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Abstract

The study examined monetary policy transmission in Zambia to market interest rates (commercial bank retail rates and government securities yield rates). A Johansen cointegration approach was used to establish the long-run relationship using monthly data from April 2012 to July 2023. A vector error correction model (VECM) where cointegration was established to determine short-run dynamics. According to estimates, the interbank fully responds to policy rate adjustments in the long-run. However, there is incomplete pass-through to commercial bank retail rates (lending rates and deposit rates) and Treasury bills yield rates. The study also establishes that there is no pass-through from the interbank rate to government bonds yield rates. In the short-run, the policy rate has a significant immediate effect on the interbank rate, aligning with established view of central bank policy's influence on short-term interest rates. The deposit rate is contemporaneously impacted by the interbank rate. Monetary policy, reflected in interbank rate fluctuations, significantly impacts Treasury bill yield rates, but decays for long-term maturities. Regarding policy, the findings reinforce the need for the Bank of Zambia to continue implementing structural reforms to enhance competition as well as more equitable flow of funds among commercial banks in the interbank money market. In addition, it is imperative develop and deepen the financial markets to improve the transmission of monetary policy to government securities, especially long-term bonds. This will in turn enhance monetary policy through the expectations channel.

Keywords: Pass-through, monetary policy rate, market interest rates, vector error correction model
JEL Classification : C32, E42, E52, E58

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1 Introduction

Monetary policy in Zambia strives to maintain the inflation rate within the bounds of the set target band of 6-8 percent. Ideally, when the inflation rate breaches the bounds of the target band, for instance exceeding the upper bound, the Bank of Zambia (BoZ) is expected to increase the official interest rate (policy rate) in order to curb inflationary pressure and steer inflation back into the target range. To stabilize inflation, the Taylor rule postulates that a central bank reacts by raising its interest rate by more than the percentage increase in inflation (Woodford, 2003). Aziakpono and Magdalene (2013) argues that there is general recognition that the effectiveness of monetary policy in macroeconomic stability, and achieving set inflation targets, is to a large extent dependent on the stickiness of market interest rates[2] such as commercial bank retail rates and other market interest rates.

Therefore, understanding the transmission mechanism for monetary policy is vital as effective monetary policy implementation is critical for achieving macroeconomic stability in an economy. Monetary policy transmission is the process through which monetary policy decisions influence activity in the real sector and ultimately the price level (Atkin, 2017). There are several channels through which monetary policy is transmitted to the economy. These include exchange rate, interest rate, credit and expectations.

The traditional interest rate channel of monetary policy transmission occurs in two ways. According to Ojaghlou and Kaya (2022), the first is referred to as the monetary policy approach relating to the impact of a change in monetary policy on market interest rates. The second is the cost of funds approach, which shows the indirect transmission channel (Bondt, 2005). Coricelli et al. (2006) show that the indirect transmission channel is decomposed into two stages. The first stage measures how changes in the policy rate are transmitted to short-term money market rates which are targeted as a channel of monetary policy to interbank market (Gopalan and Rajan, 2017). The other is the pass-through from the interbank rate to market interest rates which include commercial bank retail rates (deposit rates and lending rates) as well as the term structure of interest rates on government securities. The relevance of this transmission mechanism depends on the magnitude of the change in the monetary policy rate that is transmitted to the lending rates and the speed of adjustment. That is, the higher the proportion and speed of adjustment, the more vital this channel is. The pass-through is defined as the degree and speed of adjustment with which a change in the monetary policy instrument is passed on to the economy (Aydin, 2018).

The interest rates channel is an important aspect of the monetary policy transmission mechanism (Aydin, 2018; Ngoma and Chanda, 2022). This transmission channel is captured via the financial sector of the economy and the state of financial markets play a key role in the implementation of monetary policy. For developing countries, and in particular Zambia, a lack of well-functioning financial markets limits the effectiveness of monetary policy (Simpasa, 2014).

[2] In the context of this study, market interest rates encompass commercial bank interest rates as well as government securities yield rates similar to Ojaghlou and Kaya (2022).

