sectoral Balances

Ever since the Washington Consensus was established in the early 1980's, LAC as an emerging economic region had always been subject to structural adjustment recommendations that included boosting current account surpluses and ensuring fiscal sustainability.

The episode of falling commodity prices characterized by the oil price shock in the second half of 2014 serves as an example that points out the vulnerability of the LAC countries. An economic recovery starts to take place with a rebound in oil prices – hence, an improving the current account balance. But much before that, it is actually government sector spending that reacts in countercyclical fashion to support the weak aggregate demand. However, in addition to the balance of payments and the government sector, the private sector is the third component of the basic macroeconomic accounting identity. This has to do with the three sectoral balances (Godley 1999). We start with basic macroeconomic formula,

$$Y = C + I + G + X - M \tag{2.1}$$

Y stands for aggregate spending (i.e., GDP), C is consumption, I represents investment, X is exports, and M refers to imports. We can rearrange the terms and write the following:

$$Y - C - I = G + X - M \tag{2.2}$$

Further, we can introduce taxes, T, on both sides of equation (2), so we write:

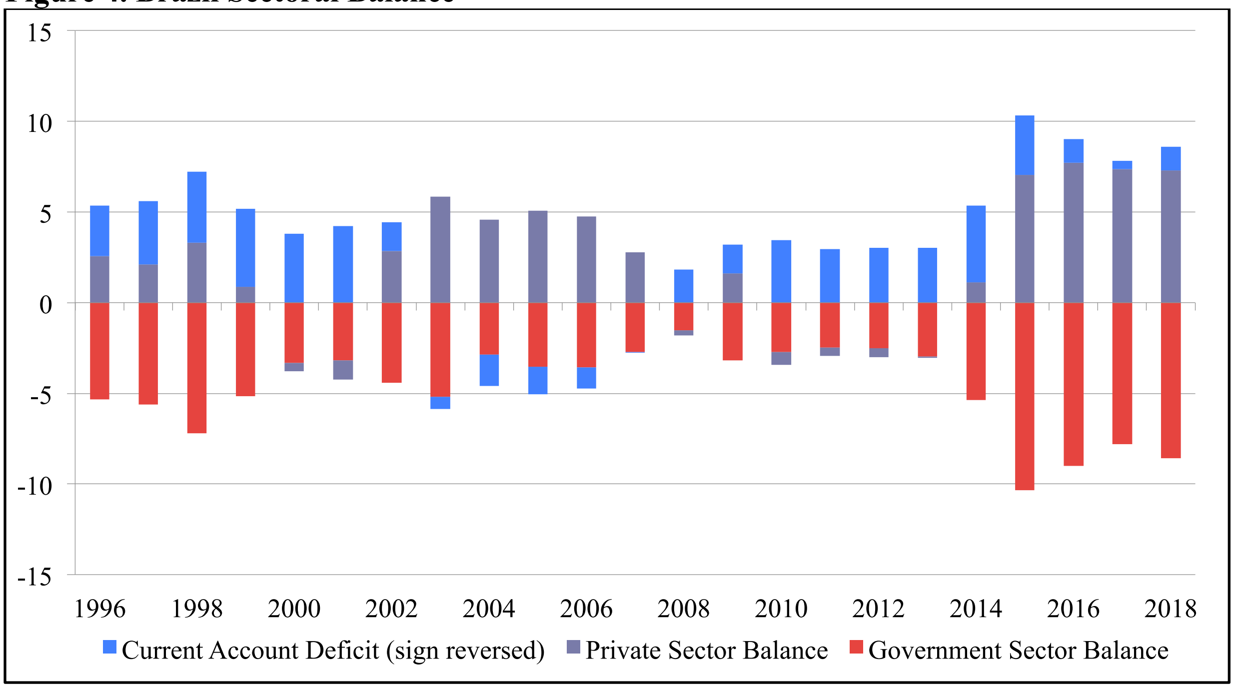
$$Y - C - I - T = G + X - M - T \tag{2.3}$$

However, we also need to take into account the income transfers, TR_{ij}, from one sector, i, to another sector, j. Thus, we can extend equation (3) and write:

$$\left[Y - C - I - T + TR_{gp} - TR_{pg} + TR_{fp} - TR_{pf}\right] =$$
$$= \left[G - T + TR_{gp} - TR_{pg} + TR_{gf} - TR_{fg}\right]$$
$$+ \left[X - M + TR_{fg} - TR_{fp} + TR_{pf} - TR_{gf}\right] \rightarrow NL_p + NL_g + NL_f = 0 \qquad (2.4)$$

NL denotes net lending, p stands for the private sector financial balance, g represents the government sector balance, and f is the foreign sector balance (i.e., current account balance). And to clarify, TR_{gp}, namely, is the amount of income transfers going from the government sector to the private sector. If the private sector is in surplus, then it is technically lending funds to the other sectors; if the government sector is in deficit, then it is spending more than it is taking out of the economy in taxation; and if the current account balance is in deficit, then it is net borrowing vis-à-vis the rest of the world. Hence, the sum of all three sectoral balances must net to zero.

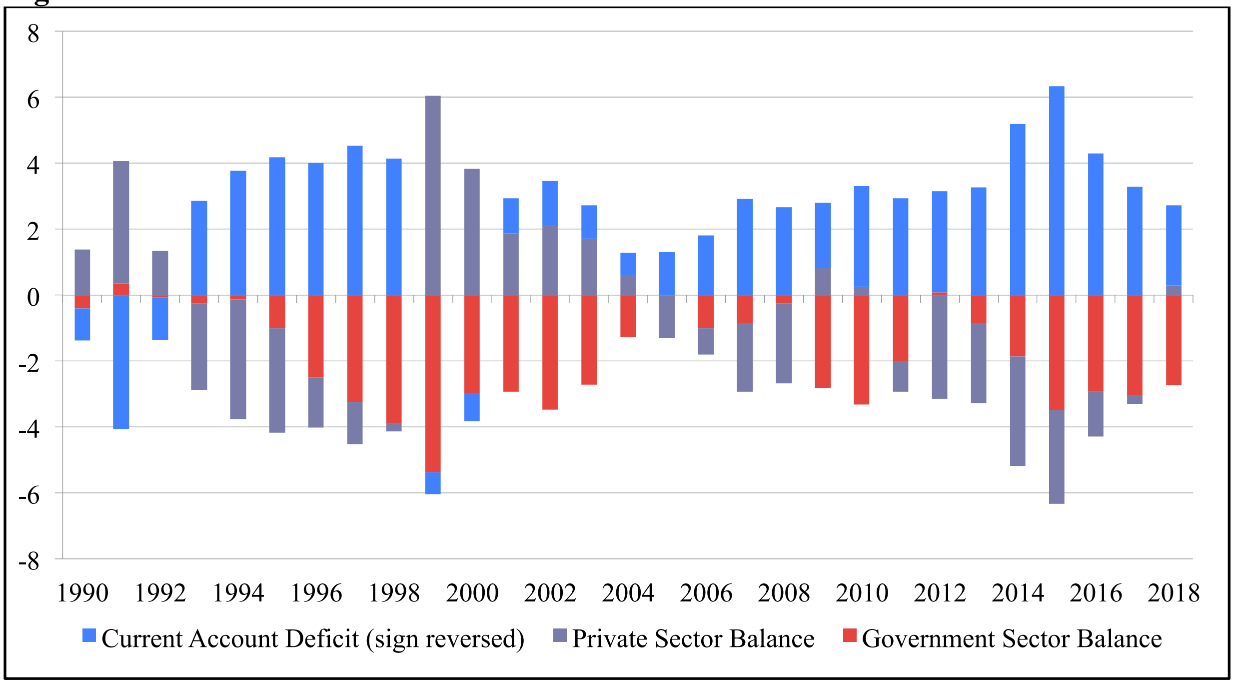
Figure 4. Brazil Sectoral Balance



Sources: IMF World Economic Outlook Database; and author's calculations.

Figures 4, 5, and 6 exemplify Brazil, Colombia, and Mexico's sectoral balances, respectively. Note that the current account balance has its sign reversed and given the accounting balance, the graphs are basically mirror images. Thus, for the case of Brazil, given the negative external balance in the last four years, it is normal for the government to run deficits because that implies private sector surpluses. This scenario is also present in Mexico but only for the past decade. In Colombia, on the other hand, given the large current account deficits and the small government deficits, the private sector has had to run deficits since 2005. Generally, all a fiscal surplus would do is to shift the burden onto the private sector.

Figure 5. Colombia Sectoral Balance

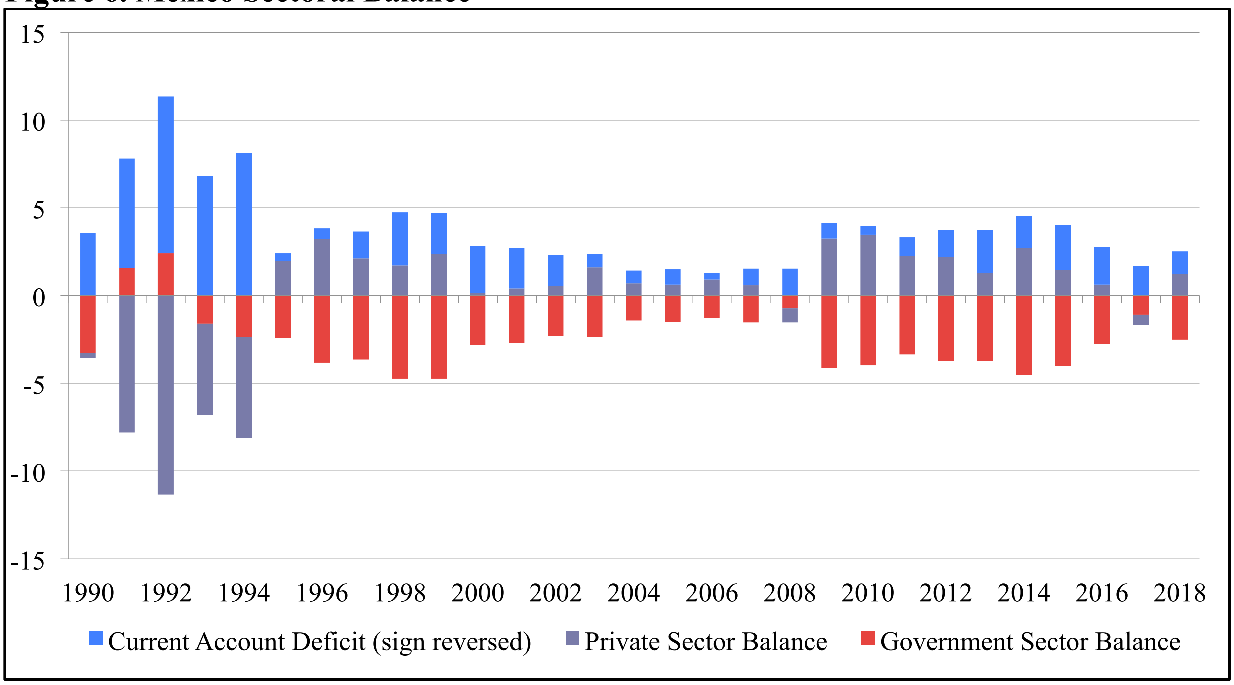


Sources: IMF World Economic Outlook Database; and author's calculations.

For sovereign countries such as Brazil, Colombia, and Mexico, the government does not resemble a household. It is the issuer of its currency and by running deficits, the government technically credits bank deposits in the system. When the government spends more than its income, it essentially adds net wealth to the private sector (see Fullwiler 2008; Wray 2003, 2012). Moreover, the government interest payments add to the private sector income, which could only induce consumption in the economy. This means higher tax revenues, and thus, reduction in the government deficits. The Washington Consensus's political agenda of forcing countries to implement fiscal consolidation generally reduces the net balance received by the private sector.

The governments in LAC are forced to follow specific guidelines regarding how to cut back government spending and promote fiscal balance. Tackling the limits of growth of public spending includes reforms such as stabilizing pension spending, reducing the government wage bill, and putting certain spending caps on health and education. But this fiscal consolidation is not justified as long as the current account has a negative balance. Generally, the net results would be negative private sector financial balances. This was the scenario in Brazil in the early 2000s and 2010s (see Figure 4); in Colombia in the mid-1990s, mid 2000s, and mid 2010s (see Figure 5); and in Mexico in the early 1990s, 2008, and 2017 (see Figure 6). Currently, Brazil runs a current account deficit of 1.3% of GDP with a government sector deficit of 8.6% of GDP – making a private sector financial surplus of 7.3% of GDP. Colombia also has a current account deficit of 0.3% of GDP and a government deficit of 2.7% of GDP, which means the private sector is running a surplus of 2.4% of GDP. Mexico has a government deficit of 2.5% of GDP and by having a negative external balance of 1.3% of GDP, its private sector financial balance is positive – totaling a surplus of approximately 1.2% of GDP.

Figure 6. Mexico Sectoral Balance

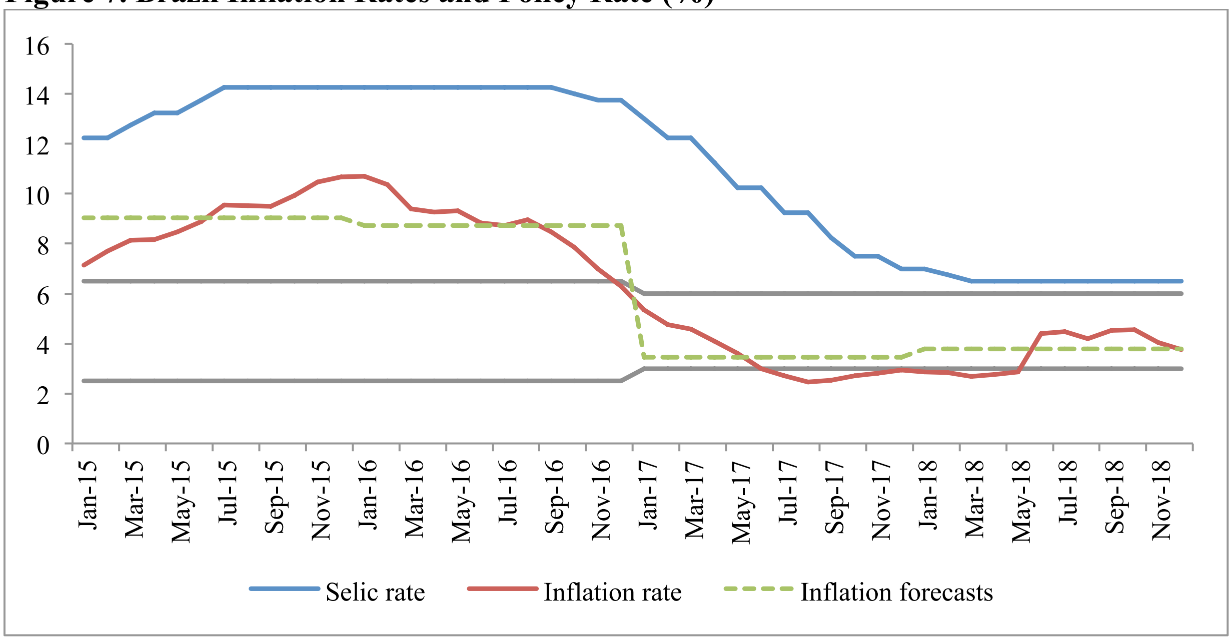


Sources: IMF World Economic Outlook Database; and author's calculations.

Monetary Stance

Another reason why the Brazilian New Macroeconomic Matrix did not turn out to be successful was that the Brazilian Central Bank decided to increase the interest rate post-2015 due to inflationary pressures (Oreiro and D'Agositini 2017, 27-8). Colombia and Mexico's central bank's have both been tightening monetary policies following the end of 2015 as a response to the oil price shock, currency depreciation, and rising inflation. With a flexible exchange rate mechanism, low and stable inflation was the most relevant macroeconomic policy objective (Sawyer 2009). Monetary authorities have to adjust policy rates in order to offset inflation increases anchor inflation expectations. Inflation and inflation forecasts are within Brazil central bank's inflation target band while the official interest rate, Selic, is at a historical low level of 6.5% (Figure 7). The Colombian central bank has also been able to anchor inflation and inflation forecasts (Figures 8). The same holds true for Mexico's central bank, which, ever since 2017, has implemented tight monetary policy (Figure 9).[4]

Figure 7. Brazil Inflation Rates and Policy Rate (%)



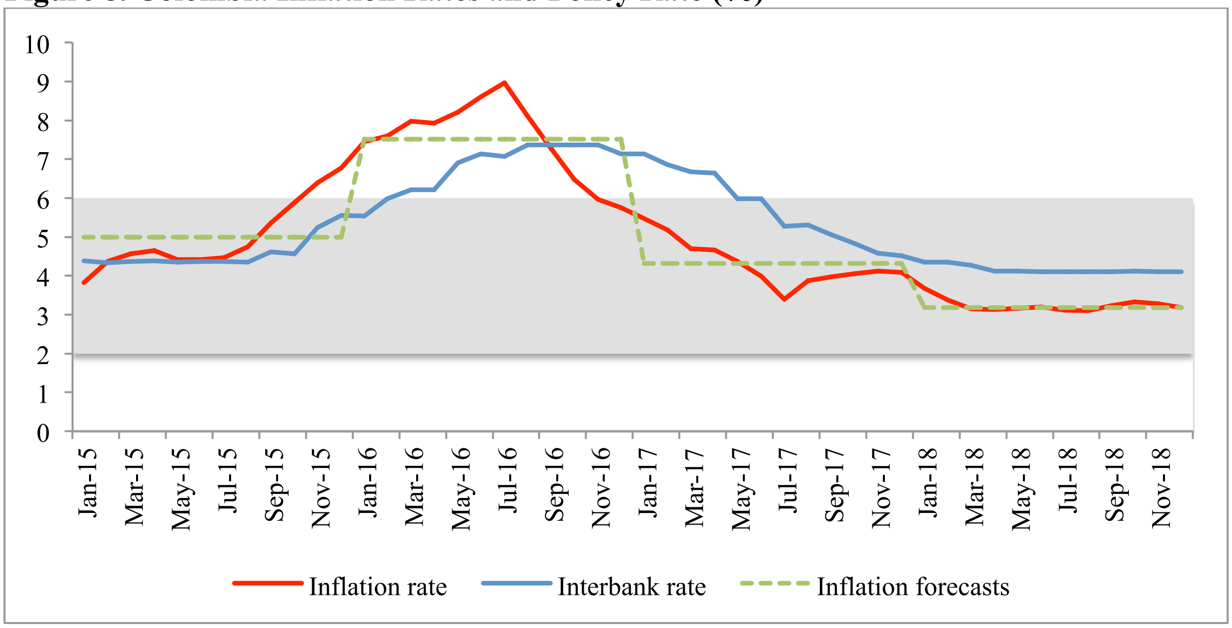
Sources: Bloomberg Terminal; OECD Inflation Forecast.
Note: The grey lines represent the inflation target band.

However, as much as this pursuit of inflation targeting is relevant for central banks meeting their objectives, it often time comes with several drawbacks. When they increase the policy rates to offset inflation increases, this could lead to disinflation, which makes it harder to pay off the public debt and cover the interest payment obligations on the debt. On top of that, the increase in interest rates feeds into higher debt servicing costs. Additionally, the higher interest rate makes it harder for the central banks to conduct sterilized interventions with the help of reserves accumulation. With budget surpluses set as targets and with inflation

[4] The OECD inflation forecasts are measured in terms of the consumer price index with projections based on an assessment of the economic climate in individual countries and the world economy.

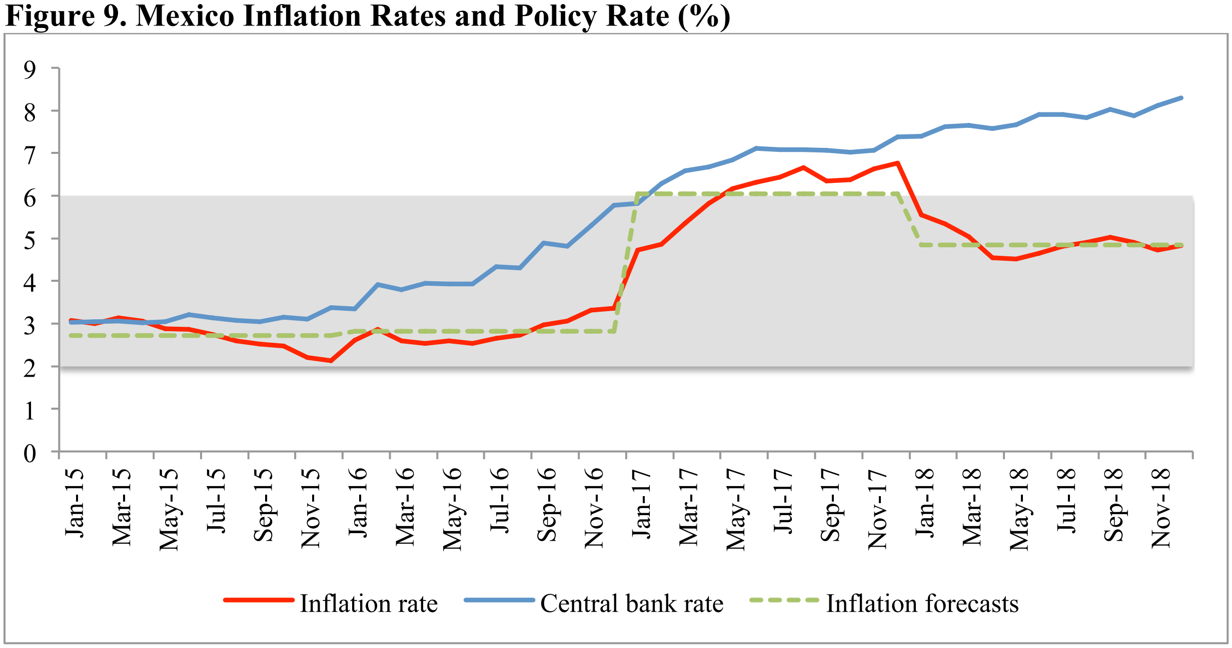
expectations being anchored within the acceptable target band, the end results could well be an even greater increase of the deficits and with that an even higher public debt-to-GDP ratios.

Figure 8. Colombia Inflation Rates and Policy Rate (%)



Sources: Bloomberg Terminal; OECD Inflation Forecast.
Note: The grey-shaded area represents the inflation target band.

Figure 9. Mexico Inflation Rates and Policy Rate (%)



Sources: Bloomberg Terminal; OECD Inflation Forecast.
Note: The grey-shaded area represents the inflation target band.

Another aspect to consider is that low and stable inflation is generally accompanied by an exchange rate overvaluation. This is problematic for the LAC commodity-based countries because it essentially leads to a loss of external competitiveness, higher imports, and lower economic activity (Ocampo, Malagon, and Ruiz 2017; Oreiro and D'Agostini 2017; Ros 2017). As a result, current account deficits follow, associated with slower growth rates that could potentially lead to larger fiscal deficits.