From 1964 when the country attained its independence, the financial sector has undergone several reforms. Particularly, liberalization of the financial sector which commenced in the early 1990s resulted in the abolishment of credit, interest rate and exchange controls (Simatele, 2004). Furthermore, the implementation of monetary policy has progressed and is done in sync with the prevailing financial and market conditions.

In April 2012, the BoZ introduced the policy rate as a key interest rate to signal the monetary policy stance. This was a transition to inflation targeting and modernization of the monetary policy framework when the operational procedure changed from monetary aggregates (quantities) targeting to interest rate (prices) targeting. The BoZ policy rate was introduced as a starting point, and this came with a shift in the monetary policy operational target from reserve money to the overnight interbank rate (Zgambo, 2017). Changes in the overnight interbank rate ultimately have an impact on commercial banks' lending rates. Lending rates are a key, if not the best, indicator of the marginal cost of short-term funding in an economy (Borio and Fritz, 1995).

Following the change of the monetary policy framework in Zambia, a few studies have attempted to assess monetary policy transmission, notably Chileshe and Akanbi (2016) and Ngoma and Chanda (2022). Empirical evidence on how the transition to inflation targeting has fared so far remains scanty. Chileshe and Akanbi (2016) attempted to examine the existence of an asymmetric response of commercial bank retail rates and selected bond yield rates to the policy rate. This study combined both monetary targeting and inflation targeting (transitional) regimes covering the period 1992–2016. However, Ngoma and Chanda (2022) argued that covering both regimes in the same study made it difficult to assess the effectiveness of the interest-rate-based framework adopted in 2012. To this effect, Ngoma and Chanda (2022) assessed the pass-through from the policy rate to commercial bank retail rates, as well as the magnitude and speed of monetary policy transmission with a focus on the period associated with inflation-targeting (transitional) regime. Nevertheless, Ngoma and Chanda (2022) did not cover the pass-through to the government securities yield curve, which leaves a gap in assessing the effectiveness of monetary policy in Zambia post the transition. Even though Government securities yield rates are not a monetary policy target, they play a critical role in overall financing as commercial banks tend to use them as a benchmark for deposit interest or for pricing loans (Ma, 2017). Thus, yield rates contribute to the effectiveness of monetary policy. Lane (2019) postulates that the yield curve is a key element in the transmission of monetary policy. Standard and non-standard monetary policy instruments affect the whole of the term structure, which in turn is a prominent determinant of the financing conditions of the economy. Further, it is argued that in as much as monetary policy is an important factor affecting the yield curve, beliefs about future monetary policy and risk premia also play a critical role (Lane, 2019). To this effect, the yield curve plays a dual role for monetary policy makers, firstly as a transmitter of monetary policy and secondly as a source of information about the expectations and risk assessments of investors about the future macroeconomic environment and the future path for monetary policy.

The policy rate primarily influences bond yield rates through arbitrage in the bond market, whereas its impact on deposit and lending rates is primarily accomplished through the portfolio rebalancing activities of banks and investors. From the bank's perspective, when the policy rate increases, creating liquidity shortage in the banking system, banks face reduced funds for bond investments, causing a rise in bond yields. In well-developed financial markets with effective arbitrage tools, this transmission is swift. An arbitrage between bonds of varying maturities occurs rapidly, such as shorting long bonds when the policy rate rises. This arbitrage mechanism enables prompt transmission of changes in the short-term policy rate to yields on medium- and long-term bonds (Ma, 2017). In addition, the policy rate also influences the yield rates through its impact on expectations of market participants about the future path of the policy rate (the signalling channel). This channel is critical to monetary policy via inflation expectations. Inflation expectations play a critical role in the effective implementation of monetary policy. If a central bank can anchor economic actors' long-term inflation expectations near its inflation target, it will have a greater chance of attaining low and stable inflation. The reason for this is that inflation expectations play a crucial role in the transmission of monetary policy since they have an effect on current inflation by influencing how prices and wages are established (Bernanke et al. 2001).

This study builds on the works by Chileshe and Akanbi (2016) and Ngoma and Chanda (2022) by extending the assessment of the pass-through from the monetary policy to the entire government securities yield curve. This effectively implies assessing the impact along the yield curve as earlier studies focused mainly on the pass-through to commercial bank retail interest rates and in some instances selected bond yield rates.