Public Debt

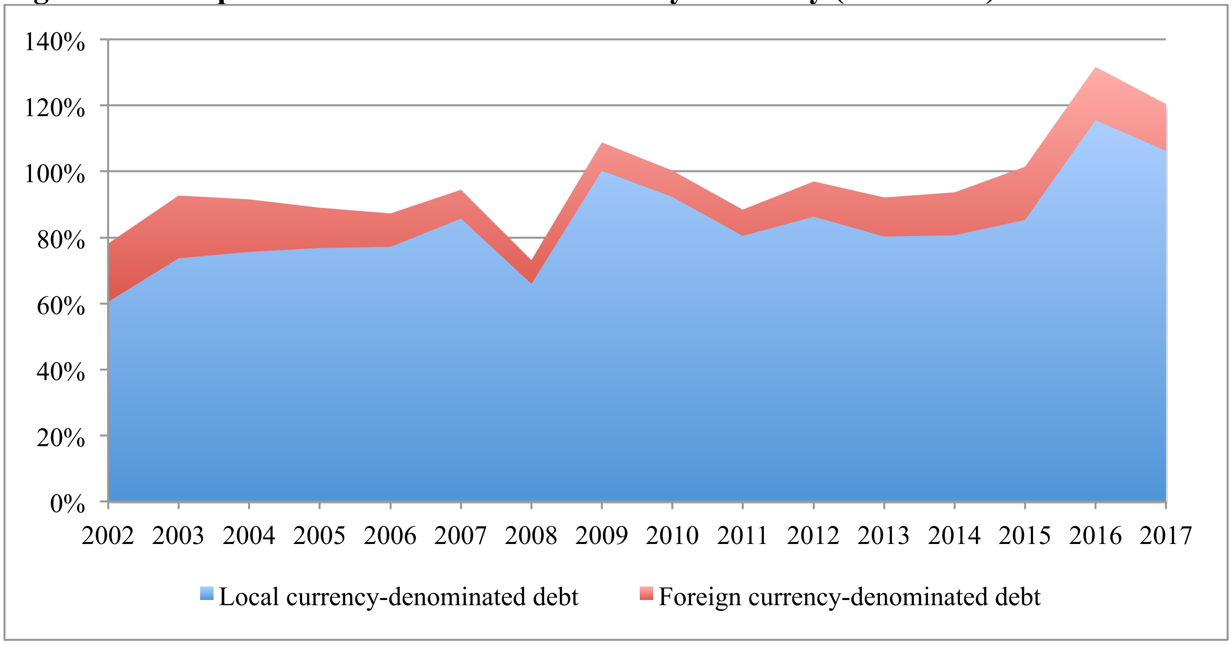
Thirty years ago, the composition of LAC public debts looked very different than it does today. One of the earlier central development policy prescriptions laid out by the Washington Consensus was foreign debt financing. As the credit from global financial markets started pouring into the LAC region, countries became vulnerable to high gross capital inflows, which lead to higher foreign debt ratios. Thus, high dollarization and capital flight impeded countries' development of "domestically financed credit-investment income process." (Dodig and Herr 2015, 183).

Composition By Currency

The fact that developing countries were financing their debt through credit denominated in foreign currency is often referred to in the literature as "original sin" hypothesis (see Das et al. 2010; Eichengreen, Hausmann, and Panizza 2003). The idea is that there is a currency mismatch as the debtors' revenues are in their respective domestic currency but their repayments of the principal and the interest on the existing debt are in foreign currency. Once the foreign debt amounts to worrying levels, investors start to question a country's ability to meet debt obligations – leading to domestic liquidity and solvency problems (Bresser-Perreira 2015). The pressure on the currency builds up, the refinancing costs increase, and the default probabilities rise. The country then enters a period of Ponzi scheme finance, an expression articulated by Hyman P. Minsky, in which the country's government indulges in additional indebtedness to cover both the interest rate and the principle obligations (Minsky 1982).

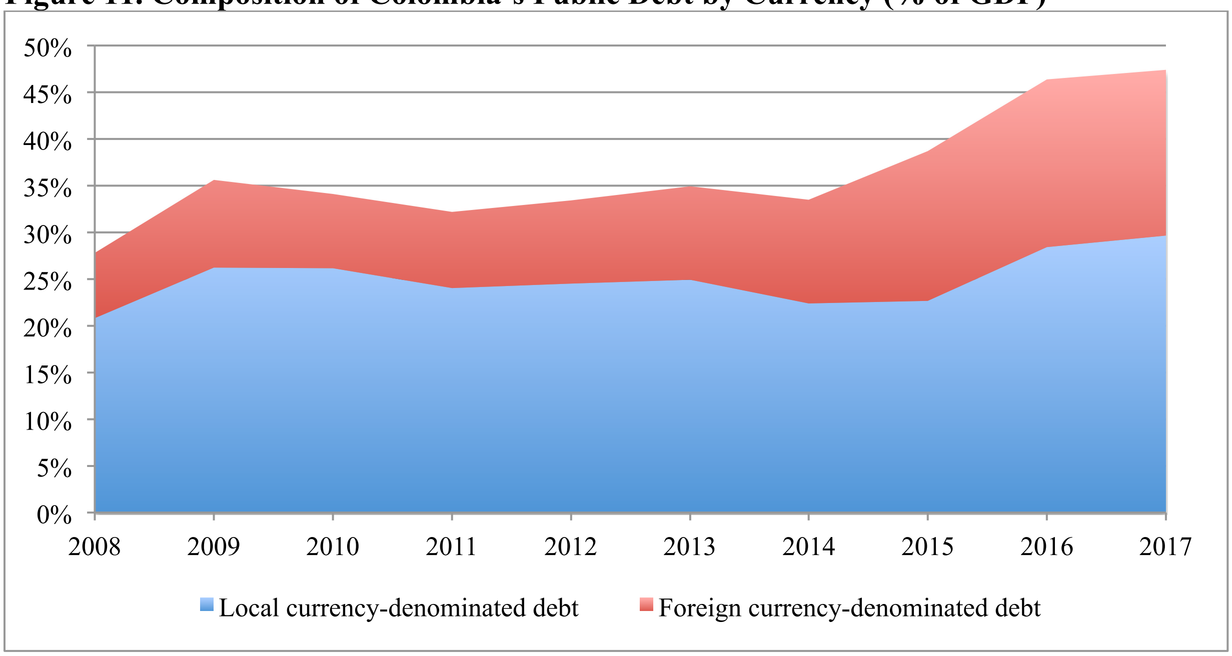
Starting in 1995, there was a gradual change in the composition of domestic public debt. Besides phasing out exchange-rate bonds (to reduce exchange rate risks) and short-term bonds (to lengthen the maturity of the debt), and recently issuing less inflation-linked bonds (because the inflation rate has generally stabilized), countries in the LAC region have significantly decreased their debt exposure to foreign currency (Das et al. 2010; Turner 2002).

Figure 10. Composition of Brazil's Public Debt by Currency (% of GDP)[5]



Source: BIS Debt Securities Statistics; IMF World Economic Outlook Database and author's calculations.

Figure 11. Composition of Colombia's Public Debt by Currency (% of GDP)



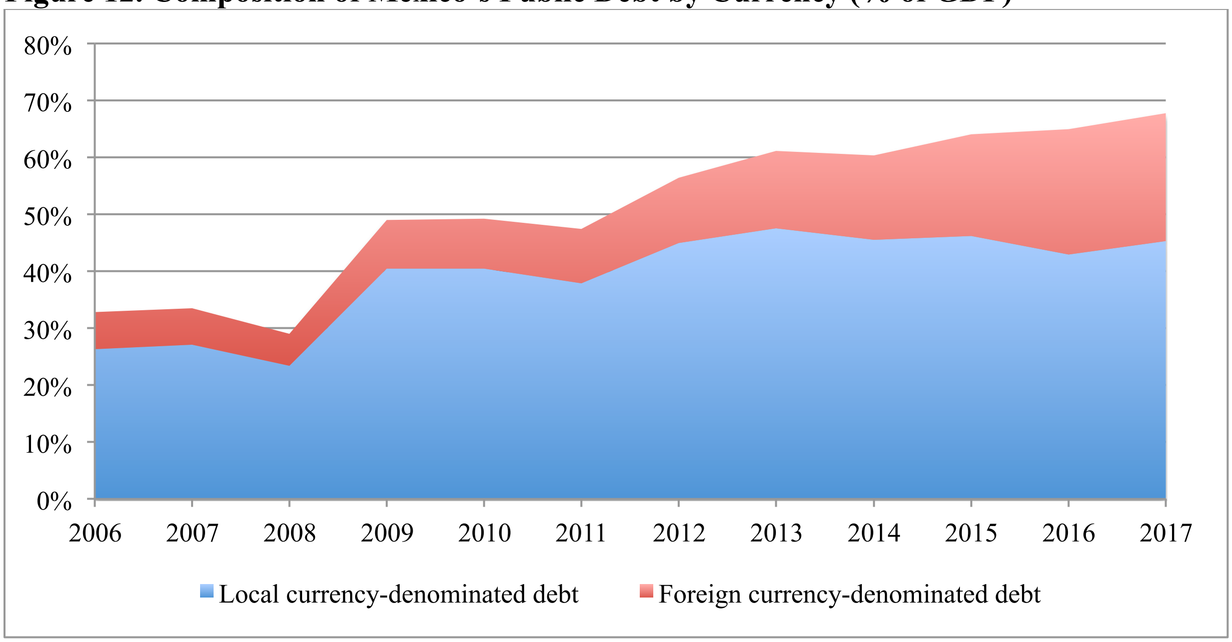
Source: BIS Debt Securities Statistics; IMF World Economic Outlook Database and author's calculations.

The latest data from 2018 in Figure 10 indicates that Brazil's foreign currency-denominated debt accounted for only 11.7% of the total government debt. In Colombia and

[5] Domestic (local) currency debt is measured by amount outstanding of domestic debt securities as percentage of GDP, while foreign currency debt is measured by amount outstanding of international debt securities as percentage of GDP.

Mexico, on the other hand, the size of the foreign debt is larger as it encompasses 37.5% and 32.8% of the total government debt, respectively (Figures 11 and 12). Nevertheless, the switch from international to domestic debt securities had been profoundly large, especially in the late 1990s and early 2000s, making most of the LAC's stock of debt to be denominated in domestic currencies (Turner 2002). At this point, the domestic currency debt markets have expended to such an extent that there are numerous global bonds that are denominated in local currencies and are traded in the international capital markets.

Figure 12. Composition of Mexico's Public Debt by Currency (% of GDP)

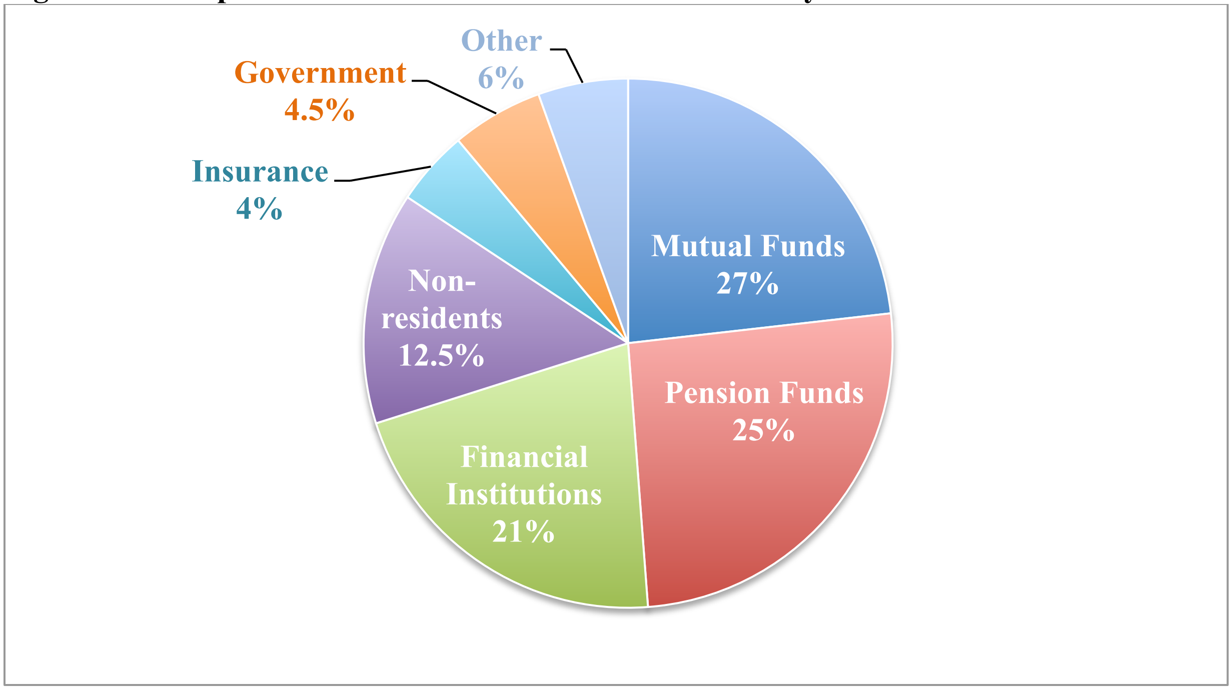


Source: BIS Debt Securities Statistics; IMF World Economic Outlook Database and author's calculations.

Composition By Holders

The investor base usually comprises pension funds, mutual funds, financial corporations and banks, as well as foreign and retail investors. Each of these institutional investors has a different time horizon. The so-called market makers such as day traders, hedge funds, and arbitrage funds, have a very short-term horizon. Mutual funds, venture capital, and banks typically operate in the medium-term. Lastly, investor groups such as pension funds and insurance companies, operate on a long-term horizon. All of these investors have different liability profiles so a well-established, well-functioning domestic bond market with various maturity instruments is instrumental for efficient investment and financing activities. Besides reducing the financing costs, the government debt managers are also responsible for meeting the financing needs of the investors (Das et al. 2010, 372-4). Namely, the pension funds with their long-term investment horizon tend to have a relatively illiquid profile, and therefore, they buy illiquid bonds and sell liquid issues (Turner 2002, 6). Another positive thing about domestic currency-denominated debt is that if the underlying conditions of the debt financing deteriorate, a greater share of the burden is passed onto the investors (Pettis 2001, 169).

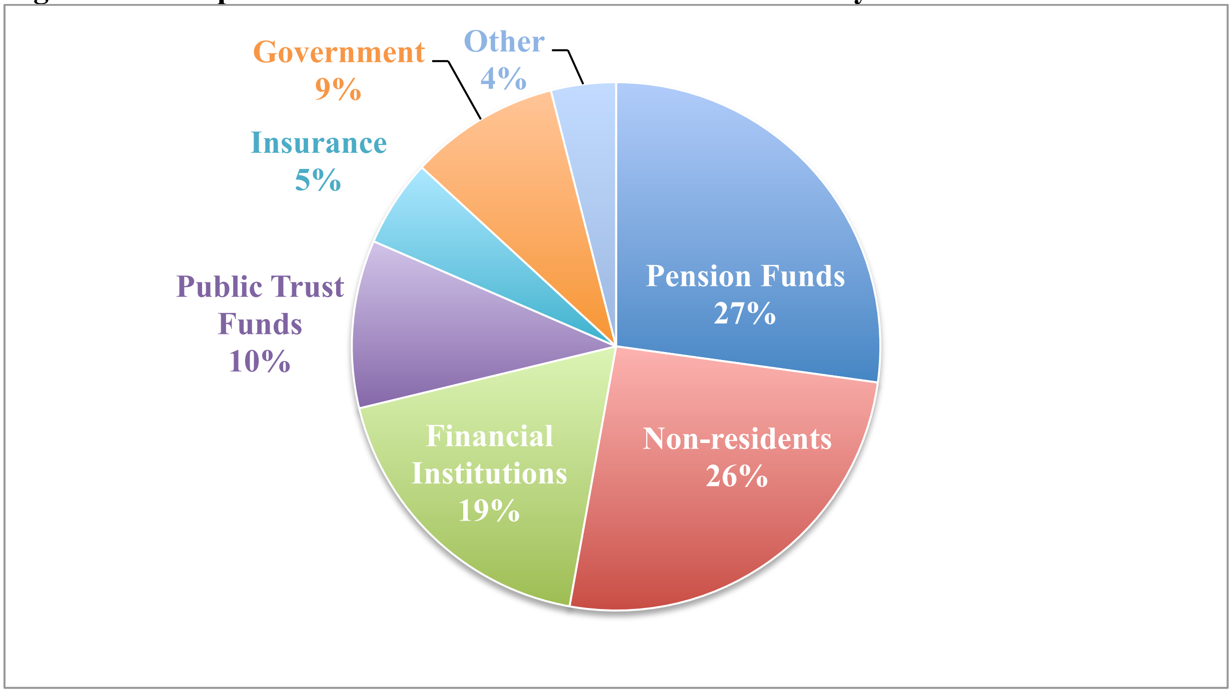
Figure 13. Composition of Brazil's Domestic Public Debt by Holders



Source: Secretaria Do Tesouro Nacional, Brazilian Federal Public Debt, Investor Presentation. (http://tesouro.fazenda.gov.br/documents/10180/268570/Kit_Ingles_06.03.17/28b36130-9c0f-417a-a7f6-411fa5400de8)

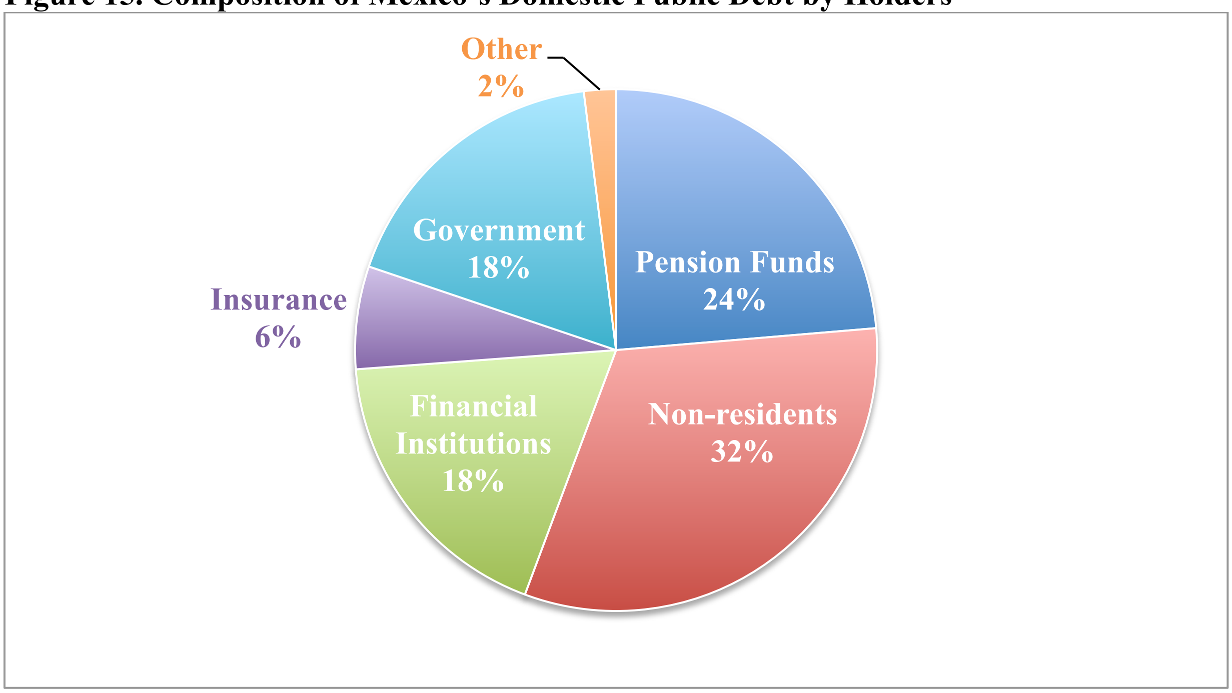
However, as one can understand from all of this, government public debt should have a well-diversified composition of holders. Institutional investors, through their operations in the capital markets, could sometimes be a source of vulnerability for the yield structure and the liquidity in the system. It is true that the public debt managers intervene in the auctions by buying and selling securities, but it is still relevant for the composition of the domestic public debt to be sufficiently diversified so that the potential liquidity problem does not translate into a solvency problem. It can be seen from Figures 13, 14, and 15 that the composition of Brazil, Colombia, and Mexico's domestic public debt, respectively, is diverse enough. One key risk present in both Colombia and Mexico's public debt composition is the high share of debt being held by non-resident holders.

Figure 14. Composition of Colombia's Domestic Public Debt by Holders



Source: Ministerio de Hacienda y Credito Publico, Internal Financing Office; and author's calculations. (http://www.irc.gov.co/webcenter/ShowProperty?nodeId=%2FMHCPUCM%2FP_MHCP_WCC-139962%2F%2FidcPrimaryFile&revision=latestreleased)

Figure 15. Composition of Mexico's Domestic Public Debt by Holders

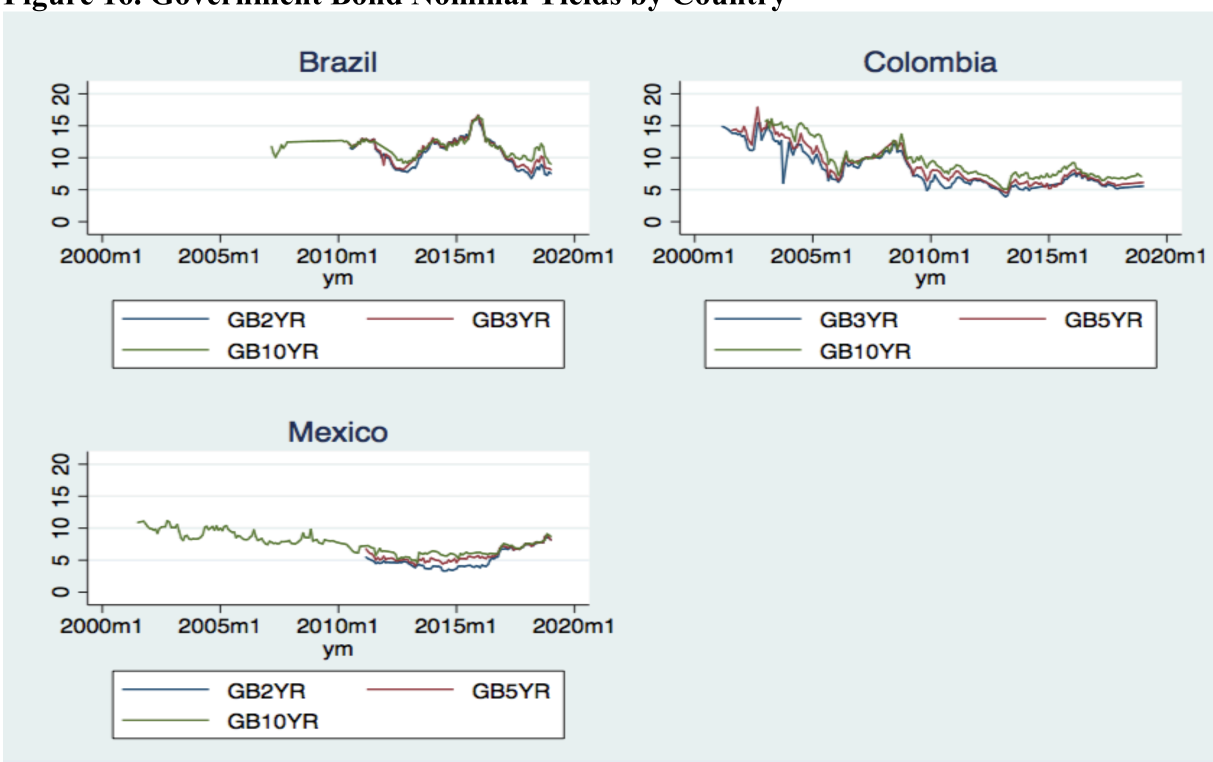


Source: Banco de Mexico; and author's calculations. (http://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=7&accion=consultarDirectorioCuadros&locale=en)

Government Bond Yields

One of the main arguments the IMF makes in its Country Reports regarding prudent debt management is that it keeps investors confident. The IMF's views are based on the crowding out argument and thus, as the deficit- and debt-to-GDP ratios exceed a certain threshold, governments have to implement austerity measures by reducing public expenditures. In other words, the conventional view holds that improvement in the fiscal balance would keep government bond yields low. However, this is not necessarily true since government spending increases the reserves in the system held by the central bank, putting downward pressure on the policy rate. This makes the short-term interest rates decline, thus catalyzing the banks to seek long-term bonds with higher yields (Akram and Li 2017b, 2018). Eventually, this leads to lower long-term interest rate, which makes a possible argument for *crowding in* mechanism.