Given evidence of a segmented interbank money market in Zambia (Chipili et al., 2019), the study assesses the impact of the policy rate on market interest rates, including yield rates on all Treasury bill and bond tenors using the interbank money market as a key transmission path in Zambia. The study uses a Johansen cointegration approach for estimation of the model. To achieve this, a stepwise (two-step) VECM model is applied. Firstly, this approach facilitates the measurement of pass-through from the monetary policy rate to the overnight interbank rate. Secondly, it allows for the assessment of the pass-through from the interbank rate to market interest rates. Twelve market interest rates are considered in this study. These include average commercial bank lending rate, 180-day deposit rate, 91-, 182-, 273-, and the 364-day Treasury bill yield rates as well as the 2-, 3-, 5-, 7-, 10-, and 15-year bond yield rates. For the assessment of the monetary policy transmission to government securities yield rates, the study assumes only the direction from policy rate to yield rates. Gürkaynak and Swanson (2005) argues that Government securities yield rates can be a valuable indicator for future monetary policy which entails that changes in yield rates may also influence monetary policy direction.

Empirical results reveal that there is complete pass-through from the policy rate to the interbank rate, consistent with previous studies. Considering the role of the interbank, there is also evidence of incomplete pass-through from the policy rate to the lending and deposit rates with the latter having a stronger pass-through. On government securities, the pass-through from the policy rate to the treasury bill yield rates is incomplete and decays along the yield curve while there is no pass-through established from the policy rate to the government bond yield rates.

The rest of the study is organized as follows. Section 2 provides an overview of the evolution of interest rates in Zambia. Section 3 reviews the relevant literature while section 4 outlines the empirical model and presents the estimation strategy. Section 5 is data description and sources. Section 6 presents the empirical findings. Section 7 concludes.

2 Overview of the Evolution of Interest Rates in Zambia

Interest rates play a crucial role in the financial system as they reflect borrowing costs and affect investment decisions, and overall economic activity. The evolution of interest rates in Zambia has been influenced by various domestic factors, including inflation, fiscal and monetary policy, exchange rate dynamics, and global economic conditions. The BoZ plays a vital role in setting and implementing interest rate policies aimed at striking a balance between managing inflation, stimulating economic activity, and promoting financial sector development in the country.

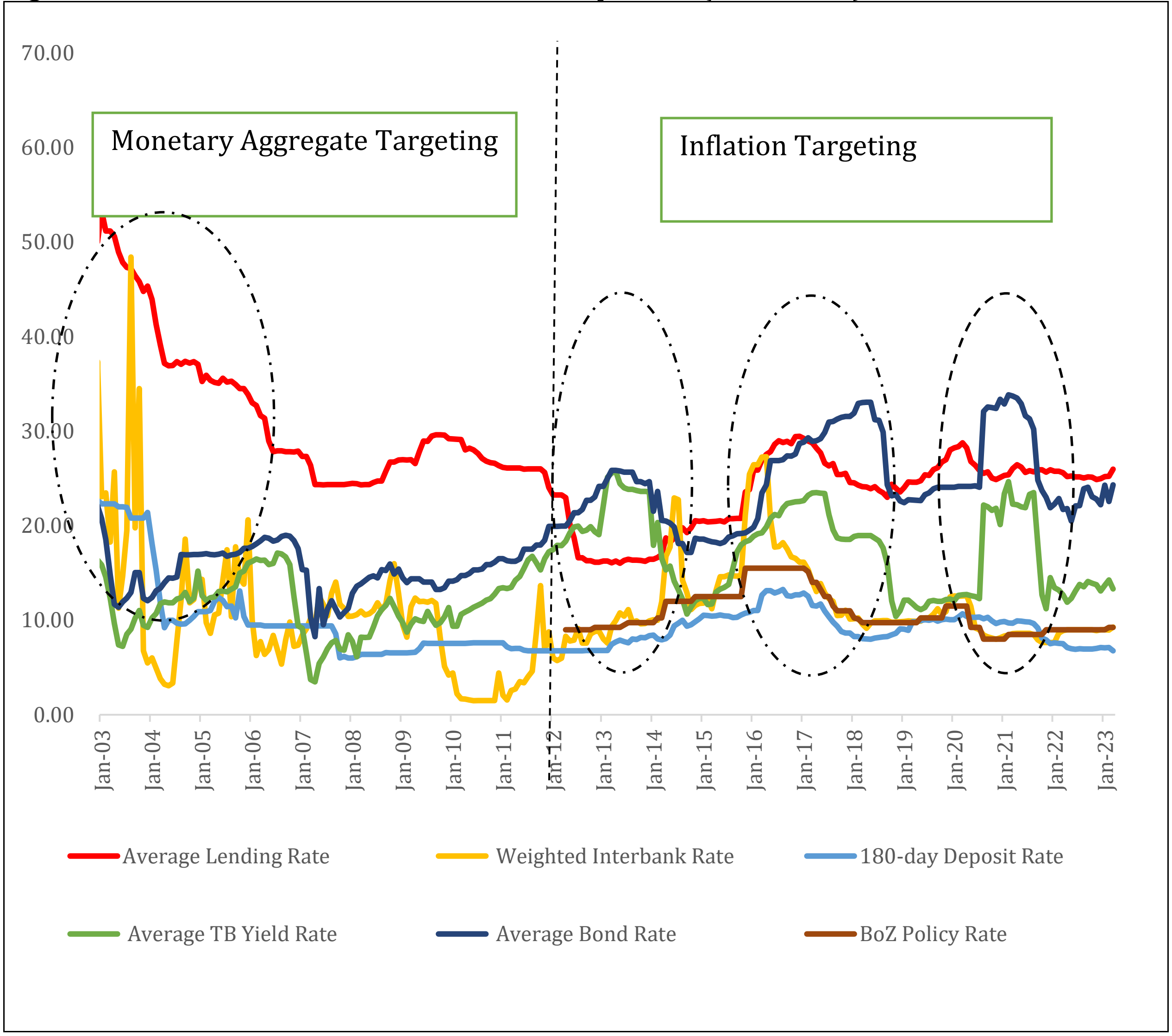
The interest rate environment has witnessed significant changes since independence in 1964. In the early years, interest rates were largely influenced by government policies aimed at promoting economic development and stability. During this period, interest rates were generally controlled and set at lower levels to support government-led initiatives (Odhiambo, 2009).

In the 1990s, Zambia underwent financial sector reforms and embraced market-oriented policies. This period marked a shift towards liberalization and the adoption of market-based interest rates (Martínez, 2006). The Bank of Zambia transitioned from direct interest rate controls to more indirect monetary policy tools such as open market operations. The process of liberalization aimed to introduce market-based interest rates and reduce government intervention in the determination of rates (Brownbridge, 1996). While Zambia switched towards market-determined interest rates, the government continued to intervene in certain instances to manage macroeconomic stability. During periods of economic volatility or financial crisis, the central bank occasionally adjusted the interest rate to address challenges such as excessive credit expansion or currency depreciation. These interventions aimed to stabilize the economy and ensure sustainable growth (Zgambo and Chileshe, 2014). As market-oriented reforms progressed, the development of the financial sector played a vital role in shaping interest rates. The introduction of new financial institutions, including commercial banks, non-bank financial institutions, and microfinance institutions, increased competition, and expanded access to credit. Increased competition exerted downward pressure on interest rates, benefiting borrowers and stimulating economic activity (Martínez, 2006).

Prior to switching to the inflation targeting framework, Zambia used the monetary aggregates targeting (MAT) framework for its monetary policy. This approach used reserve money as the operating target with broad money as the intermediate target, ultimately targeting inflation. However, as evidence revealed a weakening connection between money supply and inflation, there arose a necessity for a new monetary policy operating framework (Simpasa et al ,2014).