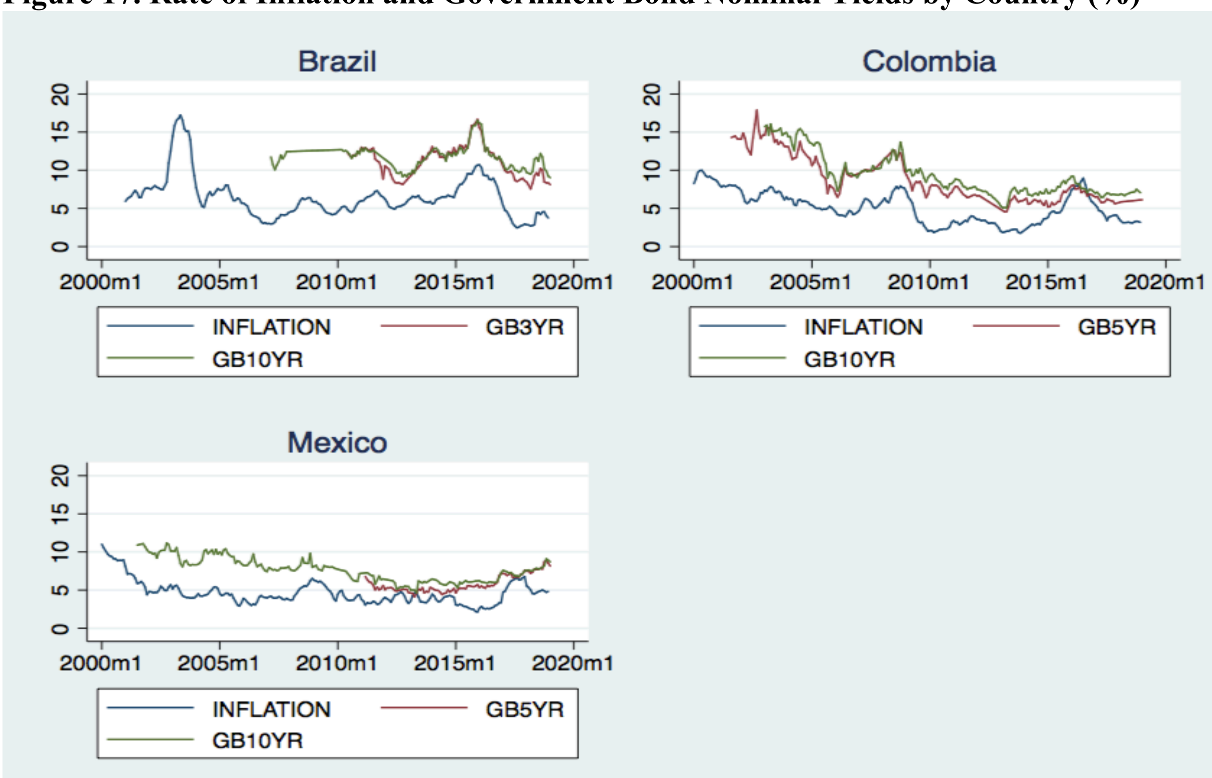
Figure 16. Government Bond Nominal Yields by Country



Sources: Bloomberg Terminal; OECD Main Economic Indicators, Finance; and author's calculations.
Notes: The yield on a 2-year bond is also depicted, but only for descriptive purposes.

Figure 16 portrays the evolution of the long-term government bond nominal yields. After 2010, Brazil's yields were on a declining trend but increased substantially right before the onset of the 2015 recession. After reaching a peak at the end of 2015, the yields started to decline again, with the 2-year, 5-year, and 10-year yields in January 2019 being equal to 7.52%, 8.11%, and 9.02%, respectively. Colombia's and Mexico's yields, on the other hand, have been on a steady declining trend. Currently, Colombia's yields amount to 5.55%, 6.13%, and 7.03%, for the 3-year, 5-year, and 10-year government bonds, accordingly. It is important to keep in mind that generally the government bonds of longer maturity have higher yields compared to government bonds of shorter maturity, which is due mostly because of the certain risk premium adjusted for the longer maturity bonds. However, in some cases this risk premium may be very marginal. For example, Mexico's latest values for the 2-year, 5-year, and 10-year bonds correspondingly have yields of 8.48%, 8.54%, and 8.64%. A careful look at Colombia's yields though, one can note a spike in the trend. The reason for this was probably the heightened uncertainty in the financial environment since Colombia has a high percentage of non-resident holders of its public sector debt as well as somewhat high foreign currency debt composition.

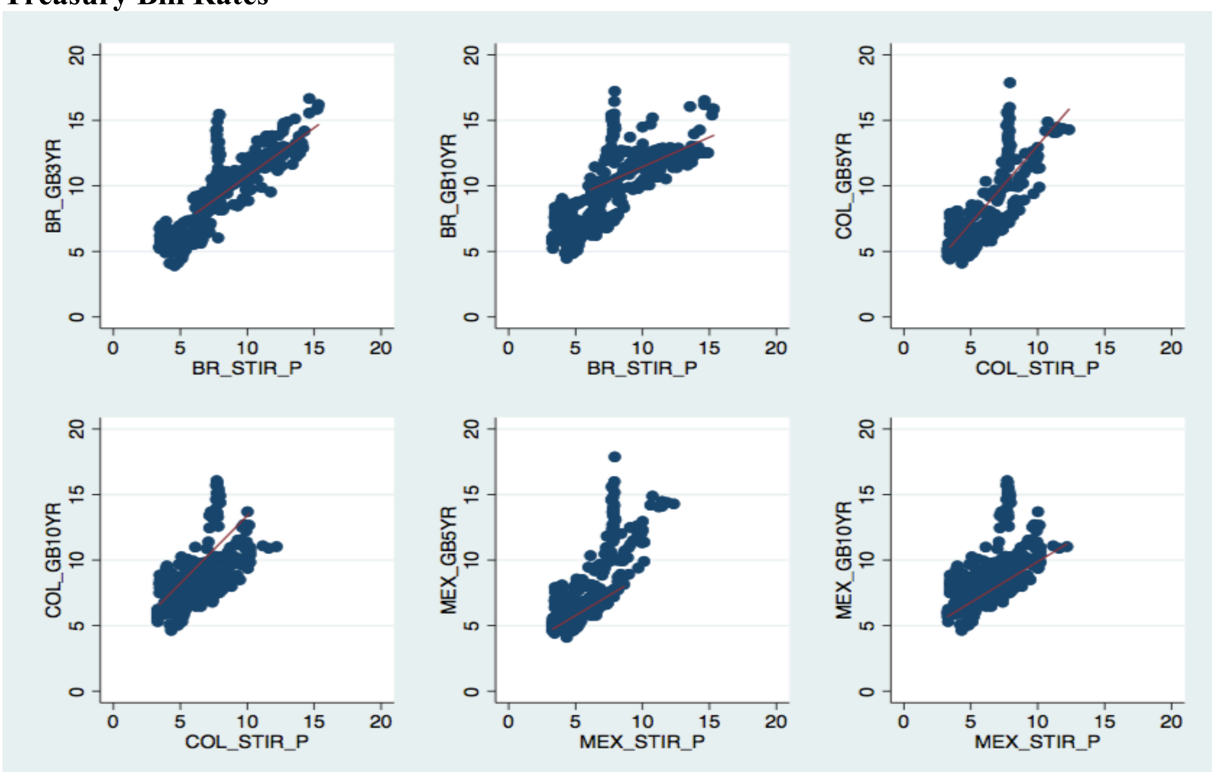
Figure 17. Rate of Inflation and Government Bond Nominal Yields by Country (%)



Sources: Bloomberg Teminal; OECD Main Economic Indicators, Finance; and author's calculations.

The declining trend of Colombian and Mexican yields came to a halt as inflation gathered steam in 2016-17. Figure 17 traces the coevolution of inflation and government bond yields, and one can note in the bottom chart that inflation has certainly played a role for the movement of the yields. For Brazil, the movement of inflation parallels very accurately the movement in the nominal yields. In addition, for Colombia and Mexico, the decline in nominal bond yields has largely been on trend with the overall fall in inflation. Historically, bond nominal yields are higher than inflation and the fact that yields move in tandem with the rate of inflation is understandable because investors tend to be compensated for inflation. Another relevant variable that enters the scheme in the evaluation of purchases and sales by investors in the bond market is the overall GDP growth rate, i.e., the country's economic activity. More on this will be covered in chapter 4 of this dissertation.

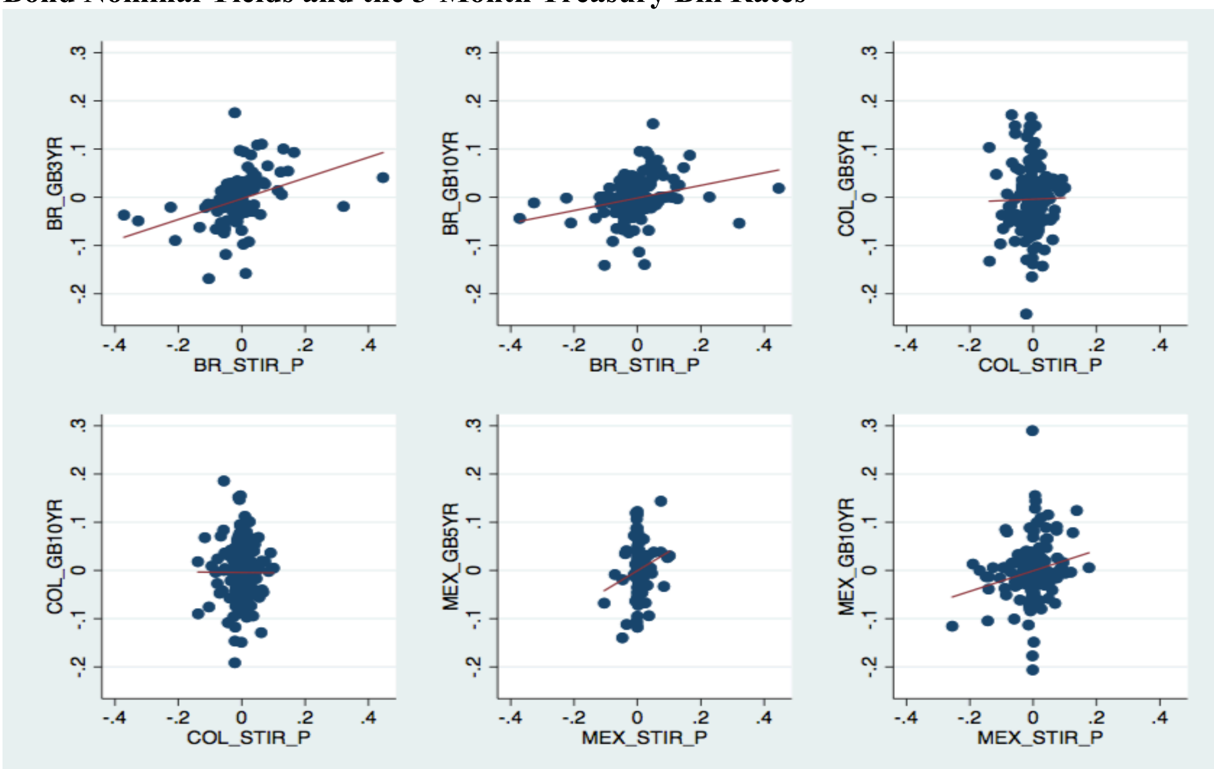
Figure 18. Scatterplots of the Government Bond Nominal Yields and the 3-Month Treasury Bill Rates



Source: Bloomberg Terminal; and author's calculations.
Note: For more detailed description of the data and the notations please refer to Table 3.

Nevertheless, the main argument of this dissertation centers around the empirical regularities that occur between the short-term and the long-term interest rate on government bonds. Figure 18 exhibits the scatterplots of the nominal yields of countries' long-term government bonds of various tenures and 3-month Treasury bills (money market rates). Figure 19 displays the scatterplots of the year-over-year percentage point changes in the nominal yields of the countries' long-term government bonds of various tenures and 3-month Treasury bills. Figure 1A shows the scatterplots of the nominal yields of long-term government bonds of various tenures and the central bank's policy rates. Figure 2A presents the scatterplots of the year-over-year percentage point changes in the nominal yields of long-term government bonds of various tenures and the central banks' policy rates.

Figure 19. Scatterplots of Year-over-Year Percentage Point Changes in the Government Bond Nominal Yields and the 3-Month Treasury Bill Rates



Source: Bloomberg Terminal; and author's calculations.
Note: For more detailed description of the data and the notations please refer to Table 3.

The scatterplots reveal strong and positive correlations between the short-term interest rate on Treasury bills and the long-term interest rate on the government bond yields. Moreover, there are positive correlations between the year-over-year percentage point changes in the short-term interest rates and the year-over-year percentage point changes in the long-term interest rate on the government bond yields. The positive correlations between the levels of the nominal yields of government bonds and 3-month Treasury bills is stronger than the positive correlations between the year-over-year percentage point changes in the nominal yields of government bonds and 3-month Treasury bills. The strong, positive correlations between the nominal yields of government bonds and 3-month Treasury bills are weaker for a higher maturity of the bond. The positive correlations between year-over-year percentage point changes in the nominal yields on government bonds and 3-month Treasury bills are also weaker for a higher maturity of the bond. All of this analysis holds true for the correlations between the levels (and the year-over-year percentage point changes) in the nominal yields of government bonds and the central bank's policy rates. These observations give credence to our argument that short-term interest rates are actually the main drivers of government bond nominal yields for the countries of Brazil, Colombia, and Mexico.

INSTITUTIONAL BACKGROUND FOR BRAZIL, COLOMBIA, AND MEXICO

Central Bank Targets And Objectives

In the early 2000s, most of the LAC adopted an inflation-targeting regime. Conducting monetary policy is done on the premise of "hitting" a certain inflation target. The central banks of Brazil, Colombia, and Mexico, all abide by the inflation-targeting regime as all of their mission statements revolve around ensuring low inflation and stability of the currency's purchasing power. All central banks are independent, transparent, and accountable to the public since these are all necessary requirements for the efficient conduct of monetary operation within the country's constitutional and legal mandate.

Banco Central do Brasil (2019), Banco de la Republica (2019), and Banco de Mexico (2019a, 2019b, 2019c) provide an abundant amount of information, legal documents, and Frequently Asked Questions (FAQs) series papers that pertain to monetary policy and public debt management. The Monetary Policy Committee (Copom) of Banco Central do Brasil has the authority to set the policy (reference) rate. The interest rate target set by Copom is the target for the Selic interest rate. Selic (Sistema Especial de Liquidacao e de Custodia) stands for Special System for Settlement and Custody in which the interest rate target is the benchmark for overnight interbank loans collateralized by government securities. In fact, approximately 96% of the domestic bonds are registered with and traded on the Selic. In Colombia, it is the Board of Directors of Banco de la Republica (BDBR) that adjusts the short-term liquidity interest rate, which is the benchmark interest rate for intervention in the money market. Similarly, in Mexico, the Governing Board of Banco de Mexico (2019c) conducts monetary policy stance by setting its interest rate target (“tasa de fondeo”) on the overnight bank funding operations. Before the “tasa de fondeo”, from 1995 to 2007-8, Banco de Mexico had an operational target level for the bank’s daily balances (“corto”). This worked well for some time because in a period of decreasing inflation, a target level for banks’ balances at the central bank allowed interest rates to decline in concordance with inflation expectations (Banco de Mexico 2008). Once low and stable inflation was achieved, “corto” was substituted by “tasa de fondeo,” through which, like most other central banks, providing or withdrawing liquidity through Open Market Operations (OMOs) to set the policy rate near the operating target became the standard monetary policy.

However, the monetary authorities’ decision to adjust their policy rate depends on inflation rate deviations from the acceptable target band. The monetarists tend to believe that ensuring price stability by adjusting the interest rate would lead to sustained growth that generates employment. Instead of pursuing these heroic goals, central banks should try and direct their attention more to their operations in the bond market. Through collaboration with the Ministries of Finance (Treasury and/or Fiscal Budget Board/Committee), central banks can effectively manage a stable yield curve and positively impact the public debt financing operations.

Domestic Bond Markets

Almost all countries are prone to some kind of yearly government plans i.e., annual borrowing requirements, which establish the structure of the public debt operational management. The National Treasury Secretariat (STN) is part of the Ministry of Finance and it is responsible for managing the Brazilian federal public debt. In Colombia, the General Directorate of Public Credit and National Treasury (DGCPTN) is in charge of structuring and directing the national public debt. The Ministry of Finance and Public Credit (SHCP), through Banco de Mexico as its financial agent, is the responsible government body for the Mexican government bond market. The main objectives of all the public debt management government bodies include smoothing the maturity structure, increasing the average maturity of outstanding debt, managing the yield curve, and increasing the liquidity of public bonds in the secondary market.

The Brazilian federal public debt is one most liquid bond markets among the emerging markets. Most of it is denominated in Brazilian reais. The Mexican federal public debt is also very liquid and just like the Brazilian bond market, the Mexican bond market offers a wide range of securities. Brazil's public debt is composed of, more or less, an equal percentage share of fixed-rate, floating-rate, and inflation-linked bonds (Secretaria do Tesouro Nacional, 2019b). Mexico, for instance, has similar distributional composition of fixed-rate, inflation-linked, and floating-rate bonds (Secretaria de Hacienda 2019b). Colombia, on the other hand, has a less diverse range of securities with domestic federal public debt consisting of approximately 65% fixed-rate peso bonds and 30% fixed-rate real value unit (UVR) bonds, with the rest of the 5% being either inflation-linked bonds and/or short-term funding bonds (Banco de la Republica 2019). Compared to Brazil, Colombia and Mexico have higher foreign currency-denominated debt, but this amount is much lower than it was in the late 1990s (see Figures 11 and 12). Yet, all three countries have successfully extended the average maturity of the government's domestic securities by issuing long-tem, fixed interest securities, ranging from 2- and 3-year bonds all the way to 10- and even 30-year bonds in the case of Brazil and Mexico.

Securities

Brazil has a high number of bonds issued in public offerings, namely, National Treasury Bills (LTN), National Treasury Notes-Series F (NTN-F), Financial Treasury Notes (LFT) with rates pegged to the Selic rate, and National Treasury Notes-Series B (NTN-B), indexed to the Consumer Price Index. These bonds operate at different vertices of the yield curve as they vary in terms of their maturity issuance structure. For instance, LTN are bonds that range in the short- and medium-term (i.e., from 6 months to 4 years), while NTN-F series bonds range within the longer-term structure spectrum (Banco Central do Brasil 2019; Secretaria do Tesouro Nacional 2019b). There are other bonds such as the National Treasury Bonds (BTN) that can have a maturity of up to 25 years.

The Colombian bonds are less complicated. All of them are class B Treasury bonds (TES B) and they can be separated into two categories. One category includes TES bonds that are used in the short-term auction as they are issued for the sole purpose of funding temporary Treasury operations (TCO). Most of these are 90-day peso-denominated TES B. The other category of TES bonds comprises of fixed-rate Colombia peso-denominated bonds and fixed-rate UVR-denominated bonds. Both of these are issued in the long-term auction with the objective of meeting the public debt borrowing requirements (Ministerio de Hacienda y Credito Publico 2019). The peso-denominated TES B can be placed with maturities ranging from 1 year to 10 years.

The government securities in Mexico range from 28 days to 30 years of maturity. The short-term securities encompass Cetes and Bondes bonds. Cetes are zero-coupon Federal Treasury Certificates that can be issued with maturities of 28 and 91 days, 6 months, and 1 year. Bondes are floating-rate Federal Government Development Bonds with maturities of 1, 3, and 5 years. Bonos are fixed-rate Federal Government Development Bonds with maturities ranging from 3 years to 30 years. And lastly, Udibonos are Federal Government Development bonds denominated in inflation-indexed investment units, UDIS, and can be of a 3-, 10-, or 30-year maturity (Secretaria de Hacienda 2019b).

Auctions (Primary Market)

Domestic public debt securities are issued in the primary market in which auctions can operate through multiple or unique price discovery frameworks. Price discovery refers to the auctioning process in which buyers and sellers simultaneously arrive at a particular transaction price for, in this case, a government security. Every auction starts off with the amount and price for purchases and sales of the securities. Once the auction closes, the government's debt management organization sorts the bond between the bidders, either through a multiple price procedure or through a uniform price mechanism, until it has raised its targeted financing needs (Banco Central do Brasil 2019; Banco de la Republica 2019; Banco de Mexico 2019a). In multiple-price auctions the winning bidder pays the price higher than or equal to his own stated bid. In uniform-price auction, often referred to as Dutch style auction, bidders pay the price that is equal to the highest rejected bid (cut-off price) at which market clears the issuance.