The Bank of Zambia adopted inflation targeting as its monetary policy framework in April 2012, a strategy that entails establishing a precise inflation target and utilizing interest rate adjustments to achieve that target (Ngoma and Chanda, 2022). Under this framework, the primary tool employed by the central bank to influence borrowing costs and overall monetary conditions is the policy rate. When inflation persistently surpasses the set target, the central bank responds by increasing interest rates to counter inflationary pressures. Conversely, if inflation persistently falls below the target, the central bank reduces interest rates (Jahan, 2012). By utilizing interest rates as a policy tool, the BoZ aims to stabilize inflation expectations and provide clarity to market participants. This is accomplished through the transmission mechanism that operates via commercial bank lending rates, which are influenced by changes in the policy rate (Ngoma and Chanda ,2022).

Figure 1: Evolution of interest rates in Zambia, percent (2003-2023)



Source: Bank of Zambia, 2023 and Authors' compilation

Figure 1 shows trends in commercial bank retail rates (deposit rates and lending rates), policy rate, interbank rate and yield rates on government bonds and Treasury bills[3]. Notable volatility in the interbank rate is observed from 2003 to2006. This reflected the goal under MAT which was principally to stabilize money supply to achieve price stability by allowing interest rates to fluctuate, as noted by Ngoma and Chanda (2022). After the adoption of the inflation targeting framework, the overnight interbank rate has been more stable as it is broadly aligned to the policy rate. Apart from selected episodes in 2014, 2015 and 2016, the two interest rates exhibit a strong covary relationship. During these times, the BoZ raised the statutory reserve ratio by 400 basis points, the policy rate and the Overnight Lending Facility (OLF) rate by 300 basis points each, and it limited daily access to central bank liquidity to once a week in an effort to reduce inflationary pressure (Ngoma and Chanda, 2022). Additionally, the Bank of Zambia eliminated the ability to convert intraday loans into overnight loans. Consequently, there was significant pressure on the overnight interbank interest rate. As a result, the interbank rate diverted from the policy rate and breached the bounds of the set policy rate corridor (+/- 1 percentage point of the policy rate). Despite the interbank rate increasing and going beyond the policy rate corridor, the central bank purposefully refrained from engaging in any expansionary open market operations to maintain tight liquidity conditions. Tight liquidity conditions tend to reduce demand for foreign exchange, thus rendering support to the Kwacha and curbing inflationary pressure (Bank of Zambia, 2014; Bank of Zambia, 2016). Roger et al. (2017) and Chipili (2021) provide empirical evidence on high pass-through from the exchange rate to inflation in Zambia.

Figure 1 also reveals that the policy rate and interbank rate are relatively synchronized with the deposit rate. On the other hand, the relationship between monetary policy-controlled rates (policy and interbank rate) and lending rates appears to be weak and this is in tandem with the experience of other countries implementing the inflation targeting framework such as South Africa (Aziakpono and Magdalene, 2010; Matemilola et al, 2015), Kenya (Berg et al, 2018), Uganda (Okkelo, 2014; Berg et al., 2018) and Turkey (Ojaghlou and Soztanaci 2022). Theoretically, the lending rate is determined by a markup or spread. The markup may vary over time and be affected by macro-financial conditions (e.g bank market structure, bank conditions, macroeconomic developments). In the Zambian case, fiscal developments tend to play a crucial role in the determination of lending rates. This evidence as can be seen by its close relationship with the government bond yield rate. Thus, episodes of fiscal deterioration/improvement tend to cause noticeable swings in lending rates. Aside from this, competition in the market also plays a part in the determination of lending rates. For example, a rapid decline in lending rates from 2003 to 2015 is attributable to increased competition in financial markets following economic reforms implemented in the 1990s coupled with reduced government borrowing in the domestic money market which compelled commercial banks to lower lending rates to attract private borrowers (Chileshe and Akambi, 2016).