In Brazil, Selic is the platform in which the BCB conducts auctions used for National Treasury's public offerings as well as open market operations. Commercial and investment banks, broker houses, mutual and pension funds have the right to participate in the Selic, which is technically the central bank's electronic system (Banco Central do Brasil 2019). The STN management of the federal public debt has to comply with the Annual Financing Plan (PAF), which states the governments borrowing needs. Most of the issuances take place in a competitive manner and it is the responsibility of the National Treasury to indicate an annual calendar of the auctions that will be held and the securities that will be offered, along with the settlement dates and their respective type and maturity profiles. The auctions are announced and held through the Public Offer System-Ofpub. (Banco Central do Brasil 2019). The competitive placement is characterized by the direct participation of dealers, who are financial institutions accredited by the National Treasury Departments with the goal of promoting efficient primary issuances of the public bonds. The STN also issues securities through noncompetitive placement, which is direct issuance for specific aims (namely, securitizing federal public debt), and through Tesouro Direto, which are direct sales to individuals (Banco Central do Brasil 2019). In Brazil, the issuance in the auctions can take place through either the multiple price structure or the unique price scheme.

The National Government in Colombia uses the structure of Dutch auctions (Ministerio de Hacienda y Credito Publico 2019). The DGCPTN establishes the cut-off rate along with the regulatory framework of the auctions. The offers from the auction are ranked in descending order and all the offers are awarded at the rate at which the auctions are completed. The bid offers that are below this cut-off rate are denied. DGCPTN has a proactive issuance strategy aimed at providing liquidity and reducing costs for the Nation's budgetary appropriations defined in the Nation's Financial Plan. Since Colombia, compared to Brazil and Mexico, does not have much proficiency and depth of the domestic bond market, the National Government through the DGCPTN has implemented a Market Maker Program. This program has helped in the enhancement of the issuance of public debt securities and regulatory financing conditions that takes place in the primary auction market (Ministerio de Hacienda y Credito Publico 2019).

One of the main points emphasized by the Mexican Ministry of Finance in the latest Annual Borrowing Plan is the financing of the government's needs primarily through domestic debt markets. Besides the primary securities auction program already in place, the Ministry of Finance has tried to include new reference rates by performing syndicated auctions (Secretaria de Hacienda 2019b). The idea behind the syndicated bond offering is that the government pays a certain group of institutions (typically banks that are primary dealers) in the primary market to boost the demand from the other groups of investors participating in the auction. If some amount of the bond offer is not sold, the banks buy the rest of the amount thus enabling the government as an issuer to raise the full amount of bond offer (McCrum, Hale, and Allen 2017). Mexico, just like Colombia, also has a Market Makers Program that has the objective of increasing liquidity in the local currency bond market. Furthermore, Mexico implemented Cetesdirecto, which is a government program that allows the investors a more efficient purchase/sale of government securities available on the auctions. This government program essentially manages the direct sale to individuals on the primary market (Secretaria de Hacienda 2019a).

The Collaborative Nature Of Fiscal And Monetary Operations

It is difficult to separate the fiscal and the monetary authority operations in the bond market since by being the government's banker (i.e., the Treasury's fiscal agent), the central bank plays an integral role in the primary and the secondary market. The central banks conduct the Treasury's payments by checks or by credits to bank accounts (Wray 2012, 102). On top of that central banks run the payments system and maintain par clearing as individual banks have accounts at the central bank for clearing with each other. Although it is mostly the STN's responsibility to manage issuances and redemptions of public securities, Banco Central do Brasil effectively is the manager of the Selic, carrying out auctions held by STN to buy or sell securities. Besides the outright purchases and sales and the repurchase agreements (repos), Banco Central do Brasil provides an even greater liquidity to the secondary market through the settlement system because Selic also acts as a facility for an outright purchase of intraday repos. For instance, a repo transaction with Banco Central do Brasil requested by a settlement bank on the clearing platform to generate additional liquidity will be automatically swept back to the Selic. These operations take place via the electronic system Offer to Dealers (Ofdealers) where auctions are held exclusively with financial institutions (e.g., banks, saving banks, brokers, and securities distributors) authorized to operate with Banco Central do Brasil Open-Market Operations Department (Banco Central do Brasil 2019).

In Colombia, Law 31 prohibits Banco de la Republica from offering credits and securities to entities. There is an exception, though, in the case of lack of liquidity. Banco de la Republica can step in as the lender of last resort to temporarily assist credits to the financial institutions. In addition, under the Constitution, Banco de la Republica can operate freely on the secondary market by purchasing/selling government bonds (Banco de la Republica 2019). Banco de la Republica has a profound significance when it comes to the payment system structure, stability of the financial system and channeling monetary indicators in the markets. It oversees the Deposit Account System (DAS), a denomination value payments system in which operations between financial intermediaries take place through electronic means. Moreover, it administers the Central Values Deposit (DCV) and the Electronic Negotiation System (ENS), through which public debt are monitored (Banco de la Republica 2019).

The Mexican Ministry of Finance, through Banco de Mexico, carries out liability management operations, namely, repurchase agreements and joint repurchases with additional issuances (Secretaria de Hacienda 2019a). Banco de Mexico provides liquidity to the national payment system by managing the accounts of the Mexican financial agents through the Account Holders Service System (SIAC). Moreover, the primary auctions of government securities are carried out through an electronic system that is developed and managed by Banco de Mexico. It also has the capability in overseeing the securities market trading volume (Banco de Mexico 2019a). Besides regulating the liquidity of Mexico's financial system, Banco de Mexico controls the securities clearing house (INDEVAL), which is the Mexican delivery-versus-payment system that serves as a private depository institution (Banco de Mexico 2019a). Banco de Mexico also reports to the public the average transaction-amount-weighted interest rate for its repo operations with government securities. Banco de Mexico, just like Banco Central do Brasil and Banco de la Republica, conducts it OMOs on the secondary market through repo and reverse repo arrangements. Depending on the market liquidity needs, Banco de Mexico can auction credits (inject liquidity) or deposits (withdraw liquidity). Amounts and interest rates of one-day maturity operations are settled through INDEVAL.

Monetary Sovereignty

The institutional framework demonstrates that Brazil, Colombia, and Mexico have modern governments each with a Treasury department and a central bank, which is the government's bank making and receiving payments for the government. Table 2 demonstrates all the requirements for a country to have full control over its monetary sovereignty. By the end of the 20th century, almost all Latin American countries have introduced a floating exchange rate regime: Mexico in 1995; Brazil and Colombia in 1999 (Damil and Frenkel 2017). A floating exchange rate regime has reduced the solvency risk because earlier, under the fixed exchange rate regime, countries in the LAC region had trouble putting unemployed domestic resources to work and were susceptible to exchange rate crises characterized by foreign currency shocks and large external debts (Sardoni and Wray 2007).

In a country with a monetary sovereignty regime, the fiscal authority functions in concordance with the monetary authority. The central banks of Brazil, Colombia, and Mexico ensure that their Treasury's fiscal operations do not move the overnight interest rate away from the target (Wray 2012, 103-5). The Brazilian, Colombian, and Mexican governments are issuers of their own currency and they spend by crediting bank accounts. The tax payments, on the other hand, result in debits to bank accounts (Wray 2006). In addition, since Brazil, Colombia, and Mexico have low amounts of foreign currency-denominated debt, their governments do not have third party IOUs ("I owe you") to service their own debt (Sardoni and Wray 2007). These operations demonstrate that the annual borrowing needs and requirements set by the Brazilian National Treasury Secretariat, the Colombian General Directorate of Public Credit and National Treasury, and the Mexican Ministry of Finance and Public Credit do not have much relevance, except perhaps for statistical purposes demanded by the IMF.

Government spending can lead to excess reserve positions due to the increase in net credits. Banks start to offer the excess reserves in the overnight lending market – thereby, bidding down the overnight interest rates. But, the central bank could easily intervene in the market through bond sale operations to drain the excess reserves, and hit its desired target. Even the mainstream macroeconomic body of literature (Bindseil 2004; Sims 2013; Woodford 2001) has addressed this fiscal-monetary operational framework in a monetary sovereignty regime. Bond sales (or purchases) are not borrowing operations, but rather they represent a coordinated mechanism by the Treasury and the central bank by which the Treasury can always sell securities and get deposits at the central bank in order to spend (Fullwiler 2008; Wray 2003, 2006, 2012). This means that central banks can directly influence the long-term interest rates on government bond yields. They could do so by purchasing long-duration government bonds from dealers and financial institutions, yield curve control, and policy pronouncements (Akram and Li 2018).

Table 2. Summary of Monetary Sovereignty Institutional Framework

Country	Their own currency and national Central Bank	Ability to tax and spend in their own currency	The tax liabilities of the private sector to the governments can be met *solely* by the payments in their own currency	Exchange-rate regime	Monetary policy objective	Foreign currency-denominated debt
Brazil	Brazilian Real (Banco Central do Brasil)	Yes	Yes	Floating	Inflation targeting	Almost none
Colombia	Colombian Peso (Banco de la Republica)	Yes	Yes	Floating	Inflation targeting	Low
Mexico	Mexican Peso (Banco de Mexico)	Yes	Yes	Free floating	Inflation targeting	Low

DATA AND METHODOLOGY

Based on the exploratory facts that we have discussed in the chapters beforehand, it follows that Brazil, Colombia, and Mexico are countries with sovereign currencies, have most of their debt issued in their own currency, have the ability to tax and spend in their own currency, are under a floating exchange rate regime, and have central banks that set the policy rate through forward guidance, communication tools, and asset purchases/sales. These features create an economic environment with monetary sovereignty in which the central banks' operations profoundly influence the country's long-term nominal domestic currency government bond yields.

A Simple Model Of Long-Term Interest Rates

The fact that Brazil, Colombia, and Mexico have most of their government debt securities denominated in their particular domestic currencies allows us to construct a concise model so that by assumption we can ignore variables such as exchange rates (vis-à-vis the US dollar), Federal Reserve Funds rates, current accounts, capital controls, dollar reserves, US Treasury yield spreads, etc. Henceforth, within this level of abstraction, we can start by saying that the long-term government bond yield depends on the short-term interest rate and the forward rate.[6] The yield of a long-term bond, r_{LT}, depends on the short-term interest rate, r_{ST}, and the appropriate forward rate, $f_{ST,LT-ST}$:

$$(1 + r_{LT})^{LT} = (1 + r_{ST})^{ST}\left(1 + f_{ST,LT-ST}\right)^{LT-ST} \tag{4.1}$$

It is important to point out that $LT - ST > 0$ as the long-term bonds have longer maturity than the short-term bills or securities. The standard practice in financial markets is to define short-term interest rate in terms of yields of bills and securities with maturities of one year or less and long-term interest rates as yields of bonds and securities with maturities of more than one year. Thus, it follows that the long-term rate can be expressed as a function of the short-term rate and an appropriate forward rate:

---

[6] The model that is presented in this section of the dissertation mostly follows Akram and Das's (2014, 2015, 2017a, 2017b, 2018) and Akram and Li's (2017a, 2017b, 2018) interpretation of Keynes's conjectures.

$$r_{LT} = F^1\left(r_{ST}, f_{ST,LT-ST}\right) \tag{4.2}$$

The forward rate, $f_{ST,LT-ST}$, is a function of the future short-term interest rate, r_F, and the term premium, z:

$$f_{ST,LT-ST} = F^2(r_F, z) \tag{4.3}$$

But the future short-term interest rate and the term premium are contingent on the expected inflation rate and the expected growth rate. Hence, it is really investor's views of the future as regards to future short-term rates and term premium that determine the forward rate. We have seen that the central banks in Brazil, Colombia, and Mexico all adjust their policy rate in response to inflation and its expectations. This is the standard conventional view that by steering the interest rate the central bank can control the rate of inflation and the rate of economic activity. The mechanism at work here is that once the inflation and/or growth are high (low) then the central bank steps in and increases (decreases) the policy rate. When the central bank induces change in the short-term interest rate, it affects the entire interest rate curve. Since short-term interest rate follow the central bank's policy rate, the investor's views of future short-term rates and term premium are jointly determined by the investor's *expectations* about the future behavior of inflation, π^e, and economic activity, g^e (Akram and Das 2014). Along these lines, we can write that:

$$F^2(r_F, z) = F^3(\pi^e, g^e) \tag{4.4}$$

Keynes's Notion Of Uncertainty

This is where our modeling starts to follow Keynes's methodology. Keynes's liquidity preference is tied with the concept of fundamental uncertainty, which is very different from calculated probabilistic risk (Davidson 1994, 86-104; Lavoie 2006, 17; Kregel 1998, 113-8). Since the future is unknown and unpredictable, it is impossible to know the probability of an event occurring. The notion of ontological uncertainty is present in Keynes, especially when he writes that:

"The outstanding fact is the extreme precariousness of the basis of

> knowledge on which our estimates of prospective yield have to be made. Our knowledge of the factors which will govern the yield of an investment some years hence is usually very slight and often negligible. If we speak frankly, we have to admit that our basis of knowledge for estimating the yield ten years hence of a railway, a copper mine, a textile factory, the goodwill of a patent medicine, an Atlantic liner, a building in the City of London amounts to little and sometimes to nothing; or even five years hence." (Keynes [1936] 2007, 149).

Keynes compared financial markets to beauty contests in order to point out how mass psychology, social norms, and tactic conventions can play a role in forcing the public, instead of trying to select the personally prettiest face, to try and choose what everyone else in the public selects as the prettiest (Keynes [1936] 2007, 156). This issue had also been tackled by Simon (1957), who argued that "the consequences an individual thinks will follow on his actions depend on what actions he thinks other individuals will take (72). By exploring the concept of bounded rationality, Simon (1957, 1978, 1984) ended up being very much against the theory of rational choice that simply ignores the limits of economic agents as mechanisms for computation and choice since the capacity of the human mind is very restricted. Foley (1998) is a more current study on bounded rationality that states that computational complexity constitutes a barrier to rationality in a nonlinear dynamical system. But even before Simon, there was Arrow (1951, 1986) who pointed out that the notions of risk-neutrality, static time, and completeness of information, are underlying necessitates, far away from reality, that make economic units rational. Thus, Keynes's claim on the formation of investor's expectations is at odds with rational actors and their calculated mathematical expectations.

Fundamental uncertainty is linked to historical time and bounded rationality. The future is different from the past and "if nothing very definite is looming up in the future to provide a fulcrum on which expectations can rest, the *present* will exert strong influence on the operative expectations (Kahn 1972, 92). Kregel has extended this line of analysis suggesting that investors fall back on common sense based on current, actual observation of the markets, rather than on formulation of probability by assessing uncertain information (Kregel 1998, 117). Ultimately, it was Keynes himself, who argued that short-term realizations drive the investor's long-term expectations. Namely, investors seem to be "oversensitive…to the near future, about which we may think that we know a little" since "in truth, we know almost nothing about the more remote future." (Keynes 1930, 359-62, cited in Kregel 2011, 4). What happens is that investors just tend to rely on "the existing situation and project it into the future". (Keynes, [1936] 2007, 148).

Hence, investor's view of the future long-term outlook becomes simply an extrapolation of current economic conditions. Clark and Davig (2018) and Faust and Wright (2013) are empirically behavioral studies of the investor's expectations of interest rates that concur with Keynes's views.

Following Keynes's views that short-term realizations drive investor's long term expectations as the investor extrapolates the future outlook from the present, current rate of inflation, π, and current rate of economic, g, activity influence investor's expectations of inflation and economic activity. Thus, we can simply write, $\pi^e = F^4(\pi)$ and $g^e = F^5(g)$. From here it follows that:

$$f_{ST,LT-ST} = F^2(r_F, z) = F^3(\pi^e, g^e) = F^3\big(F^4(\pi), F^5(g)\big) \tag{4.5}$$

The equation above simply states that the forward rate is a function of the current inflation rate and the current growth rate based on Keynes's conjectures that near-term views predominantly affect investors' long-term outlook. Therefore, the long-term interest rate, r_{LT}, is a function of short-term interest rate, r_{ST}, current inflation rate, π, and current growth rate, g, and this can be expressed in the following way:

$$r_{LT} = F^1\left(r_{ST}, F^3\big(F^4(\pi), F^5(g)\big)\right) = F^6(r_{ST}, \pi, g) \tag{4.6}$$

Lastly, testing for crowding out implies that we need to take into consideration the government deficit (or debt)-to-GDP ratios. This ultimately tests the mainstream crowding out argument that higher government deficit and debt ratios increase the long-term government bond yields. The government finance variable could affect the long-term rates by influencing the forward rate. Consequently, we can easily incorporate the government finance variable – making the long-term interest rate to be a function of the short-term interest rate, the inflation rate, the growth rate, and the government finance variable, V. That is,

$$r_{LT} = F^7(r_{ST}, \pi, g, V) \tag{4.7}$$

Data

Time-series monthly data on short-term interest rates, long-term interest rates, and inflation rates are used for the econometric models that we evaluate in the following chapter. Short-term interest rate data cover the official interest rate (i.e., reference rate) targets set by each individual central bank. The _P notation after some of the _STIR variables denotes a proxy variable. Figure 20 illustrates that the proxy variables tend to follow closely the central banks' policy (reference) rates. We need to be cautious with regards to Brazil, as there seems to be a discrepancy between BR_STIR and BR_STIR_P. The Selic target rate is the official policy rate set by the Brazilian central bank. The IRB Interbank overnight rate indicates Colombia's monetary market liquidity where the Colombian central bank is the manager of the IBR index. Similarly, the central bank of Mexico conducts the operational overnight target interest rate. With respect to the proxy short-term interest rates we use the IMF (for Brazil) and the OECD (for Colombia and Mexico) average estimates of rates at which short-term government paper is issued or traded in the market. These rates are based on the three-month money market rate and the Treasury bill rate.

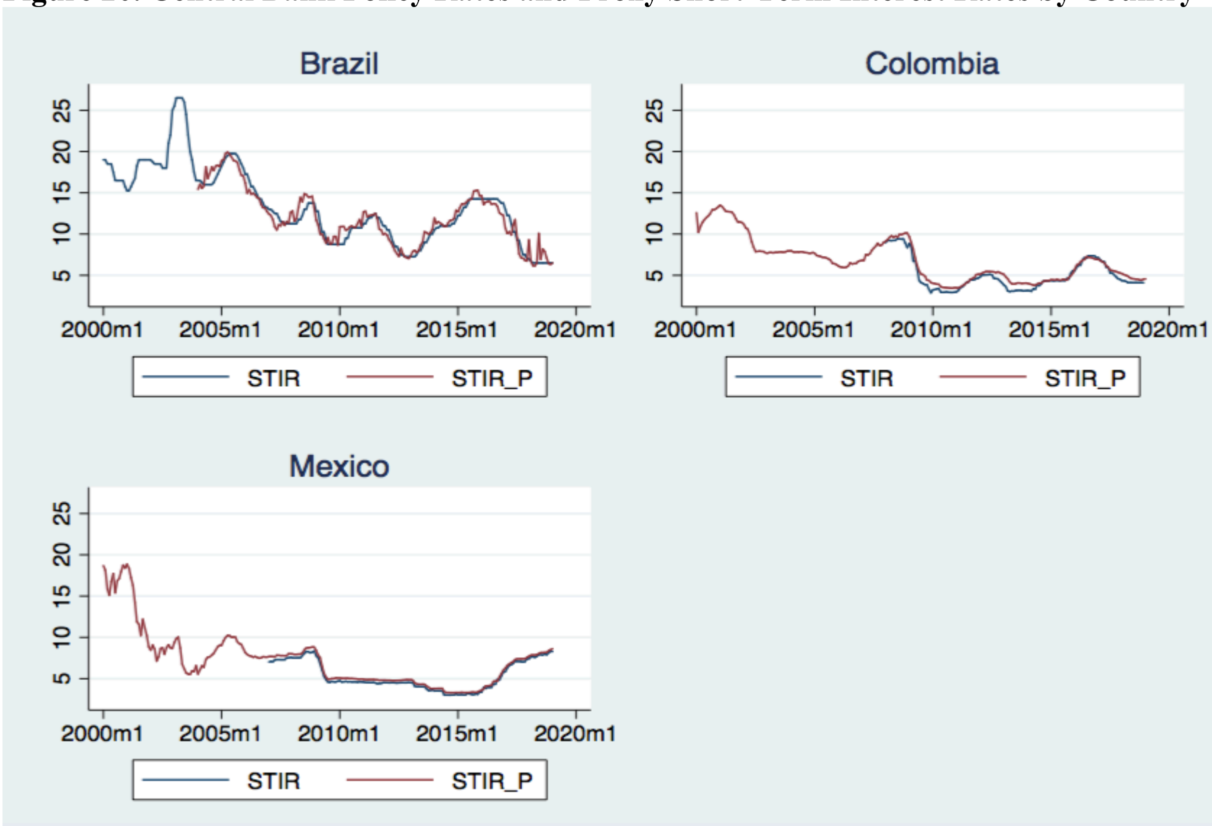
The long-term interest rate data include yields from long-term sovereign domestic currency denominated government bonds of a 3-year (for Brazil), 5-year (for Colombia and Mexico), and 10-year maturities (for all three countries). These interest rates are also implied by the prices at which these securities are traded on the financial markets and the value that is taken is the last monthly bid price.[7] All these securities are denominated in their respective domestic currency. The government sector is the issuer of all these securities with the obligor being the Federative Republic of Brazil, Republic of Colombia, and the United Mexican States, respectively. These bonds are a fixed type – meaning that each individual government upon issuance of the securities fixes the interest rate paid. The modality of the bonds is nominal and non-negotiable with redemption taking place at nominal value on maturity date. All of the bonds that we are using are fixed-rate securities whose par value is the nominal value of the security on the issuance date of the auctions.

The consumer price index (CPI) is a measure of prices paid by consumers for a market basket of consumer goods and services. This is sometimes referred to as the core inflation,

[7] Interpolation technique is used to populate very few missing data observations of the long-term interest rate.

which excludes food and energy items, measured as the percentage change year-over-year. These yearly growth rates represent the inflation rate.

Figure 20. Central Bank Policy Rates and Proxy Short-Term Interest Rates by Country



Source: Bloomberg Terminal; IMF International Financial Statistics; OECD Main Economic Indicators, Finance.
Note: For more detailed description of the data and the notations please refer to Table 3.

Gross Domestic Product (GDP) is the standard measure of the value of final goods and services produced by a country in a given period of time. Data are internationally comparable following the System of National Accounts. This indicator is seasonally adjusted and is measured as the percentage change year-over-year. Industrial production is often referred to as a proxy for the GDP as it indicates the output of industrial operation and activity within sectors such as mining, manufacturing, and electricity. This is a seasonally adjusted indicator expressed in an index, also measured as a percentage change year-over-year.

Government finance data covers gross and net government debt, and overall net and primary net lending/borrowing, all measured as a percentage of nominal GDP. Gross government debt and net government debt-to-GDP ratios are stock variables and represent the general government financial liabilities. The difference between the two is that net debt comprises all financial liabilities minus all financial assets of the general government. Some of these financial assets include currency and deposits, securities, loans, and other accounts receivable. The overall net lending/borrowing, and the primary net lending/borrowing-to-GDP ratios, are flow variables and represent the overall and the primary government balance, respectively. The overall balance is the more common fiscal balance measure and it simply measures the difference between revenues and grants, and expenditures and net lending. The primary budget balance is just the overall balance but excluding interest payments from expenditures. Positive balance indicates overall/primary surplus, while a negative balances indicates overall/primary deficit. There is an ongoing discussion on what is the better measure as the interest rates are assigned based on the size of the previous government deficits. For this reason, in the following chapter we include all of the government finance variables in our econometric analysis.

Table 3 below provides a summary of the data and the variables used in the econometric models. The first column lists the variable names; the second column provides the description and the date range of the data; the third column indicates the frequency and points out if it has also been converted to a different frequency; the final column shows the primary and the secondary sources.

Table 3. Summary of the Data and the Variables

Variables	Data Description and Date Range	Frequency	Source(s)
Short-Term Interest Rates			
BR_STIR	Brazil, Selic Target Rate, % 2000M1-2019M1	Daily; converted to monthly	Bloomberg Terminal
BR_STIR_P	Brazil, Money Market Rate (or 3-Month Treasury Bill Rate), % 2004M1-2019M1	Monthly	IMF International Financial Statistics
COL_STIR	Colombia, IBR Overnight Nominal Interbank Reference Rate, % 2008M1-2018M12	Daily; converted to monthly	Bloomberg Terminal
COL_STIR_P	Colombia, Money Market Rate (or 3-Month Treasury Bill Rate), % 2000M1-2019M1	Monthly	OECD Main Economic Indicators: Finance
MEX_STIR	Mexico, Overnight Target Interest Rate, % 2007M1-2019M1	Daily; converted to monthly	Bloomberg Terminal

Variables	Data Description and Date Range	Frequency	Source(s)
MEX_STIR_P	Mexico, Money Market Rate (or 3-Month Treasury Bill Rate), % 2000M1-2019M1	Monthly	OECD Main Economic Indicators: Finance
Long-Term Interest Rates			
BR_GB3YR	Brazil, Generic Government Bond, 3 Year, Yield, % 2010M6-2018M12	Monthly	Bloomberg Terminal
BR_GB10YR	Brazil, Generic Government Bond, 10 Year, Yield, % 2007M3-2019M1	Monthly	Bloomberg Terminal
COL_GB5YR	Colombia, Generic Government Bond, 5 Year, Yield, % 2001M8-2019M1	Monthly	Bloomberg Terminal
COL_GB10YR	Colombia, Generic Government Bond, 10 Year, Yield, % 2003M1-2018M12	Monthly	OECD Main Economic Indicators: Finance
MEX_GB5YR	Mexico, Generic Government Bond, 5 Year, Yield, % 2011M3-2019M1	Monthly	Bloomberg Terminal
MEX_GB10YR	Mexico, Generic Government Bond, 10 Year, Yield, % 2001M7-2019M1	Monthly	OECD Main Economic Indicators: Finance
Inflation			
BR_INF	Brazil, Consumer Price Index (CPI), Total, Index, % Change, Y/Y 2000M1-2019M1	Monthly	Bloomberg Terminal
COL_INF	Colombia, CPI, Total, Index, % Change, Y/Y Bloomberg Terminal 2000M1-2019M1	Monthly	Bloomberg Terminal
MEX_INF	Mexico, CPI, Total, Index, % Change, Y/Y 2000M1-2019M1	Monthly	Bloomberg Terminal
Economic Activity			
BR_GDP	Brazil, GDP, Total, Constant Prices, Seasonally Adjusted (SA), Chained, % Change, Y/Y 2000Q1-2018Q4	Quarterly	OECD Main Economic Indicators: National Accounts Statistics
BR_IP	Brazil, Industrial Production Index, SA, % Change, Y/Y 2000Q1-2018Q2	Quarterly	OECD Main Economic Indicators: Production and Sales

Variables	Data Description and Date Range	Frequency	Source(s)
COL_GDP	Colombia, GDP, Total, Constant Prices, Seasonally Adjusted (SA), Chained, % Change, Y/Y 2006Q1-2018Q3	Quarterly	OECD Main Economic Indicators: National Accounts Statistics
COL_IP	Colombia, Industrial Production Index, SA, % Change, Y/Y 2000Q1-2018Q2	Quarterly	OECD Main Economic Indicators: Production and Sales
MEX_GDP	Mexico, GDP, Total, Constant Prices, Seasonally Adjusted (SA), Chained, % Change, Y/Y 2000Q1-2018Q4	Quarterly	OECD Main Economic Indicators: National Accounts Statistics
MEX_IP	Mexico, Industrial Production Index, SA, % Change, Y/Y 2000Q1-2017Q4	Quarterly	OECD Main Economic Indicators: Production and Sales
Government Finance			
BR_GROSS	Brazil, Gross Government Debt, % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
BR_NET	Brazil, Net Government Debt, % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
BR_OVERALL	Brazil, Net Lending/Borrowing (Overall Balance), % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
BR_PRIMARY	Brazil, Primary Net Lending/Borrowing (Primary Balance), % of Nominal GDP 2002-2018	Yearly	IMF Fiscal Monitor
COL_GROSS	Colombia, Gross Government Debt, % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
COL_NET	Colombia, Net Government Debt, % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
COL_OVERALL	Colombia, Net Lending/Borrowing (Overall Balance), % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
COL_PRIMARY	Colombia, Primary Net Lending/Borrowing (Primary Balance), % of Nominal GDP 2002-2018	Yearly	IMF Fiscal Monitor

Variables	Data Description and Date Range	Frequency	Source(s)
MEX_GROSS	Mexico, Gross Government Debt, % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
MEX_NET	Mexico, Net Government Debt, % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
MEX_OVERALL	Mexico, Net Lending/Borrowing (Overall Balance), % of Nominal GDP 2000-2018	Yearly	IMF Fiscal Monitor
MEX_PRIMARY	Mexico, Primary Net Lending/Borrowing (Primary Balance), % of Nominal GDP 2002-2018	Yearly	IMF Fiscal Monitor

EMPIRICAL APPROACH, FINDINGS, AND INTERPRETATIONS

Model Specification And Estimation

Macroeconomic time-series studies are typically categorized as either stationary or non-stationary models. For stationary data, one can proceed with an econometric model using the classical, standard method of estimation. However, our variables are non-stationary, meaning that there is more than one trend in the series.[8] Due to the nature of our variables, it is imperative that we conduct econometric analysis under a non-stationary cointegration framework in order to study the long-run relationship of the determinants of long-term interest rates for Brazil, Colombia, and Mexico. For this reason, the Vector Error Correction (VEC) model, as developed by Johansen (1998, 1991, 1995), is applied to examine the dynamic relation among the long-term interest rates (r_{LT}), the short-term interest rates (r_{ST}), the inflation rate (π), GDP growth rate (g), and the government finance variables (V). If the series are cointegrated[9], then they are trending together in the long run. Using Vector Autoregressive (VAR) model in first differences would not be able to capture the long-run tendencies since Johansen's VEC framework restricts the long-run behavior of the endogenous variable from converging to their cointegrating relations, while allowing for short-run adjustment dynamics

[8] It will be shown later that the variables in the model are non-stationary.
[9] It will be shown later that the variables of interest are cointegrated.

(Akram and Li 2017b, 2018). Basically, a VAR framework can be extended to the VEC model, which is adapted to the first differences of the non-stationary variables with a lagged error correction terms among the series.

Any VAR model can be adapted and re-written as a VEC model (Engle and Granger 1987). Thus, we can express the VEC framework as:

$$\Delta y_t = v + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + \epsilon_t \tag{5.1}$$

In this equation, $\Pi = \sum_{j=1}^{j=p} \mathrm{A}_j - \mathrm{I}_k$ and $\Gamma_j = -\sum_{j=i+1}^{j=p} \mathrm{A}_j$. Based on our Keynesian framework, we would be dealing with two models, namely, $y_t = (r_{LT}, r_{ST}, \pi, g)$ (Model 1), or $y_t = (r_{LT}, r_{ST}, \pi, g, V)$ (Model 2). In this specification, $\Gamma_j \Delta y_{t-j}$ is the vector autoregressive component in the first difference and Πy_{t-p} is the error-correction component; v is a determininstic shift vector with an $(n \times 1)$ vector of constants; ϵ_t is the residual of the model with an $(n \times 1)$ vector of white noise error terms; Γ_j is an $(n \times n)$ matrix that stands for the short-run adjustment coefficients between the variables with $(p-1)$ number of lags and Π is an $(n \times n)$ matrix of parameters. $\Pi = \alpha\beta'$, where α and β are $(n \times n)$ matrices of rank r, where r is the number of linearly independent cointegrating vectors; α then explains the long-run disequilibrium by representing the speed of adjustment coefficient of the error correction mechanism, whereas β stands fro the matrix of cointegrating vectors that explains the long-run relations (StataCorp 2013). Within this model specification, the y_t process is non-stationary, while both the first-differenced process Δy_t and the linear combinations $\beta' y_{t-1}$ are stationary.

The model estimation process consists of four steps. First, we test for a unit root in each series and its first difference. Second, given that we cannot reject the null hypothesis that the series have a unit root, we test whether the variables in our model are cointegrated or not, and, if so, we detect the number of cointegrating vectors in the system. Third, we perform diagnostic tests on our multivariate VEC estimation models by conducting an analysis on the significance of the short-run error-correction terms (ECT), as well as comment on serial correlation, normality, and stability. Fourth, we interpret the results from a Keynesian perspective.

Stationarity Testing

The first step in estimating the VEC model is to conduct unit root tests. The Augmented Dickey-Fuller (ADF) test is one of the most common tests used in examining stationarity and the level of integration of the variables (Dickey and Fuller 1979, 1981). The tests are conducted in levels and first differences. Table 4 reports the ADF unit root results of the variables used in our empirical analysis. The null hypothesis is that the variable has a unit root. If the *p-value* is below the 5% significance level, we reject the null hypothesis of a unit root.

Based on the results reported, most of the variables indicate a presence of a unit root, even when using a trend, and trend and lags. From the short-term interest rates, COL_STIR, COL_STIR_P, and MEX_STIR_P are the only variables that show no signs of unit root when conducted with trend and lags. All of the long-term interest rate and inflation rate variables have a unit root. The same holds true for all of the four government finance variables for all three countries, except perhaps for BR_PRIMARY (with a trend, and with a trend and lag), which comes close to the 5% level of significance of rejecting the unit root presence. For economic activity, the *p-values* for BR_GDP and COL_GDP indicate a stronger evidence for the presence of a unit root compared to BR_IP and COL_IP. However, this does not hold true for Mexico since MEX_IP is the variable with *p-values* that are closer to the acceptable region of the unit root. Thus, for Mexico, we use industrial production as a proxy for GDP growth. Figure 3A from the appendix shows the strong correlation between the year-over-year growth of industrial production and the year-over-year growth of real GDP for Mexico. Since industrial production captures the change and fluctuation of the business conditions, we can use MEX_IP as a proxy indicator of economic activity.

One way to deal with a unit root (stochastic trend) is by taking the first difference of the variables (i.e., Δ). When we take the first difference of the variables, the null hypothesis of a unit root becomes rejected. The only exceptions to this are ΔCOL_STIR, ΔMEX_STIR, and ΔBR_GB3YR, but only with trend and lags. Hence, we can conclude that all of the variables in our model are integrated of the first order, I(1), series. This means that our variables are non-stationary in levels, but stationary in first differences.

Table 4. Results From Augmented Dickey-Fuller (ADF) Tests

Variables	Without a Trend	With a Trend	With Trend and Lags
Short-Term Interest Rates			
BR_STIR	0.8481	0.8733	0.2951
ΔBR_STIR	0.000	0.000	0.001
BR_STIR_P	0.6028	0.606	0.3409
ΔBR_STIR_P	0.000	0.000	0.028
COL_STIR	0.2248	0.6571	0.0011
ΔCOL_STIR	0.000	0.000	0.2229
COL_STIR_P	0.2475	0.8096	0.0189
ΔCOL_STIR_P	0.000	0.000	0.03
MEX_STIR	0.9611	0.997	0.9637
ΔMEX_STIR	0.000	0.000	0.1638
MEX_STIR_P	0.1751	0.4891	0.0159
ΔMEX_STIR_P	0.000	0.000	0.0008
Long-Term Interest Rates			
BR_GB3YR	0.7024	0.8977	0.4904
ΔBR_GB3YR	0.000	0.000	0.3615
BR_GB10YR	0.4666	0.6876	0.3127
ΔBR_GB10YR	0.000	0.000	0.0441
COL_GB5YR	0.3653	0.3467	0.2833
ΔCOL_GB5YR	0.000	0.000	0.000
COL_GB10YR	0.1743	0.2734	0.3238
ΔCOL_GB10YR	0.000	0.000	0.0049
MEX_GB5YR	0.8488	0.0839	0.8102
ΔMEX_GB5YR	0.000	0.000	0.0159
MEX_GB10YR	0.1324	0.4654	0.9892
ΔMEX_GB10YR	0.000	0.000	0.0001
Inflation			
BR_INF	0.6663	0.8241	0.7158
ΔBR_INF	0.000	0.000	0.0013
COL_INF	0.5376	0.8246	0.5914
ΔCOL_INF	0.000	0.000	0.0042
MEX_INF	0.0877	0.3204	0.9022
ΔMEX_INF	0.000	0.000	0.0049
Economic Activity			
BR_GDP	0.1387	0.2596	0.0125
ΔBR_GDP	0.000	0.000	0.000
BR_IP	0.0679	0.1643	0.0002
ΔBR_IP	0.000	0.000	0.0004
COL_GDP	0.2712	0.4179	0.3407
ΔCOL_GDP	0.000	0.000	0.0001
COL_IP	0.0736	0.238	0.1333
ΔCOL_IP	0.000	0.000	0.000
MEX_GDP	0.0657	0.2057	0.0003
ΔMEX_GDP	0.000	0.000	0.0004
MEX_IP	0.143	0.385	0.0073
ΔMEX_IP	0.000	0.000	0.0005
Government Finance			
BR_GROSS	0.9541	0.9866	0.9875
ΔBR_GROSS	0.000	0.000	0.000
BR_NET	0.8274	0.99	0.9904
ΔBR_NET	0.000	0.000	0.000
BR_OVERALL	0.7815	0.7535	0.7543

Variables	Without a Trend	With a Trend	With Trend and Lags
ΔBR_OVERALL	0.000	0.000	0.000
BR_PRIMARY	0.2051	0.0681	0.0562
ΔBR_PRIMARY	0.000	0.000	0.000
COL_GROSS	0.9177	0.7942	0.9188
ΔCOL_GROSS	0.000	0.000	0.000
COL_NET	0.7439	0.8461	0.8472
ΔCOL_NET	0.000	0.000	0.000
COL_OVERALL	0.2426	0.5249	0.5164
ΔCOL_OVERALL	0.000	0.000	0.000
COL_PRIMARY	0.2353	0.3423	0.3306
ΔCOL_PRIMARY	0.000	0.000	0.000
MEX_GROSS	0.9091	0.6982	0.7017
ΔMEX_GROSS	0.000	0.000	0.000
MEX_NET	0.9212	0.7642	0.7664
ΔMEX_NET	0.000	0.000	0.000
MEX_OVERALL	0.2663	0.518	0.5093
ΔMEX_OVERALL	0.000	0.000	0.000
MEX_PRIMARY	0.2166	0.5045	0.4948
ΔMEX_PRIMARY	0.000	0.000	0.000

Notes: ADF test (H_0: series has a unit root). We use 12 lags for the monthly data, 4 lags for the quarterly data, and 1 lag the yearly data series. The symbol Δ denotes first difference.

Cointegration Testing

For the cointegration analysis we implement a cointegration method developed by Johansen (1988) and Johansen and Juselius (1990) in order to examine the possible long-run relationship between the long-term interest rate, the short-term interest rate, the inflation rate, the rate of economic activity, and the government finance ratios. The first step of the Johansen (1988) and Johansen and Juselius (1990) cointegration method involves determining the optimal number of lag length and the common procedure for this is performing a VAR model with the variables in levels. To analyze the cointegration relationship between the variables, we run ten VAR models for each of the three countries. Results using VAR are generally sensitive to the lag length criteria. Too many lags could increase the error in the forecast, whereas too few errors might miss out on a relevant causal relation. Consequently, before determining the number of the cointegrating relationship, lag lengths were chosen using four common criterion procedures, namely, the Schwarz's Bayesian information criterion (SBIC), the Akaike's information criterion (AIC), the Hannan and Quinn information criterion (HQIC), and the sequence of likelihood-ratio test statistic criterion. Due to the nature of the data we conduct lag criteria testing with a maximum of 12 lags.[10]

[10] The results of the lag length criteria are not reported due to space constraints, but are available upon request.

The second step is generating a trace statistic (or a maximum likelihood) estimation based on the data with linear time trends. The Johansen cointegraton test compares the trace statistics to their critical values. Tables 5, 6, and 7 present the trace tests' statistics for determining whether the long-term interest rate is cointegrated with any of the variables, for Brazil, Colombia, and Mexico, respectively. Tables B1, B2, and B3 from the appendix reports the same set of results regarding the trace statistics, but the central banks' policy (reference) rate is used for the short-term interest rate variable.

The first row for each VAR model that we run has a row ($r = 0$), which tests the null hypothesis of no cointegration. If the log likelihood of the unconstrained model that includes the cointegrating relations is significantly different from the log likelihood of the constrained model that does not include the cointegrating relations, we can reject the null hypothesis of no cointegration.

The second row ($r = 1$) tests the null hypothesis of one cointegrating relation and so on. For instance, if we take the first VAR model we run for Brazil (BR_GB10YR, BR_STIR_P, BR_INF, BR_GDP), we can strongly reject the null hypothesis of no cointegration because the computed value of the trace test statistic (47.7285) is greater than the critical value (47.21). In the next step, however, we fail to reject the null hypothesis of at most one cointegrating relation since the trace statistic (19.0469) is less than the criticial value (29.68). Hence, we accept the null hypothesis that there is one cointegrating relation in the multivariate model. All of our VAR model in Tables 5, 6, and 7, as well as Tables B1, B2, and B3 from the appendix, demonstrate evidence of at least one cointegrating relation. This means that there is always at least one long-run permanent component driving the entire system of our models for Brazil, Colombia, and Mexico.

Table 5. Brazil Multivariate Cointegration Trace Tests Using the 3-Month Rate

Null Hypothesis	Test Statistic	5% Critical Value
(BR_GB10YR, BR_STIR_P, BR_INF, BR_GDP); Lag order=11		
$r = 0$	47.7285	47.21
$r = 1$	19.0469*	29.68
$r = 2$	7.6435	15.41
(BR_GB3YR, BR_STIR_P, BR_INF, BR_GDP); Lag order=1		
$r = 0$	48.8189	47.21
$r = 1$	18.9534*	29.68
$r = 2$	6.2169	15.41
(BR_GB10YR, BR_STIR_P, BR_INF, BR_GDP, BR_GROSS); Lag order=12		
$r = 0$	134.4933	68.52
$r = 1$	47.9506	47.21
$r = 2$	25.2822*	29.68
$r = 3$	9.7612	15.41
(BR_GB10YR, BR_STIR_P, BR_INF, BR_GDP, BR_NET); Lag order=12		
$r = 0$	117.0694	68.52
$r = 1$	49.8540	47.21
$r = 2$	25.25492*	29.68
$r = 3$	13.4280	15.41
(BR_GB10YR, BR_STIR_P, BR_INF, BR_GDP, BR_OVERALL); Lag order=12		
$r = 0$	94.7548	68.52
$r = 1$	40.1536*	47.21
$r = 2$	20.1754	29.68
(BR_GB10YR, BR_STIR_P, BR_INF, BR_GDP, BR_PRIMARY); Lag order=12		
$r = 0$	122.9702	68.52
$r = 1$	37.4213*	47.21
$r = 2$	16.3327	29.68
(BR_GB3YR, BR_STIR_P, BR_INF, BR_GDP, BR_GROSS); Lag order=12		
$r = 0$	248.4520	68.52
$r = 1$	114.7140	47.21
$r = 2$	54.4332	29.68
$r = 3$	19.4103	15.41
$r = 4$	0.7069*	3.76
(BR_GB3YR, BR_STIR_P, BR_INF, BR_GDP, BR_NET); Lag order=12		
$r = 0$	256.2889	68.52
$r = 1$	107.3021	47.21
$r = 2$	56.229	29.68
$r = 3$	16.5522	15.41
$r = 4$	0.0595*	3.76
(BR_GB3YR, BR_STIR_P, BR_INF, BR_GDP, BR_OVERALL); Lag order=12		
$r = 0$	181.5997	68.52
$r = 1$	111.9028	47.21
$r = 2$	59.0106	29.68
$r = 3$	22.2352	15.41
$r = 4$	0.0795*	3.76
(BR_GB3YR, BR_STIR_P, BR_INF, BR_GDP, BR_PRIMARY); Lag order=12		
$r = 0$	173.8239	68.52
$r = 1$	85.8244	47.21
$r = 2$	37.8426	29.68
$r = 3$	6.2222*	15.41
$r = 4$	0.1827	3.76

Notes: r denotes the number of cointegrated vectors. The symbol * indicates significance at the 5% level.

Table 6. Colombia Multivariate Cointegration Trace Tests Using the 3-Month Rate

Null Hypothesis	Test Statistic	5% Critical Value
(COL_GB10YR, COL_STIR_P, COL_INF, COL_GDP); Lag order=6		
$r = 0$	79.0098	47.21
$r = 1$	32.1022	29.68
$r = 2$	8.8366*	15.41
$r = 3$	2.2560	3.76
(COL_GB5YR, COL_STIR_P, COL_INF, COL_GDP); Lag order=5		
$r = 0$	54.3529	47.21
$r = 1$	22.5667*	29.68
$r = 2$	9.012	15.41
(COL_GB10YR, COL_STIR_P, COL_INF, COL_GDP, COL_GROSS); Lag order=1		
$r = 0$	71.9195	68.52
$r = 1$	42.3110*	47.21
$r = 2$	17.4481	29.68
(COL_GB10YR, COL_STIR_P, COL_INF, COL_GDP, COL_NET); Lag order=1		
$r = 0$	72.0935	68.52
$r = 1$	43.0379*	47.21
$r = 2$	17.5020	29.68
(COL_GB10YR, COL_STIR_P, COL_INF, COL_GDP, COL_OVERALL); Lag order=5		
$r = 0$	77.9479	68.52
$r = 1$	41.4805*	47.21
$r = 2$	18.8970	29.68
(COL_GB10YR, COL_STIR_P, COL_INF, COL_GDP, COL_PRIMARY); Lag order=1		
$r = 0$	157.8659	68.52
$r = 1$	46.1254*	47.21
$r = 2$	23.4448	29.68
(COL_GB5YR, COL_STIR_P, COL_INF, COL_GDP, COL_GROSS); Lag order=1		
$r = 0$	145.7566	68.52
$r = 1$	41.7911*	47.21
$r = 2$	16.3866	29.68
(COL_GB5YR, COL_STIR_P, COL_INF, COL_GDP, COL_NET); Lag order=1		
$r = 0$	144.6347	68.52
$r = 1$	43.4298*	47.21
$r = 2$	17.8063	29.68
(COL_GB5YR, COL_STIR_P, COL_INF, COL_GDP, COL_OVERALL); Lag order=5		
$r = 0$	71.3426	68.52
$r = 1$	36.5564*	47.21
$r = 2$	17.5455	29.68
(COL_GB5YR, COL_STIR_P, COL_INF, COL_GDP, COL_PRIMARY); Lag order=5		
$r = 0$	76.3654	68.52
$r = 1$	37.2603*	47.21
$r = 2$	19.0655	29.68

Notes: r denotes the number of cointegrated vectors. The symbol * indicates significance at the 5% level.