Broadly, movements in the interbank rate and the policy rate are in line with changes in government securities yield rates, especially the short-term tenors (represented by the average Treasury bills yield rates). However, the spread between bond yield rates and the

[3] The average bond rate is a simple average of the 2-, 3-, 5-, 7-, 10- and 15-year yield rates. The average Treasury bills rate is the simple average of the 91-, 182-,273- and 364-days Treasury bills yield rates.

monetary policy-controlled rates (policy rate and interbank rate) is wide. This spread in part may explain the weak relationship between the policy rate and lending rates. Government securities yield rates reflect the risk-free cost of credit. Thus, when there is a significant gap from the monetary policy rate, banks may set interest rates relatively closer to the risk-free rate as it is key in pricing retail rates (International Monetary Fund, 2001). This gap tends to widen in periods of fiscal deterioration and vice versa. Particularly, this can be observed around 2014-15, yield rates soared when BoZ embarked on monetary tightening (Bank of Zambia, 2015) following strong inflationary pressures (inflation rising to 21.1 percent in December 2015 from 7.7 percent in September 2015) largely driven by increased government's borrowing coupled with the Kwacha depreciation (International Monetary Fund, 2015). The second period is 2017-18 when the government pursued measures to manage its budget more tightly coinciding with reduced inflationary pressures and lower policy and interbank rates (Bank of Zambia, 2017). The other period is 2020-21 when the government faced worsening budget deficits and escalating public debt levels, exacerbated by the repercussions of the COVID-19 pandemic (International Monetary Fund, 2022). Further in 2021, with commitment to fiscal consolidation, the spread narrowed between government securities yield rates and the monetary policy-controlled rates. This was mainly due to the announcement of a Staff Level Agreement on a US$1.3 billion 3-year Extended Credit Facility between the International Monetary Fund and Zambian Government aimed at an eventual comprehensive debt restructuring. This contributed to the decline in government securities yield rates.

3 Literature Review

According to the monetary transmission mechanism theory, a change in the policy rate affects the economy through different channels. The main channels of monetary policy transmission include the interest rate, credit, asset price, and exchange rate (Chileshe, 2017). This study focuses on the interest rate channel.

Based on the Keynesian assumption of sticky prices, the traditional interest channel implies that an increase in money supply translates into a decrease in the real interest rate[4]. This implies that the central bank is able to influence long-term interest rates by affecting short-term interest rates. The rational expectations hypothesis of the term structure states that the long-term interest rate is an average of expected future short-term interest rates (Chileshe, 2017).

The interest rate pass-through is a critical element in the monetary policy transmission mechanism as it explains how changes in the policy rate or interbank rates are transmitted to various bank rates, including lending rates, for corporations and consumers or bank

[4] An increase in supply of money works in twofold: firstly, through lowering interest rates, which spurs investment, and secondly through putting more money in the hands of consumers, making them feel wealthier, and thus stimulating spending. Business firms may respond to increased demand by ordering more raw materials, increasing production and/or increasing prices. Thus, this may be inflationary. High inflation, while nominal interest rates remain unchanged, results in lower real interest rates. Real interest rate = nominal interest rate minus rate of inflation.

deposit rates (Mishkin, 1996). This pass-through mechanism represents the initial stage of the interest rate channel. The speed and extent of the pass-through are key determinants of the impact of monetary policy decisions on bank lending rates, thereby affecting investment and consumption choices and ultimately inflation.

According to Rousseas (1985), the pass-through from monetary policy changes to bank lending rates can be outlined as follows:

$$lr = g(mc) = \underset{(markup)}{\mu_t} + \underset{(pass\text{-}through\ coefficient)}{\beta} * \underset{(marginal\ cost\ of\ funding)}{mc}$$

where lr is the bank lending rate, mc is conceptualized as a function of the bank's marginal cost of funding, which is estimated using the interbank rates. In its simplest form, this function exhibits linearity, where the lending rate is determined by an added margin or spread (μ), interbank rate and the multiplication of the pass-through factor (β) by the marginal cost. Changes in the monetary policy rate exert an impact on the marginal cost of funding, and consequently influence the lending rate through the pass-through coefficient (β). It is worth noting that the markup can vary over time and is susceptible to macro-financial conditions, such as the structure and health of the banking sector.

According to Aziakpono (2010), it is expected that the value of the pass-through coefficient would lie between 0 and 1 i.e. $0 \leq \beta \leq 1$. If β is less than 1, the degree of long-run pass-through is incomplete, while the value of 1 implies complete pass-through. The value of β is unlikely to be equal to 1 owing to monopolistic behavior of banks, collusive arrangements, high banking sector competition and high switching cost. There are also cases were β could be greater than 1, reflective of over pass-through. Over pass-through is associated with banks charging higher interest rates to counter higher risks due to asymmetric information rather than reducing the supply of loans (De Bondt, 2005; Aziakpono, 2010).