Table 7. Mexico Multivariate Cointegration Trace Tests Using the 3-Month Rate

Null Hypothesis	Test Statistic	5% Critical Value
(MEX _GB10YR, MEX _STIR_P, MEX _INF, MEX_IP); Lag order=2		
$r = 0$	53.4789	47.21
$r = 1$	30.4897	29.68
$r = 2$	14.8214*	15.41
$r = 3$	4.5878	3.76
(MEX _GB5YR, MEX _STIR_P, MEX _INF, MEX _IP); Lag order=1		
$r = 0$	76.1271	47.21
$r = 1$	19.4520*	29.68
$r = 2$	9.5094	15.41
(MEX _GB10YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _GROSS); Lag order=1		
$r = 0$	76.6509	68.52
$r = 1$	42.9618*	47.21
$r = 2$	17.9091	29.68
(MEX _GB10YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _NET); Lag order=1		
$r = 0$	75.3057	68.52
$r = 1$	41.7223*	47.21
$r = 2$	18.4237	29.68
(MEX _GB10YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _OVERALL); Lag order=4		
$r = 0$	86.9310	68.52
$r = 1$	46.9712*	47.21
$r = 2$	26.4831	29.68
(MEX _GB10YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _PRIMARY); Lag order=4		
$r = 0$	84.5639	68.52
$r = 1$	47.1436*	47.21
$r = 2$	27.0968	29.68
(MEX _GB5YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _GROSS); Lag order=1		
$r = 0$	100.6117	68.52
$r = 1$	38.8986*	47.21
$r = 2$	15.3574	29.68
(MEX _GB5YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX_NET); Lag order=1		
$r = 0$	99.8084	68.52
$r = 1$	38.9193*	47.21
$r = 2$	14.3840	29.68
(MEX _GB5YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _OVERALL); Lag order=1		
$r = 0$	102.1040	68.52
$r = 1$	44.2139*	47.21
$r = 2$	18.918	29.68
(MEX _GB5YR, MEX _STIR_P, MEX _INF, MEX _IP, MEX _PRIMARY); Lag order=1		
$r = 0$	102.3381	68.52
$r = 1$	43.8951*	47.21
$r = 2$	18.2857	29.68

Notes: r denotes the number of cointegrated vectors. The symbol * indicates significance at the 5% level.

Diagnostics Testing

Tables 8 and 9 (Brazil), 10 and 11 (Colombia), and 12 and 13 (Mexico) present the VEC model estimations using the 3-month rate. Similarly, Tables B4 and B5 (Brazil), B6 and B7 (Colombia), and B8 and B9 (Mexico), from the appendix, demonstrate the VEC model estimations using the central banks' policy rates. We basically specified two models earlier, however, the second model includes four different measures for the government finance variable. Therefore, we estimate the following models:

- $y_t =$ (Long-term interest rate, short-term interest rate, rate of inflation, rate of economic activity) (Model 1)
- $y_t =$ (Long-term interest rate, short-term interest rate, rate of inflation, rate of economic activity, gross debt ratio) (Model 2a)
- $y_t =$ (Long-term interest rate, short-term interest rate, rate of inflation, rate of economic activity, net debt ratio) (Model 2b)
- $y_t =$ (Long-term interest rate, short-term interest rate, rate of inflation, rate of economic activity, overall balance ratio) (Model 2c)
- $y_t =$ (Long-term interest rate, short-term interest rate, rate of inflation, rate of economic activity, primary balance ratio) (Model 2d)

Before jumping into interpretation of the empirical findings we need first to comment on the diagnostic tests presented in the bottom panel of the tables. First, we conduct a Lagrange-multiplier test for serial correlation in the residuals. The null hypothesis is that there is no serial correlation at a particular lag order. Most of our VEC model estimations do not indicate the presence of a serial correlation in the residuals. However, there are some that do exhibit serial correlation and we refit our models by increasing the number of lags since underspecifying the number of lags in a VEC model can significantly increase the finite-sample bias in the parameter estimates (Gonzalo 1994).[11]

Second, the instrumental assumption behind deriving a likelihood function is that errors of the series are independently, identically, and normally distributed with zero mean and finite variance. When the errors are of this nature, then the parameter estimates are consistent and efficient. However, often times the errors are only independently and identically distributed, which makes the parameter estimates still consistent, but not efficient. For this reason we conduct a normality test by estimating skewness statistics. The null hypothesis is that the residual errors are normally distributed. For most of our VEC models we can reject the null

[11] In order to see in what models we have increased the number of lags, please refer to the first two rows from the diagnostics section of Tables 8, 9, 10, 11, 12, 13, B4, B5, B6, B7, B8, and B9. The values in the parentheses represent the new, increased number of observations and lags used in the models.

hypothesis, which means that the errors seem to be skewed. Model (1) from Table 8, model (2b) from Table 9, models (1) and (2c) from Table 10, model (1) from Table B4, model (2d) from Table B8, and model (1) from Table B9, are the only models that exhibit normality of the errors. However, we have to note that we deal with estimations that have monthly, quarterly, and yearly data in them. Hence, our model's goodness of fit will never be ideal since we are regressing yearly and quarterly data on a monthly data basis.[12]

Next, we evaluate the stability of the estimated VEC models, which essentially means checking whether we have correctly specified the number of cointegrating equations. In a K-variable model with r cointgrating equations (i.e., relations) the matrix of the VEC model has $(K - r)$ unit eigenvalues. For the model to be stable, the moduli of the remaining r eigenvalues should be less than one, and this holds true for all of our VEC estimated models (StataCorp 2013).

Lastly, one critical component of the VEC models is the error correction term (ECT) presented in the middle panel of the tables. The term itself represents the dependent variable's speed of adjustment towards long-run equilibrium after a change in the independent variables in the model. The lagged ECT should be negative and significant. This provides evidence of an existing long-run relationship between the independent and the dependent variables because the significantly negative feedback is necessary for the independent variable to revert back to the existing, stable long-run equilibrium. ECTs for all equations are shown in the middle panel of the tables, but our only interest is in the first row; that a stable cointegration relation enters significantly in the long-term interest rate equation. All VEC model equations that have a negative and significant ECT for the lagged long-term interest rate are highlighted in light green in the tables for the Johanesen VEC model estimations.

Interpretation Of Results

We normalize all of the VEC models with respect to the coefficient of the long-term interest rate. The process of normalization reverses the signs in the tables for the VEC model estimations. Since we are interested in analyzing the drivers of the long-term interest rates, we select the models that contain the longer maturity government bonds (i.e., the 10-year bonds).

[12] By conducting the skewness statistic to test the null hypothesis that the residual errors are normally distributed, it is exactly the government finance variables that generate the highest chi-squared statistic in the VEC equation, which basically make the results to indicate non-normality. Detailed results from the skewness statistics tests are available upon request.

We take model (2b) from Table 8, model (2c) from Table 10, and model (2a) from Table B8, for Brazil, Colombia, and Mexico, respectively, as base-line examples and state the cointegrating vector relationships:

$$BR\_GB10YR = -11.85 + 0.712\,\boldsymbol{BR\_STIR\_P} - 0.557\,\boldsymbol{BR\_INF} - 0.009\,BR\_GDP - 0.117\,\boldsymbol{BR\_NET} \tag{5.1}$$

$$COL\_GB10YR = 1.279 + 0.946\,\boldsymbol{COL\_STIR\_P} + 0.262\,COL\_INF + 0.577\,\boldsymbol{COL\_GDP} - 0.36\,COL\_OVERALL \tag{5.2}$$

$$MEX\_GB10YR = = 7.746 + 1.689\,\boldsymbol{MEX\_STIR} - 1.113\,\boldsymbol{MEX\_INF} + 0.287\,\boldsymbol{MEX\_IP} + 0.218\,\boldsymbol{MEX\_NET} \tag{5.3}$$

These models have the highest-magnitude, negative, and significant error correction terms for the lagged long-term interest rate. The variables in bold in the three equations represent the significant variables in the cointegrating relation. For Mexico we use the central bank's policy rate because none of the VEC model estimations, with the 3-month Treasury bill rate, have negative and significant error-correction terms. The cointgrating equation (5.2) for Colombia is also the only one of the three that exhibits normality in the residual errors.

The results of the equations indicate that there is a significant long-run relationship between the short-term interest rate and the long-term interest rate. A 1 percentage point increase in the 3-month Treasury bill rate causes a 71.2 basis point rise in the Brazilian long-term interest rates. For Colombia and Mexico, the size of the coefficients for the short-term interest rates is even higher – namely, a 1 percentage point increase in the 3-month Treasury bill rate (or central bank's policy rate for Mexico) leads to 94.6 and 168.9 basis points rise in the Colombian and Mexican long-term interest rates, respectively. These results align with the Keynesian view that short-term interest rates are the key drivers of long-term interest rates. Besides in these models, short-term interest rates are the main drivers of long-term interest rates for models (1), (2b), (2c), (2d) from Table 8; for models (2b) and (2d) from Table 9; for model (1) from Table B4; for models (1) and (2c) from Table B5; for models (1), (2c), and (2d) from Table 10; for models (1), (2c), and (2d) from Table 11; for models (1), (2b), (2c), and (2d) from

Table B6; and for models (1), (2a), and (2b) from Table B9. The magnitude of the coefficients of the short-term interests from the appendix tables parallels with the magnitude when using the 3-month rate, thus, reinforcing our findings. Furthermore, in some cases (e.g., Colombia 10-year bond) the central bank's policy rate seem to be, by far, in terms of size of the coefficient, the most important long-run determinant of the yields.

Over the long run, the inflation rate is significantly and negatively related to the Brazilian and Mexican government bond yields (see equations 5.1 and 5.3). In equation (5.2), the coefficient for the rate of inflation for Colombia is positive, but insignificant. However, for Brazil, Tables 8 and 9 indicate an unclear effect of the inflation rate on the long-term interest rates. In some cases it is positive, in some it is negative, and in some instances it is insignificant. For Colombia, we encounter similarities - the inflation has a positive, but weak, relation to the 10-year bond yield (see Table 10), and positive and significant association with the 5-year bond yield for model (1) from Table 11 and for models (2c) and (2d) from Table B7. Table B9 also demonstrates evidence of some positive impact of the inflation rate on the 5-year Mexican government bond yield. These results align with the view that inflation and inflation expectations exert an upward pressure on the government bond yields as investors seek to be compensated for holding bonds with longer maturities.

Nevertheless, Tables B4 and B5 for Brazil, Table B6 for Colombia, and Table B8 for Mexico, show that a rise in inflation leads to a fall in the long-term interest rates. This is contrary to the conventional view that higher inflation and higher inflationary expectations exert an upward pressure on the government bond yields. In some of these models, the inflation rate is the most influential driver of the long-term interest rates. One possible explanation for this could be that Banco Central do Brasil, Banco de la Republica, and Banco de Mexico, increase (lower) their benchmark policy rates in the face of upward (downward) inflationary pressures or in anticipation of higher (lower) inflationary expectations. This means that the short-term interest rates tend be collinear with inflation, so the coefficient of the inflation rate does not necessarily mean that it would have the expected sign (Akram and Das 2017b). Another plausible explanation would be that when inflation increases, a commodity price boom follows, which improves the current account balance, furthermore improving the country's credit rating. Since investment grade bonds tend to have lower yields, it follows that higher inflation rates can lead to lower government bond yields.

The results from equations (5.2) and (5.3) indicate a positive relationship between the rates of economic activity and the long-term interest rates for Colombia and Mexico, respectively, whereas the results from equation (5.1) show negative but insignificant relationships between the rates of economic activity and the long-term interest rates for Brazil. The models in Tables 8 (except for models (1) and (2b)) and 9 indicate positive and significant impact on the Brazilian government bond yields. The pace of economic activity also tends to increase the long-term interest rates on the Colombian (see Tables 10, 11, and B7) and Mexican (see Table B8) government bonds. There are three channels through which the pace of economic activity positively impacts the government bond yields. The first channel could be through the short-term interest rates because the central banks would try to slow down the economy by increasing their policy rates. Second, it could be that inflation increases following a higher economic activity so the transitory mechanism works through the inflation rate. Or, third, it could simply be that investors are prone to higher risk taking as the economic activity improves (Akram and Li 2017a). However, in Tables B4 and B5, the rate of economic activity seems to exert downward pressure on the Brazilian government bond yields. One reason behind this could be that favorable economic conditions improve the credit rating of the Brazilian public debt, thus leading to lower yields.

The most interesting result from equation (5.1) is that an increase in government finance impacts negatively the long-term interest rates. That is, an increase in the government net debt-to-GDP ratio by 1 percentage point leads to a 11.7 basis points decline in the government bond yields. We observe similar results for model (2b) from Table 9 and for models (2a) and (2b) from Table B4, that is, that higher government indebtedness reduces the long-term interest rate on the Brazilian government bonds. Furthermore, models (2c) and (2d) from Tables B4 and B5, show that an improvement in the overall and primary fiscal balance ratios actually leads to an increase in the government bond yields. This also goes against the conventional view that an increase in the fiscal balance ratios crowds out available funds for the private sector's borrowing/lending in the loanable funds market.

An explanation to these findings is that the act of government spending actually increases the amount of banks deposits/reserves in the system by the same amount. The Treasury department of Brazil coordinates operations with the central bank, so that, when the Treasury spends, it pays from its account at the central bank. Treasury spending is a simultaneous credit to the bank deposits and the banking system's reserves at the central bank.

As the banking system's deposits and/or reserves rise, banks offer to lend reserves in the overnight market and eventually lend at even lower interest rates. This exerts downward pressure on the policy rate, and with that, on the short-term interest rates. Banks are now willing to own long-duration securities with higher yields over short-term securities with lower yields. However, as banks have more incentive to hold long-term securities, this causes downward pressure on the long-term interest rates (Akram and Das 2017a, 28; Akram and Li 2017b, 32-3; 2018, 388; Wray 2003, 74-96; 2012, 98-109).

For Colombia and Mexico, on the other hand, the result with regards to the overall and the fiscal balance does not hold. In fact, in their case, a rise in the overall balance (i.e., improvement) lowers government bond yields. For Colombia, we can observe this in model (2d) from Table 10, and models (2c) and (2d) from Table 11. Similarly, models (2a) and (2b) from Table B8, as well as model (2b) from Table B9, show that in the long run higher gross and net debt ratios tend to increase the nominal yields of Mexican government bonds.

One plausible explanation for these findings is that Colombia and Mexico have a relatively high share of non-residents (see Figures 14 and 15), so either a negative economic outlook and/or fears of debt defaulting can trigger a selling activity. This ultimately decreases the price of the bonds and leads to an increase in the long-term interest rates. Another reason could be that the governments of Colombia and Mexico are reliant on oil (and other commodities) revenues. Thus, when there is an improvement in the commodity prices government balances improve and investors buy more bonds. This pushes the price of bonds up and with that the long-term interest rates decline.

Nevertheless, in model (2a) from Table 8 and model (2a) from Table 9, for Brazil; in model (2c) from Table 10, models (2b), (2c), and (2d) from Table B6, and models (2c) and (2d) from Table B7, for Colombia; all seem to demonstrate insignificant coefficients for the government finance variables. This is also a result since it gives an indication that the economic effect of the government finance variables is relatively weak in comparison to that of short-term interest rates, rate of inflation, and rate of economic activity.

Table 8. Brazil 10-Year Bond Yield Johansen VEC Model Using the 3-Month Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
BR_GB10YR					
BR_STIR_P	-0.394***	-0.154	-0.712***	-0.511***	-0.590***
	(0.138)	(0.147)	(0.119)	(0.0758)	(0.0502)
BR_INF	0.453*	-0.363	0.557**	-0.192	-0.396***
	(0.268)	(0.333)	(0.272)	(0.169)	(0.115)
BR_GDP	-0.00187	-0.720***	0.00983	-0.269**	-0.593***
	(0.105)	(0.220)	(0.127)	(0.127)	(0.106)
BR_GROSS		0.0564			
		(0.0347)			
BR_NET			0.117***		
			(0.0370)		
BR_OVERALL				0.0762	
				(0.0900)	
BR_PRIMARY					0.427***
					(0.0976)
Constant	-10.47	-9.496	-11.85	-4.251	-2.013
Error correction terms (ECT)					
ΔBR_GB10YR(-1)	-0.112**	-0.161***	-0.336***	-0.344***	-0.436***
	(0.0475)	(0.0524)	(0.0945)	(0.0886)	(0.128)
ΔBR_STIR_P(-1)	-0.117	-0.125	-0.199	-0.0397	-0.302
	(0.0854)	(0.0949)	(0.178)	(0.183)	(0.247)
ΔBR_INF(-1)	-0.0760**	-0.0871***	-0.0368	-0.0480	-0.00819
	(0.0306)	(0.0331)	(0.0661)	(0.0577)	(0.0867)
ΔBR_GDP(-1)	0.337***	0.262***	0.119	0.478***	0.659***
	(0.0986)	(0.0903)	(0.180)	(0.177)	(0.234)
ΔBR_GROSS(-1)		0.0904			
		(0.127)			
ΔBR_NET(-1)			0.0320		
			(0.257)		
ΔBR_OVERALL(-1)				0.0370	
				(0.131)	
ΔBR_PRIMARY(-1)					-0.0887
					(0.102)
Diagnostics					
Observations	131	130 (129)	130 (129)	130 (129)	130 (129)
Lags	11	12 (13)	12 (13)	12 (13)	12 (13)
Log Likelihood	-333.509	-386.977	-380.455	-291.742	-222.596
Serial Correlation Test	20.642	16.288	22.938	27.959	26.811
P-value	0.193	0.906	0.906	0.31	0.365
Skewness Test	7.622	157.656	157.656	193.384	120.797
P-value	0.107	0.000	0.000	0.000	0.000
Highest Modulus	0.972	0.958	0.983	0.962	0.961

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9. Brazil 3-Year Bond Yield Johansen VEC Model Using the 3-Month Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
BR_GB3YR					
BR_STIR_P	-0.705***	-0.403***	-0.576***	-0.825***	-1.261***
	(0.0985)	(0.153)	(0.0313)	(0.196)	(0.201)
BR_INF	-0.0769	-1.030***	-0.195***	1.061***	0.0448
	(0.132)	(0.379)	(0.0740)	(0.398)	(0.429)
BR_GDP	0.0276	-0.860***	-0.238***	1.192***	-0.628**
	(0.0598)	(0.171)	(0.0336)	(0.255)	(0.258)
BR_GROSS		0.00592			
		(0.0401)			
BR_NET			0.0206**		
			(0.00874)		
BR_OVERALL				-0.715***	
				(0.207)	
BR_PRIMARY					0.178
					(0.298)
Constant	-3.295	1.397	-3.998	-14.71	2.996
Error correction terms (ECT)					
ΔBR_GB3YR(-1)	-0.0145	-0.188***	-0.531*	0.135	-0.220*
	(0.0684)	(0.0642)	(0.307)	(0.127)	(0.115)
ΔBR_STIR_P(-1)	0.387***	0.0272	0.254	0.132	-0.138
	(0.0905)	(0.0958)	(0.434)	(0.184)	(0.188)
ΔBR_INF(-1)	0.129***	-0.0466	-0.0231	-0.000645	-0.0941
	(0.0407)	(0.0350)	(0.165)	(0.0613)	(0.0620)
ΔBR_GDP(-1)	-0.171**	0.161**	0.691**	-0.519***	0.455***
	(0.0778)	(0.0731)	(0.311)	(0.101)	(0.124)
ΔBR_GROSS(-1)		0.768***			
		(0.190)			
ΔBR_NET(-1)			4.551***		
			(0.460)		
ΔBR_OVERALL(-1)				0.216	
				(0.176)	
ΔBR_PRIMARY(-1)					-0.147*
					(0.0846)
Diagnostics					
Observations	102	91	91	91	91
Lags	1	12	12	12	12
Log Likelihood	-337.167	-164.175	-151.579	-74.491	-35.438
Serial Correlation Test	15.802	27.767	32.443	29.007	27.649
P-value	0.467	0.319	0.146	0.264	0.324
Skewness Test	36.959	22.93	10.317	82.543	52.472
P-value	0.00	0.003	0.068	0.000	0.000
Highest Modulus	0.698	0.990	0.998	0.999	0.993

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10. Colombia 10-Year Bond Yield Johansen VEC Model Using the 3-Month Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
COL_GB10YR					
COL_STIR_P	-0.708***	-1.281**	-1.500*	-0.946***	-1.052***
	(0.177)	(0.602)	(0.815)	(0.221)	(0.290)
COL_INF	-0.534***	1.631***	2.193***	-0.262	-0.291
	(0.197)	(0.580)	(0.760)	(0.230)	(0.269)
COL_GDP	-0.541***	2.559***	3.253***	-0.577***	-0.622***
	(0.119)	(0.266)	(0.346)	(0.116)	(0.143)
COL_GROSS		0.385***			
		(0.112)			
COL_NET			0.466***		
			(0.155)		
COL_OVERALL				0.360	
				(0.219)	
COL_PRIMARY					0.673**
					(0.301)
Constant	0.238	-34.42	-37.45	1.279	1.195
Error correction terms (ECT)					
ΔCOL_GB10YR(-1)	-0.134***	0.00970	0.00804	-0.155***	-0.127***
	(0.0302)	(0.00705)	(0.00559)	(0.0322)	(0.0323)
ΔCOL_STIR_P(-1)	-0.0113	0.0281***	0.0221***	-0.00982	0.00146
	(0.0127)	(0.00266)	(0.00212)	(0.0132)	(0.0115)
ΔCOL_INF(-1)	0.0677***	0.0235***	0.0184***	0.0575**	0.0307
	(0.0211)	(0.00454)	(0.00361)	(0.0231)	(0.0208)
ΔCOL_GDP(-1)	0.171***	-0.0248**	-0.0202**	0.184***	0.173***
	(0.0557)	(0.0105)	(0.00836)	(0.0611)	(0.0531)
ΔCOL_GROSS(-1)		-0.0217*			
		(0.0131)			
ΔCOL_NET(-1)			-0.0209*		
			(0.0121)		
ΔCOL_OVERALL(-1)				-0.0565*	
				(0.0302)	
ΔCOL_PRIMARY(-1)					-0.0445*
					(0.0249)
Diagnostics					
Observations	147	152	152	148 (147)	152 (149)
Lags	6	1	13	5 (6)	1 (4)
Log Likelihood	-110.895	-445.435	-468.912	-127.64	-179.095
Serial Correlation Test	16.69	21.587	22.283	20.434	35.432
P-value	0.406	0.66	0.62	0.724	0.081
Skewness Test	3.757	582.122	625.351	10.13	26.285
P-value	0.439	0.000	0.000	0.072	0.000
Highest Modulus	0.909	0.94	0.94	0.863	0.865

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 11. Colombia 5-Year Bond Yield Johansen VEC Model Using the 3-Month Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
COL_GB5YR					
COL_STIR_P	-0.950***	-1.016***	-1.027***	-1.332***	-1.465***
	(0.206)	(0.300)	(0.366)	(0.240)	(0.181)
COL_INF	-0.448*	0.615**	0.737**	0.0280	0.109
	(0.232)	(0.289)	(0.341)	(0.247)	(0.170)
COL_GDP	-0.588***	1.207***	1.402***	-0.635***	-0.544***
	(0.141)	(0.132)	(0.155)	(0.125)	(0.0922)
COL_GROSS		0.255***			
		(0.0556)			
COL_NET			0.285***		
			(0.0694)		
COL_OVERALL				0.564**	
				(0.237)	
COL_PRIMARY					0.794***
					(0.187)
Constant	2.233	-19.77	-19.58	3.673	2.338
Error correction terms (ECT)					
ΔCOL_GB5YR(-1)	-0.106***	0.0261**	0.0236**	-0.136***	-0.169***
	(0.0272)	(0.0113)	(0.00996)	(0.0302)	(0.0370)
ΔCOL_STIR_P(-1)	-0.00114	0.0533***	0.0468***	0.0000950	0.00776
	(0.0125)	(0.00489)	(0.00436)	(0.0138)	(0.0168)
ΔCOL_INF(-1)	0.0525**	0.0496***	0.0436***	0.0307	0.0382
	(0.0211)	(0.00824)	(0.00731)	(0.0246)	(0.0306)
ΔCOL_GDP(-1)	0.169***	-0.0366*	-0.0339*	0.187***	0.249***
	(0.0562)	(0.0198)	(0.0175)	(0.0652)	(0.0808)
ΔCOL_GROSS(-1)		-0.0462*			
		(0.0243)			
ΔCOL_NET(-1)			-0.0490*		
			(0.0251)		
ΔCOL_OVERALL(-1)				-0.0619*	
				(0.0319)	
ΔCOL_PRIMARY(-1)					-0.0807**
					(0.0378)
Diagnostics					
Observations	148	152	152	148	148
Lags	5	1	1	5	5
Log Likelihood	-111.839	-420.954	-444.936	-131.746	-122.218
Serial Correlation Test	24.358	22.595	21.631	32.332	35.473
P-value	0.082	0.601	0.657	0.149	0.08
Skewness Test	12.491	532.923	556.892	15.957	30.518
P-value	0.014	0.000	0.000	0.007	0.000
Highest Modulus	0.916	0.946	0.946	0.877	0.882

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 12. Mexico 10-Year Bond Yield Johansen VEC Model Using the 3-Month Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
MEX_GB10YR					
MEX_STIR_P	-0.673***	-1.074***	-1.319***	-3.270***	-2.803***
	(0.0956)	(0.279)	(0.334)	(0.483)	(0.469)
MEX_INF	-0.246	-1.068*	-1.012	0.0307	-1.239
	(0.228)	(0.578)	(0.638)	(0.693)	(0.777)
MEX_IP	-0.0887	-0.868***	-0.926***	0.00226	0.342
	(0.0691)	(0.192)	(0.211)	(0.201)	(0.229)
MEX_GROSS		-0.212**			
		(0.0979)			
MEX_NET			-0.235**		
			(0.110)		
MEX_OVERALL				4.774***	
				(0.781)	
MEX_PRIMARY					4.557***
					(0.773)
Constant	-2.188	14.26	15.00	25.19	12.46
Error correction terms (ECT)					
ΔMEX_GB10YR(-1)	-0.0451	0.0166	0.0184	0.0156	0.0102
	(0.0361)	(0.0150)	(0.0137)	(0.00996)	(0.00915)
ΔMEX_STIR_P(-1)	0.0500	-0.00278	0.00163	0.0428***	0.0336***
	(0.0347)	(0.0128)	(0.0117)	(0.00783)	(0.00732)
ΔMEX_INF(-1)	-0.0103	-0.00982	-0.00792	0.0245***	0.0280***
	(0.0277)	(0.0117)	(0.0107)	(0.00762)	(0.00683)
ΔMEX_IP(-1)	0.299***	0.137***	0.116***	-0.0120	-0.0132
	(0.0751)	(0.0296)	(0.0272)	(0.0206)	(0.0187)
ΔMEX_GROSS(-1)		0.00477			
		(0.0312)			
ΔMEX_NET(-1)			0.0134		
			(0.0247)		
ΔMEX_OVERALL(-1)				-0.00496	
				(0.00786)	
ΔMEX_PRIMARY(-1)					0.000734
					(0.00840)
Diagnostics					
Observations	196	197 (194)	197 (194)	194	194
Lags	2	1 (4)	1 (4)	4	4
Log Likelihood	-454.118	-585.357	-559.209	-383.534	-416.932
Serial Correlation Test	22.676	22.639	20.27	20.406	20.827
P-value	0.123	0.54	0.732	0.725	0.707
Skewness Test	25.395	410.04	260.611	204.191	27.827
P-value	0.000	0.000	0.000	0.000	0.000
Highest Modulus	0.903	0.872	0.867	0.808	0.856

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 13. Mexico 5-Year Bond Yield Johansen VEC Model Using the 3-Month Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
MEX_GB5YR					
MEX_STIR_P	0.0215	0.516***	0.474***	-0.0299	-0.121
	(0.105)	(0.175)	(0.163)	(0.205)	(0.209)
MEX_INF	-0.347***	-0.679***	-0.634***	-0.353***	-0.407***
	(0.111)	(0.187)	(0.175)	(0.117)	(0.126)
MEX_IP	0.0101	0.195*	0.161	0.00949	0.0461
	(0.0508)	(0.106)	(0.0992)	(0.0594)	(0.0679)
MEX_GROSS		0.105***			
		(0.0329)			
MEX_NET			0.104***		
			(0.0371)		
MEX_OVERALL				0.0631	
				(0.215)	
MEX_PRIMARY					0.230
					(0.170)
Constant	-4.049	-11.02	-10.08	-3.565	-3.093
Error correction terms (ECT)					
ΔMEX_GB5YR(-1)	-0.0702	-0.0123	-0.0164	-0.0653	-0.0483
	(0.0475)	(0.0273)	(0.0295)	(0.0468)	(0.0415)
ΔMEX_STIR_P(-1)	0.114***	0.0688***	0.0737***	0.113***	0.103***
	(0.0180)	(0.00987)	(0.0108)	(0.0176)	(0.0154)
ΔMEX_INF(-1)	0.146***	0.0954***	0.102***	0.142***	0.128***
	(0.0488)	(0.0272)	(0.0294)	(0.0480)	(0.0424)
ΔMEX_IP(-1)	0.0165	-0.00447	-0.00373	0.0180	0.0102
	(0.0789)	(0.0448)	(0.0485)	(0.0775)	(0.0686)
ΔMEX_GROSS(-1)		-0.108			
		(0.0730)			
ΔMEX_NET(-1)			-0.127*		
			(0.0676)		
ΔMEX_OVERALL(-1)				0.0924**	
				(0.0384)	
ΔMEX_PRIMARY(-1)					0.102**
					(0.0447)
Diagnostics					
Observations	81	81	81	81	81
Lags	1	1	1	1	1
Log Likelihood	-24.95	-115.895	-101.682	-23.903	-43.652
Serial Correlation Test	19.935	30.415	28.782	20.502	19.395
P-value	0.223	0.209	0.273	0.72	0.778
Skewness Test	18.787	107.932	83.802	50.936	68.382
P-value	0.000	0.000	0.000	0.000	0.000
Highest Modulus	0.882	0.946	0.94	0.887	0.911

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Future Research Work

In future research it would be worthwhile to encompass variables such as oil shocks and non-resident debt-holders ratio dummies. All three countries' economies depend on oil revenues, so an indicator of oil price movements would certainly be a relevant variable. Non-resident holders own a high share of Colombia and Mexico's public domestic debt, thus, controlling for that could prove to be important for the future model estimations. Other variables such as exchange rates, credit flows, and financial volatility (e.g., VIX index) should also be considered. Future work may also include higher frequency data for the government finance variables. Impulse response functions could also be provided to detect the pace of the return of the underlying variables to long-run equilibrium. Finally, detecting the long-run dynamics by applying the Keynesian methodology ought to be applied to other set of countries with similar institutional framework and government bond markets.

CONCLUSION AND POLICY REMARKS

During the past two decades, the central banks of Brazil, Colombia, and Mexico have focused solely on achieving price stability by targeting inflation and inflation expectations. But in the same time period, the results from this dissertation show that Banco Central do Brasil, Banco de la Republica, and Banco de Mexico can exert strong influence on their respective government bond yields. Since the short-term interest rates are the main drivers of the long-term interest rates, and since the short-term interest rates follow central banks' policy rates, it can be argued that the monetary authorities in Brazil, Colombia, and Mexico can manage the yield curve. This dissertation reinvigorates the Keynesian view that a central bank's actions, mainly through the influence of the policy rate on the short-term interest rates, affect government bond yields (Keynes 1930, [1936] 2007).

Interest rates come into play for credit growth, whether it is households' demand for loans and mortgages or firms' investment credit demand. Thus, reducing the spread between the short rate and the long rate helps stabilize the interest rate term structure. A stable yield curve would also help to preserve the liquidity of the investors' financial positions (Hannsgen 2005; Kregel 1998, 2003). In terms of government finance, results obtained from a number of the models for Colombia and Mexico indicate that deficit-and debt-to-GDP ratios have relatively weak influence on the government bond yields. Moreover, for Brazil, an increase in the deficit and debt ratios leads to a decline in the long-term government bond yields. These results closely accord with the findings of Akram and Das (2014, 2015, 2017a, 2017b, 2018) and Akram and Li (2017a, 2017b, 2018), and are in agreement with recent developments in monetary macroeconomic theory and policy for countries with monetary sovereignty (see Bindseil 2004; Fullwiler 2008; Lavoie 2014; Sims 2013; Wray 2003, 2012; Woodfoord 2001). The results obtained in this dissertation are in contrast to the government "crowding out" arguments present in the mainstream literature (see Ardagna, Caselli, and Lane 2007; Baldacci and Kumar 2010; Cebula 2014; Grandes 2007; Gruber and Kamin 2012; Lam and Tokuoka 2011; Martinez, Tercenoa, and Teruelb 2013; Min et al. 2003; Paccagnini 2016; Perovic 2015; Poghosyan 2012).

The results in this dissertation provide some evidence that, even in the Latin American emerging market economies, governments can lower the bond issuance costs regardless of the fiscal stance. This has positive fiscal policy implications because through proficient collaboration between the central banks and the Treasury departments, the countries of Brazil, Colombia, and Mexico can lengthen and smoothen the average maturity of their outstanding debt. A stable yield curve also enhances the robustness of the capital debt markets in the economies since it serves as a benchmark for pricing other financial instruments. Hence, understanding the main determinants of long-term government bond yields is relevant for fixed income investors and their portfolio allocation strategies in the local currency debt securities markets. Finally, this dissertation contributes to current discussions regarding the effectiveness of monetary policy, the implications of fiscal stance on long-term government bond yields, and the ongoing debates of government debt management and sustainability.

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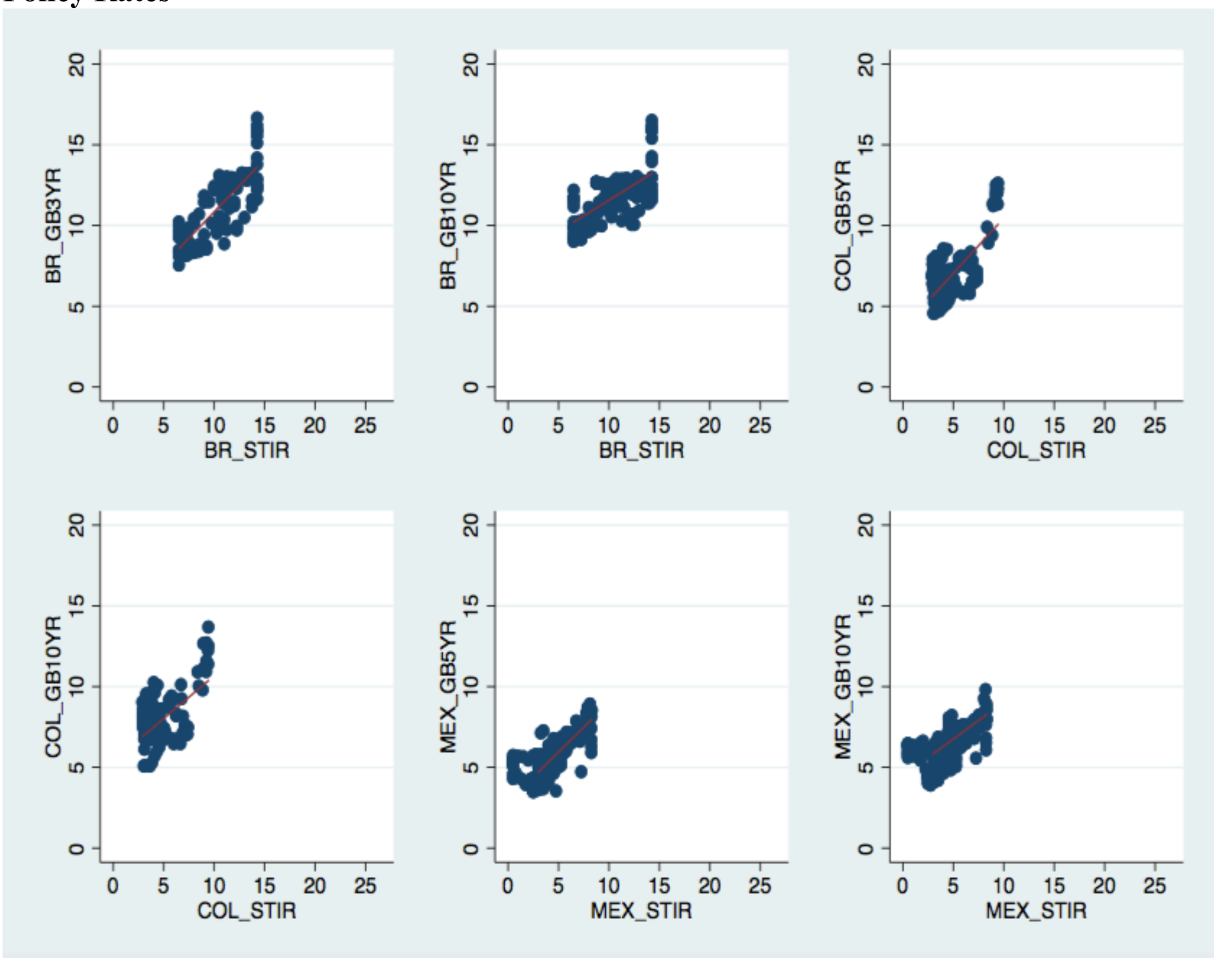
APPENDIX

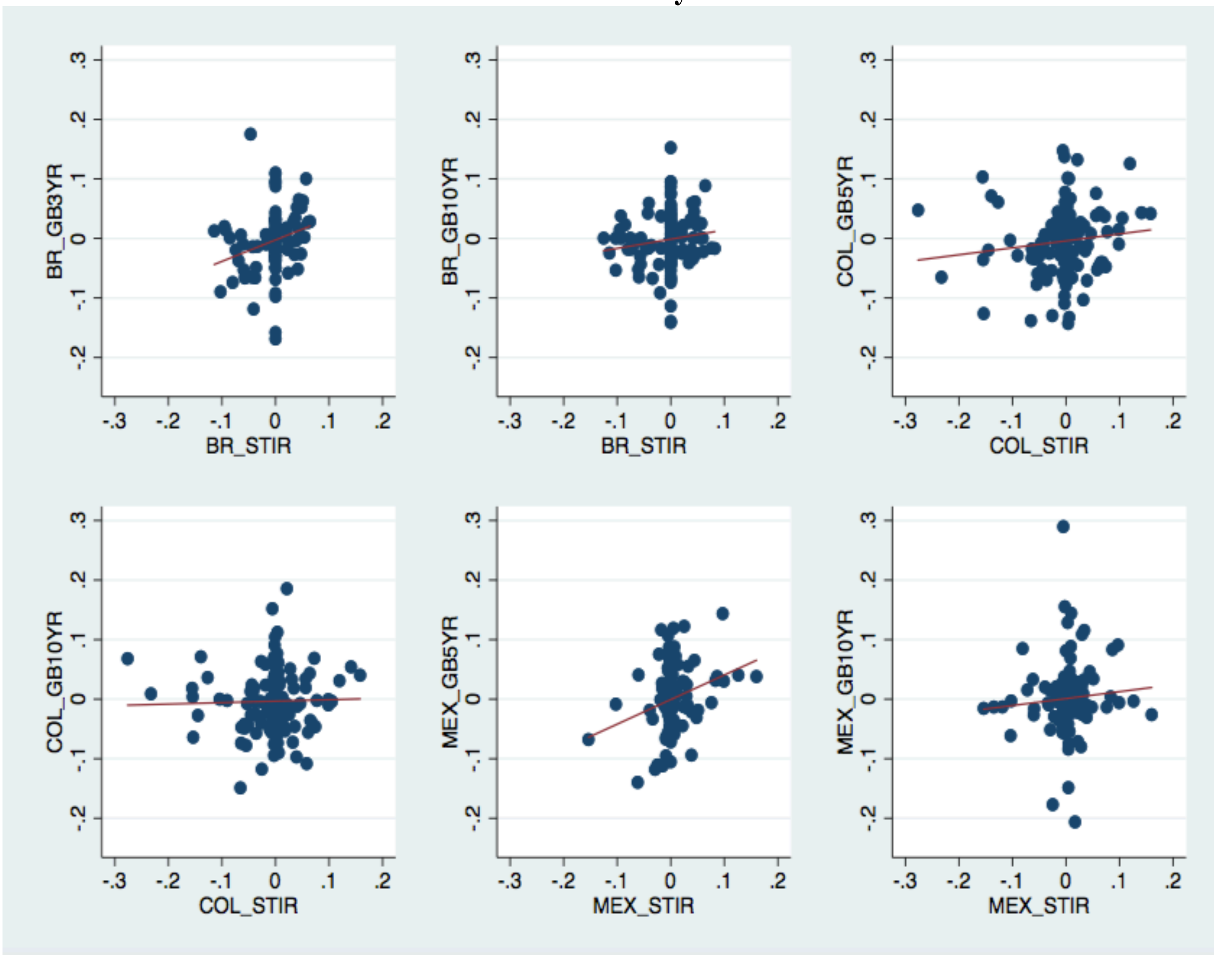
A. Figures

Figure 1A. Scatterplots of the Government Bond Nominal Yields and the Central Bank Policy Rates



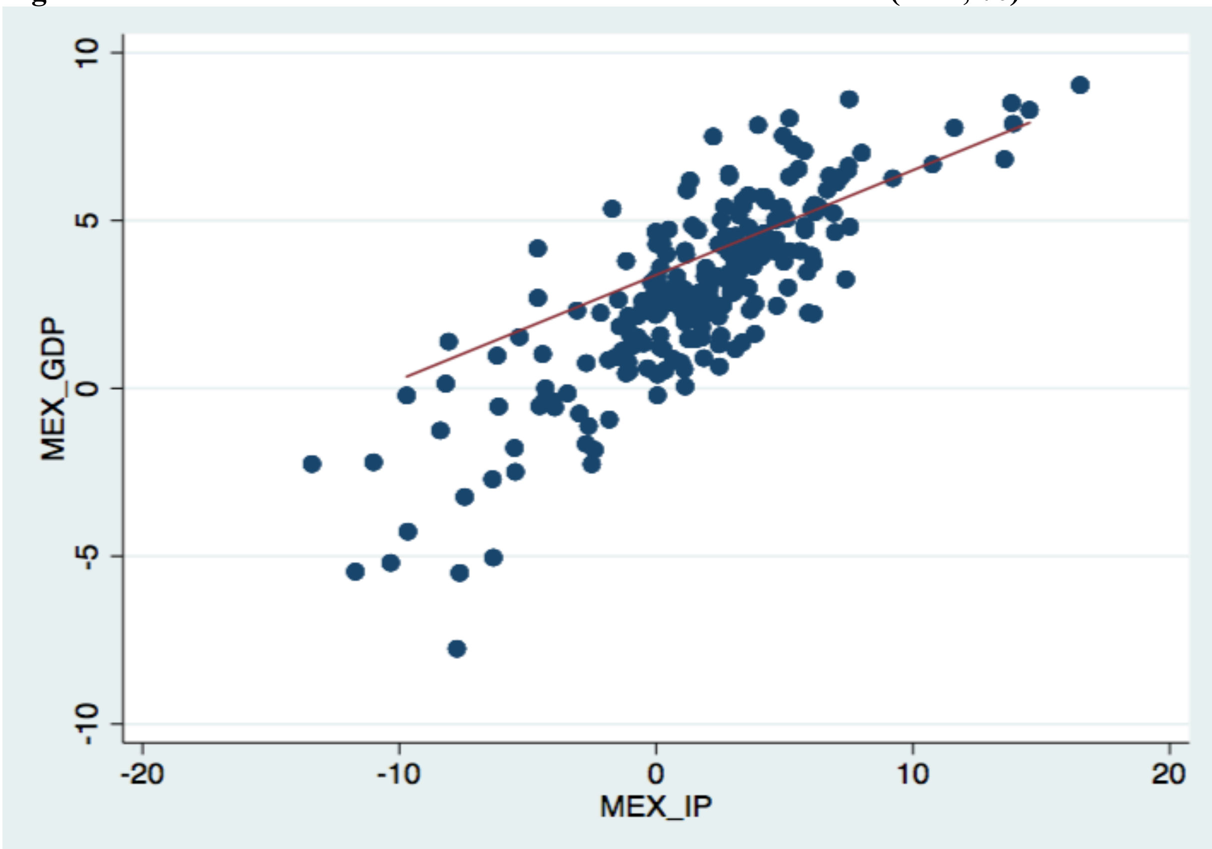
Sources: Bloomberg Terminal; and author's calculations.

Figure 2A. Scatterplots of Year-over-Year Percentage Point Changes in the Government Bond Nominal Yields and the Central Bank Policy Rates



Sources: Bloomberg Terminal; and author's calculations.

Figure 3A. Mexico Real GDP Growth and Industrial Production (YoY, %)



Source: OECD Main Economic Indicators, Production and Sales.