Some of the theories explaining the size of pass-through factor (β) include: monopolistic behaviour of banks as explained in the Monti-Klein model. This model postulates that banks influence the pass-through factor (β) through restrictions to entry into the banking sector by regulatory agencies combined with monopoly power promoting bank concentration. This causes interest rates to be sticky and adjust asymmetrically to changes in the monetary policy rate (Bondt, 2002). Secondly, banks may influence pass-through factor (β) through collusive arrangements and so unlikely to reduce lending rates thereby resulting in rigid downward adjustments in lending rates and flexible upward adjustments in deposit rates in response to changes in the policy rate (Bondt, 2005; Aziakpono and Magdalene, 2013). In addition, commercial banks operating in highly competitive environments may avoid increasing lending rates for fear of negative customer reactions as postulated by the customer reaction hypothesis. This may affect the pass-through factor (β) as deposit rates could be adjusted rigidly downward in response to decreases in the policy rate while lending rates may be adjusted rigidly upward when the policy rate rises so as to retain customers (Aziakpono and Magdalene, 2013). Finally, customers may be reluctant to change financial products and institutions due to high switching costs as postulated by the switching costs hypothesis. As such, banks may exploit this inertia to selectively price their products and adjust interest rates asymmetrically, thereby influencing the pass-through factor (β) leading to rigidity in interest rates (Liu et al., 2008).

The transmission of monetary policy rate to government securities yield rates is explained by the expectations hypothesis of the term structure of interest rates. This hypothesis postulates that long-term yields on government securities are determined by market expectations of future short-term interest rates. Monetary policy actions, such as changes in the policy rate, or its predicted path can affect these expectations and consequently influence long-term yields. Campbell and Shiller (1991) and Ang et al. (2008) provide empirical evidence supporting the expectations hypothesis.

Arbitrage is an essential component in the transmission of the monetary policy rate to government securities yield rates (Ma, 2017). It ensures that any discrepancies between short-term and long-term interest rates are quickly corrected by market participants seeking to capitalize on yield differentials (Mishkin, 2001). When central banks adjust the policy rate, these changes impact short-term interest rates and consequently influence the yield rate disparities between short-term and long-term government securities. Arbitrage activities work to maintain equilibrium in the bond market, aligning long-term yields on government securities with market expectations of future short-term interest rates (Duffie, 1996). Cochrane and Piazzesi (2005) and Gürkaynak and Swanson (2005) further underscore the importance of arbitrage in shaping the term structure of interest rates and its response to monetary policy changes.

Numerous studies have been conducted to evaluate the transmission of monetary policy to market interest rates. Empirical evidence shows that there is generally pass-through from monetary policy to market rates (mostly commercial bank interest rates). Most studies have endeavoured to assess the pass-through via the interbank money market. Evidence shows that there is broadly complete pass-through from the policy rate to the interbank rate while partial from the interbank rate to market rates (Aziakpono, 2010; Das, 2015; Mbowe, 2015; and Ngoma and Chanda, 2022). Some studies have also attempted to extend the pass-through from monetary policy to government securities yield rates in the United States of America (Gürkaynak and Swanson, 2005); Turkey (Ojaghlou and Kaya, 2022); Ghana (Kovanen, 2011 and Akosah, 2015) and Zambia (Chileshe and Akambi, 2016).

Evidence of incomplete pass-through from monetary policy to commercial bank retail rates is presented by Aziakpono (2010). The study analyzed the response of market interest rates to changes in the official rate and whether the adjustment was asymmetric using monthly interest rates data for the period 1980 to 2007 by applying symmetric and asymmetric error correction modelling techniques in South Africa. The findings suggest that interference with market forces may slow down the pass-through process and reduce the effectiveness of monetary policy. The study also found that targeting the prime lending rate of commercial banks may be as effective as targeting the prime interbank lending rate. The weak pass-through to the capital market interest rate suggests that it may take a long time before the effects of a monetary policy action can be felt. The study also highlighted the need for intervention to protect depositors from exploitation by banks in the deposit market. However, regulations may target more transparent banking operations rather than reducing the level of concentration in the banking industry.