B. Tables

Table B1. Brazil Multivariate Cointegration Trace Tests Using the Central Bank Policy Rate

Null Hypothesis	Test Statistic	5% Critical Value
(BR_GB10YR, BR_STIR, BR_INF, BR_GDP); Lag order=4		
$r = 0$	49.0104	47.21
$r = 1$	23.2586*	29.68
$r = 2$	12.4439	15.41
(BR_GB3YR, BR_STIR, BR_INF, BR_GDP); Lag order=1		
$r = 0$	83.7577	47.21
$r = 1$	21.0856*	29.68
$r = 2$	11.3254	15.41
(BR_GB10YR, BR_STIR, BR_INF, BR_GDP, BR_GROSS); Lag order=4		
$r = 0$	73.2135	68.52
$r = 1$	42.2307*	47.21
$r = 2$	18.8859	29.68
(BR_GB10YR, BR_STIR, BR_INF, BR_GDP, BR_NET); Lag order=4		
$r = 0$	71.1754	68.52
$r = 1$	44.8410*	47.21
$r = 2$	19.7194	29.68
(BR_GB10YR, BR_STIR, BR_INF, BR_GDP, BR_OVERALL); Lag order=4		
$r = 0$	70.8355	68.52
$r = 1$	39.5350*	47.21
$r = 2$	15.0184	29.68
(BR_GB10YR, BR_STIR, BR_INF, BR_GDP, BR_PRIMARY); Lag order=1		
$r = 0$	104.2075	68.52
$r = 1$	28.2977*	47.21
$r = 2$	13.7721	29.68
(BR_GB3YR, BR_STIR, BR_INF, BR_GDP, BR_GROSS); Lag order=1		
$r = 0$	97.1812	68.52
$r = 1$	34.2255*	47.21
$r = 2$	16.5080	29.68
(BR_GB3YR, BR_STIR, BR_INF, BR_GDP, BR_NET); Lag order=1		
$r = 0$	102.5688	68.52
$r = 1$	37.5625*	47.21
$r = 2$	19.3542	29.68
(BR_GB3YR, BR_STIR, BR_INF, BR_GDP, BR_OVERALL); Lag order=1		
$r = 0$	109.9087	68.52
$r = 1$	32.1805*	47.21
$r = 2$	15.2392	29.68
(BR_GB3YR, BR_STIR, BR_INF, BR_GDP, BR_PRIMARY); Lag order=1		
$r = 0$	106.0108	68.52
$r = 1$	35.6405*	47.21
$r = 2$	13.8051	29.68

Note: r denotes the number of cointegrated vectors. The symbol * indicates significance at the 5% level.

Table B2. Colombia Multivariate Cointegration Trace Tests Using the Central Bank Policy Rate

Null Hypothesis	Test Statistic	5% Critical Value
(COL_GB10YR, COL_STIR, COL_INF, COL_GDP); Lag order=1		
$r = 0$	84.5793	47.21
$r = 1$	30.0610	29.68
$r = 2$	14.0242*	15.41
$r = 3$	5.9130	3.76
(COL_GB5YR, COL_STIR, COL_INF, COL_GDP); Lag order=1		
$r = 0$	87.8268	47.21
$r = 1$	31.8217	29.68
$r = 2$	13.8614*	15.41
$r = 3$	6.0001	3.76
(COL_GB10YR, COL_STIR, COL_INF, COL_GDP, COL_GROSS); Lag order=1		
$r = 0$	106.3738	68.52
$r = 1$	40.5882*	47.21
$r = 2$	23.4263	29.68
(COL_GB10YR, COL_STIR, COL_INF, COL_GDP, COL_NET); Lag order=1		
$r = 0$	107.3633	68.52
$r = 1$	42.1624*	47.21
$r = 2$	24.3068	29.68
(COL_GB10YR, COL_STIR, COL_INF, COL_GDP, COL_OVERALL); Lag order=4		
$r = 0$	75.4070	68.52
$r = 1$	46.2758*	47.21
$r = 2$	22.2758	29.68
(COL_GB10YR, COL_STIR, COL_INF, COL_GDP, COL_PRIMARY); Lag order=4		
$r = 0$	100.9597	68.52
$r = 1$	58.1795	47.21
$r = 2$	24.3031*	29.68
$r = 3$	12.4563	15.41
(COL_GB5YR, COL_STIR, COL_INF, COL_GDP, COL_GROSS); Lag order=1		
$r = 0$	117.6255	68.52
$r = 1$	42.2076*	47.21
$r = 2$	22.2885	29.68
(COL_GB5YR, COL_STIR, COL_INF, COL_GDP, COL_NET); Lag order=1		
$r = 0$	118.3555	68.52
$r = 1$	44.2859*	47.21
$r = 2$	23.5165	29.68
(COL_GB5YR, COL_STIR, COL_INF, COL_GDP, COL_OVERALL); Lag order=4		
$r = 0$	77.7118	68.52
$r = 1$	50.1303	47.21
$r = 2$	25.7875*	29.68
$r = 3$	10.2705	15.41
(COL_GB5YR, COL_STIR, COL_INF, COL_GDP, COL_PRIMARY); Lag order=4		
$r = 0$	77.4294	68.52
$r = 1$	50.7259	47.21
$r = 2$	25.1240*	29.68
$r = 3$	12.5578	15.41

Note: r denotes the number of cointegrated vectors. The symbol * indicates significance at the 5% level.

Table B3. Mexico Multivariate Cointegration Trace Tests Using the Central Bank Policy Rate

Null Hypothesis	Test Statistic	5% Critical Value
(MEX_GB10YR, MEX_STIR, MEX_INF, MEX_IP); Lag order=1		
$r = 0$	73.7773	47.21
$r = 1$	33.8507	29.68
$r = 2$	10.2177*	15.41
$r = 3$	3.5940	3.76
(MEX _GB5YR, MEX _STIR, MEX _INF, MEX _IP); Lag order=1		
$r = 0$	56.100	47.21
$r = 1$	19.1095*	29.68
$r = 2$	8.8309	15.41
(MEX _GB10YR, MEX _STIR, MEX _INF, MEX _IP, MEX _GROSS); Lag order=1		
$r = 0$	118.7646	68.52
$r = 1$	45.5984*	47.21
$r = 2$	13.2914	29.68
(MEX _GB10YR, MEX _STIR, MEX _INF, MEX _IP, MEX _NET); Lag order=1		
$r = 0$	114.2709	68.52
$r = 1$	44.7886*	47.21
$r = 2$	12.1893	29.68
(MEX _GB10YR, MEX _STIR, MEX _INF, MEX _IP, MEX _OVERALL); Lag order=1		
$r = 0$	73.2892	68.52
$r = 1$	49.2170	47.21
$r = 2$	29.9767	29.68
$r = 3$	11.5768*	15.41
$r = 4$	2.4699	3.76
(MEX _GB10YR, MEX _STIR, MEX _INF, MEX _IP, MEX _PRIMARY); Lag order=1		
$r = 0$	77.0608	68.52
$r = 1$	44.7199*	47.21
$r = 2$	26.8552	29.68
(MEX _GB5YR, MEX _STIR, MEX _INF, MEX _IP, MEX _GROSS); Lag order=1		
$r = 0$	73.8923	68.52
$r = 1$	36.1798*	47.21
$r = 2$	14.3717	29.68
(MEX _GB5YR, MEX _STIR, MEX _INF, MEX _IP, MEX _NET); Lag order=1		
$r = 0$	73.8313	68.52
$r = 1$	35.7376*	47.21
$r = 2$	13.3011	29.68
(MEX _GB5YR, MEX _STIR, MEX _INF, MEX _IP, MEX _OVERALL); Lag order=1		
$r = 0$	143.296	68.52
$r = 1$	54.7794	47.21
$r = 2$	20.6953*	29.68
$r = 3$	11.5559	15.41
(MEX _GB5YR, MEX _STIR, MEX _INF, MEX _IP, MEX _PRIMARY); Lag order=1		
$r = 0$	88.9535	68.52
$r = 1$	46.7517*	47.21
$r = 2$	19.7669	29.68

Note: r denotes the number of cointegrated vectors. The symbol * indicates significance at the 5% level.

Table B4. Brazil 10-Year Bond Yield Johansen VEC Model Using the Central Bank Policy Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
BR_GB10YR					
BR_STIR	-0.608***	-0.837***	-0.913***	-0.754***	-0.553**
	(0.127)	(0.179)	(0.202)	(0.199)	(0.266)
BR_INF	0.180	1.520***	1.496***	1.618***	2.011***
	(0.224)	(0.374)	(0.427)	(0.391)	(0.539)
BR_GDP	0.0158	0.744***	0.522***	1.129***	1.564***
	(0.0871)	(0.170)	(0.160)	(0.222)	(0.327)
BR_GROSS		0.120***			
		(0.0413)			
BR_NET			0.128**		
			(0.0540)		
BR_OVERALL				-0.686***	
				(0.173)	
BR_PRIMARY					-1.394***
					(0.333)
Constant	-6.647	-22.16	-17.00	-18.97	-19.84
Error correction terms (ECT)					
ΔBR_GB10YR(-1)	-0.161***	-0.119***	-0.117***	-0.0745***	-0.0640***
	(0.0409)	(0.0271)	(0.0269)	(0.0250)	(0.0209)
ΔBR_STIR(-1)	0.0471*	0.0184	0.0230	0.0148	0.0107
	(0.0251)	(0.0171)	(0.0173)	(0.0154)	(0.0123)
ΔBR_INF(-1)	0.000702	-0.0340*	-0.0367**	-0.0193	-0.0319**
	(0.0263)	(0.0176)	(0.0176)	(0.0156)	(0.0134)
ΔBR_GDP(-1)	0.165*	-0.0641	-0.00400	-0.101*	-0.0650
	(0.0870)	(0.0596)	(0.0610)	(0.0525)	(0.0434)
ΔBR_GROSS(-1)		-0.0773			
		(0.0762)			
ΔBR_NET(-1)			0.00483		
			(0.0869)		
ΔBR_OVERALL(-1)				0.0744***	
				(0.0284)	
ΔBR_PRIMARY(-1)					0.0218
					(0.0141)
Diagnostics					
Observations	138	138	138	138	141 (137)
Lags	4	4	4	4	1 (5)
Log Likelihood	-297.286	-511.129	-523.740	-386.638	-290.423
Serial Correlation Test	15.038	22.852	24.071	25.847	25.801
P-value	0.522	0.586	0.515	0.416	0.418
Skewness Test	8.923	486.387	170.951	519.354	246.309
P-value	0.063	0.000	0.000	0.000	0.000
Highest Modulus	0.838	0.830	0.829	0.838	0.895

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B5. Brazil 3-Year Bond Yield Johansen VEC Model Using the Central Bank Policy Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
BR_GB3YR					
BR_STIR	-0.793***	-0.803***	-0.739***	-1.006***	-0.968***
	(0.131)	(0.107)	(0.0971)	(0.166)	(0.269)
BR_INF	0.469**	0.442**	0.201	1.317***	2.557***
	(0.187)	(0.189)	(0.166)	(0.331)	(0.618)
BR_GDP	0.119	0.190*	0.0608	0.895***	1.953***
	(0.0843)	(0.104)	(0.0774)	(0.220)	(0.427)
BR_GROSS		0.00822			
		(0.0263)			
BR_NET			-0.0158		
			(0.0241)		
BR_OVERALL				-0.615***	
				(0.171)	
BR_PRIMARY					-1.900***
					(0.466)
Constant	-5.832	-6.122	-3.713	-13.46	-19.06
Error correction terms (ECT)					
ΔBR_GB3YR(-1)	-0.0890*	0.00980	0.00934	-0.197***	-0.110***
	(0.0488)	(0.0383)	(0.0419)	(0.0555)	(0.0335)
ΔBR_STIR(-1)	0.124***	0.148***	0.159***	0.0324	0.00782
	(0.0239)	(0.0180)	(0.0199)	(0.0257)	(0.0154)
ΔBR_INF(-1)	0.00139	0.0847***	0.0995***	-0.0280	-0.0403**
	(0.0267)	(0.0224)	(0.0242)	(0.0310)	(0.0187)
ΔBR_GDP(-1)	-0.0435	-0.117***	-0.117**	-0.0774	-0.0508
	(0.0560)	(0.0431)	(0.0473)	(0.0611)	(0.0367)
ΔBR_GROSS(-1)		0.00931			
		(0.0903)			
ΔBR_NET(-1)			0.123		
			(0.0976)		
ΔBR_OVERALL(-1)				0.124**	
				(0.0588)	
ΔBR_PRIMARY(-1)					0.0347*
					(0.0193)
Diagnostics					
Observations	102 (101)	102	102	102 (99)	102 (99)
Lags	1 (2)	1	1	1 (4)	1 (4)
Log Likelihood	-212.889	-410.862	-406.760	-242.175	-189.118
Serial Correlation Test	20.241	33.472	34.159	29.007	20.561
P-value	0.209	0.119	0.105	0.264	0.717
Skewness Test	21.938	299.106	280.196	82.543	193.104
P-value	0.001	0.000	0.000	0.000	0.000
Highest Modulus	0.906	0.906	0.903	0.892	0.885

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B6. Colombia 10-Year Bond Yield Johansen VEC Model Using the Central Bank Policy Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
COL_GB10YR					
COL_STIR	-3.863***	-1.022*	-2.704***	-4.335***	-3.883***
	(0.673)	(0.584)	(0.587)	(1.048)	(0.841)
COL_INF	2.180***	1.111*	1.025*	2.259**	1.973**
	(0.689)	(0.579)	(0.582)	(1.056)	(0.813)
COL_GDP	0.168	2.231***	0.0754	-0.135	-0.206
	(0.406)	(0.280)	(0.369)	(0.558)	(0.431)
COL_GROSS		0.386***			
		(0.0883)			
COL_NET			0.0855		
			(0.0836)		
COL_OVERALL				0.0814	
				(0.802)	
COL_PRIMARY					0.586
					(0.702)
Constant	1.127	-32.18	-1.429	4.320	3.389
Error correction terms (ECT)					
ΔCOL_GB10YR(-1)	-0.0375***	0.0129	-0.0458***	-0.0214*	-0.0286**
	(0.0125)	(0.00920)	(0.0159)	(0.0111)	(0.0137)
ΔCOL_STIR(-1)	0.0341***	0.0384***	0.0424***	0.0255***	0.0305***
	(0.00793)	(0.00538)	(0.00981)	(0.00612)	(0.00744)
ΔCOL_INF(-1)	0.000702	0.0354***	0.0147	0.00190	0.00189
	(0.0263)	(0.00615)	(0.0110)	(0.00752)	(0.00929)
ΔCOL_GDP(-1)	0.0455*	-0.0333**	0.0600**	0.0389**	0.0494**
	(0.0235)	(0.0145)	(0.0299)	(0.0188)	(0.0232)
ΔCOL_GROSS(-1)		-0.0168			
		(0.0188)			
ΔCOL_NET(-1)			0.0419		
			(0.0495)		
ΔCOL_OVERALL(-1)				-0.00177	
				(0.00972)	
ΔCOL_PRIMARY(-1)					-0.00615
					(0.0113)
Diagnostics					
Observations	128 (124)	128	128 (124)	125	125
Lags	1 (5)	1	1 (5)	4	4
Log Likelihood	-148.608	-418.923	-322.326	-204.810	-194.236
Serial Correlation Test	16.083	35.906	22.556	32.271	33.849
P-value	0.447	0.073	0.545	0.15	0.111
Skewness Test	29.843	658.286	496.629	39.438	25.721
P-value	0.001	0.000	0.000	0.000	0.001
Highest Modulus	0.888	0.932	0.911	0.893	0.896

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B7. Colombia 5-Year Bond Yield Johansen VEC Model Using the Central Bank Policy Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
COL_GB5YR					
COL_STIR	-2.933***	-2.216***	-1.884***	0.603	-0.200
	(0.561)	(0.475)	(0.452)	(0.610)	(0.485)
COL_INF	1.331**	0.684	0.326	-1.906***	-1.147**
	(0.574)	(0.475)	(0.453)	(0.615)	(0.468)
COL_GDP	-0.104	0.176	-0.0386	-1.392***	-1.080***
	(0.338)	(0.316)	(0.291)	(0.326)	(0.249)
COL_GROSS		0.129*			
		(0.0669)			
COL_NET			0.115*		
			(0.0664)		
COL_OVERALL				0.120	
				(0.470)	
COL_PRIMARY					0.228
					(0.402)
Constant	1.971	-4.731	-2.409	3.445	2.725
Error correction terms (ECT)					
ΔCOL_GB5YR(-1)	-0.0240	-0.0198	-0.0282	-0.0562***	-0.0742***
	(0.0165)	(0.0202)	(0.0218)	(0.0172)	(0.0220)
ΔCOL_STIR(-1)	0.0411***	0.0557***	0.0532***	-0.0244**	-0.0143
	(0.0111)	(0.0131)	(0.0143)	(0.0110)	(0.0142)
ΔCOL_INF(-1)	0.00368	0.0847***	0.0202	0.00650	0.00991
	(0.0126)	(0.0224)	(0.0162)	(0.0129)	(0.0167)
ΔCOL_GDP(-1)	0.0886***	0.0144	0.115**	0.0777**	0.122***
	(0.0336)	(0.0152)	(0.0448)	(0.0334)	(0.0427)
ΔCOL_GROSS(-1)		0.0457			
		(0.0574)			
ΔCOL_NET(-1)			0.0653		
			(0.0733)		
ΔCOL_OVERALL(-1)				-0.0287*	
				(0.0172)	
ΔCOL_PRIMARY(-1)					-0.0359*
					(0.0212)
Diagnostics					
Observations	128 (124)	128 (124)	128 (124)	125	125
Lags	1 (5)	1 (5)	1 (5)	4	4
Log Likelihood	-136.447	-287.012	-306.318	33.191	-180.656
Serial Correlation Test	20.891	24.44	22.338	50.286	33.312
P-value	0.183	0.494	0.616	0.126	0.123
Skewness Test	42.851	507.98	426.874	50.286	41.461
P-value	0.000	0.000	0.000	0.000	0.000
Highest Modulus	0.908	0.914	0.93	0.899	0.883

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B8. Mexico 10-Year Bond Yield Johansen VEC Model Using the Central Bank Policy Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
MEX_GB10YR					
MEX_STIR	-0.93***	-1.689***	-2.260***	-3.446***	1.116*
	(0.127)	(0.252)	(0.358)	(0.721)	(0.590)
MEX_INF	0.509**	1.113***	1.425***	0.320	1.785***
	(0.2)	(0.319)	(0.398)	(0.548)	(0.595)
MEX_IP	-0.052	-0.287***	-0.349***	0.130	-0.491***
	(0.06)	(0.109)	(0.130)	(0.154)	(0.180)
MEX_GROSS		-0.218***			
		(0.0557)			
MEX_NET			-0.304***		
			(0.0746)		
MEX_OVERALL				4.581***	
				(0.974)	
MEX_PRIMARY					-3.826***
					(0.802)
Constant	-5.089	7.746	11.51	23.08	-18.88
Error correction terms (ECT)					
ΔMEX_GB10YR(-1)	-0.827***	-0.0686**	-0.0459**	-0.00494	-0.0261
	(0.133)	(0.0286)	(0.0232)	(0.0235)	(0.0160)
ΔMEX_STIR(-1)	-0.0322	-0.0340***	-0.0257***	0.0309***	-0.0250***
	(0.0236)	(0.0123)	(0.00992)	(0.00892)	(0.00628)
ΔMEX_INF(-1)	0.583***	-0.0804***	-0.0677***	0.00477	-0.0320**
	(0.219)	(0.0222)	(0.0178)	(0.0182)	(0.0126)
ΔMEX_IP(-1)	0.0631	0.0930*	0.0799*	-0.0194	0.0490*
	(0.0618)	(0.0555)	(0.0449)	(0.0418)	(0.0292)
ΔMEX_GROSS(-1)		0.0498			
		(0.0673)			
ΔMEX_NET(-1)			0.0826*		
			(0.0468)		
ΔMEX_OVERALL(-1)				-0.0489**	
				(0.0208)	
ΔMEX_PRIMARY(-1)					0.000931
					(0.0180)
Diagnostics					
Observations	131 (130)	131 (128)	131 (128)	131 (127)	131 (128)
Lags	1 (2)	1 (4)	1 (4)	1 (5)	1 (4)
Log Likelihood	-187.276	-260.839	-241.512	-119.235	-158.724
Serial Correlation Test	32.254	18.712	17.219	22.818	25.012
P-value	0.009	0.811	0.873	0.588	0.462
Skewness Test	28.47	396.854	237.802	30.148	4.404
P-value	0.000	0.000	0.000	0.000	0.493
Highest Modulus	0.889	0.901	0.902	0.889	0.895

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B9. Mexico 5-Year Bond Yield Johansen VEC Model Using the Central Bank Policy Rate

	Model (1)	Model (2a)	Model (2b)	Model (2c)	Model (2d)
MEX_GB5YR					
MEX_STIR	0.0356	0.150	0.0600	-0.0194	-0.145
	(0.140)	(0.158)	(0.139)	(0.248)	(0.244)
MEX_INF	-0.352**	-0.421**	-0.367**	-0.340**	-0.356**
	(0.145)	(0.166)	(0.147)	(0.134)	(0.139)
MEX_IP	0.0579	0.102	0.0649	0.0143	0.0452
	(0.0673)	(0.0938)	(0.0837)	(0.0675)	(0.0746)
MEX_GROSS		0.0152			
		(0.0293)			
MEX_NET			-0.00241		
			(0.0313)		
MEX_OVERALL				-0.0328	
				(0.256)	
MEX_PRIMARY					0.142
					(0.196)
Constant	-4.131	-5.572	-4.436	-4.011	-3.261
Error correction terms (ECT)					
ΔMEX_GB5YR(-1)	-0.0823*	-0.0636	-0.0835*	-0.0825	-0.0663
	(0.0477)	(0.0422)	(0.0470)	(0.0504)	(0.0465)
ΔMEX_STIR(-1)	0.101***	0.0903***	0.0979***	0.108***	0.107***
	(0.0258)	(0.0227)	(0.0256)	(0.0272)	(0.0246)
ΔMEX_INF(-1)	0.149***	0.140***	0.150***	0.148***	0.137***
	(0.0491)	(0.0430)	(0.0484)	(0.0521)	(0.0479)
ΔMEX_IP(-1)	0.00354	-0.00318	0.00167	0.0182	0.00924
	(0.0795)	(0.0702)	(0.0786)	(0.0839)	(0.0772)
ΔMEX_GROSS(-1)		-0.122			
		(0.115)			
ΔMEX_NET(-1)			-0.149		
			(0.111)		
ΔMEX_OVERALL(-1)				0.108***	
				(0.0413)	
ΔMEX_PRIMARY(-1)					0.123**
					(0.0500)
Diagnostics					
Observations	81	81	81	81	81
Lags	1	1	1	1	1
Log Likelihood	-50.964	-144.064	-129.247	-49.326	-69.278
Serial Correlation Test	16.886	24.095	20.848	17.514	25.225
P-value	0.393	0.514	0.701	0.862	0.449
Skewness Test	5.656	105.405	82.684	16.305	29.376
P-value	0.226	0.000	0.000	0.006	0.000
Highest Modulus	0.869	0.889	0.868	0.862	0.887

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.