Das (2015) extended the monetary policy assessment by considering the role of the interbank in the transmission mechanism. Das (2015) attempted to examine the pass-through from monetary policy changes to bank deposit and lending rates in India from 2002 to 2014 using a two-step vector error correction model. The study found slow but significant pass-through from policy changes to bank interest rates, with larger pass-through to deposit rates than lending rates and quicker adjustment of deposit rates to changes in the policy rate. The study also found evidence of asymmetric adjustment to monetary policy, with deposit rates not adjusting upwards to tightening but adjusting downwards to loosening, and lending rates adjusting more quickly to tightening than to loosening monetary policy. The extent of pass-through to lending rates increased over the sample period. Similar to Das (2015), Mbowe (2015) also presents evidence of incomplete pass-through in Tanzania using the interest rate channel.

Gürkaynak and Swanson (2005) explored the monetary transmission to the government securities yield rates and investigated the effects of changes in the federal funds rate on the yield curve of U.S. Treasury securities. They found that monetary policy actions had a significant impact on both short-term and long-term yield rates, indicating the influence of monetary policy on government securities yield rates. On the other hand, Ojaghlou and Kaya (2022) took a more comprehensive approach by assessing the monetary policy pass-through to commercial bank retail rates and government securities. The study attempted to investigate market interest rates' response to the official interest rate set by the Central Bank in Turkey. The study analyzed six interest rates data series from January 2002 to March 2021. The results revealed a long-term relationship between interest rates, particularly a strong correlation between the bank rate and the money market rate, deposit rate, and lending rate, indicating various degrees of pass-through among these rates. The study also reveals a strong pass-through from the bank rate to treasury bill rates but no pass-through to government bond yield rates.

There is similar pass-through evidence in Ghana. Akosah (2015) focused on the role of Treasury bills in the monetary policy transmission process. The study conducted a comprehensive examination, investigating the signaling ability of the monetary policy rate (MPR) in both the short- and long-term to a range of market interest rates, including Treasury bills, while also assessing its impact on the real sector encompassing output and inflation. The findings highlighted the MPR's effectiveness in communicating with various market interest rates, with particular importance placed on the 91-day Treasury bill rate. Furthermore, the study revealed that the transmission from MPR changes to government securities yield rates is not one-to-one in line with Kovanen (2011). This underscores the importance of Treasury bills in the hierarchy of interest rates in Ghana and their influence on bank retail interest rates.

In the Zambian case, there is also evidence of policy rate transmission to commercial bank retail rates and yields on government securities. Chileshe and Akanbi (2016) carried out an empirical analysis using quarterly data for the period Q1 1992 to Q2 2016. The study, using a linear ARDL model, revealed that there was low pass-through from the policy rate to deposit rates while there was a high and complete pass-through to lending and yield rates. The policy rate strongly influenced the money market rate in the short- and long-run.

Interest rates showed short-term stickiness relative to the long-run, and the pass-through from the money market rate was higher for longer maturity deposit and asset rates. The NARDL model confirmed asymmetry in pass-through: higher from the policy rate than the interbank rate, and negative asymmetry for deposit rates, while positive asymmetry was observed for lending and yield rates. These findings shed light on commercial bank behavior and the impact of monetary policy on interest rates in Zambia.

Using bank level data, Simpasa and Nandwa (2014) also investigated the efficacy of monetary policy pass-through in Zambia. The study compares the effectiveness of monetary policy using the bank lending channel during the monetary aggregates targeting and interest rate targeting regimes. The findings indicated that monetary policy anchored in price signals was more effective than quantity-based approaches. Large banks responded more significantly to policy shocks while medium-sized banks showed a weaker response. However, small banks did not exhibit evidence of the bank lending channel's operation, even with relationship lending considered. Medium-sized banks seemed to learn from larger banks' lending behavior. Exchange rate volatility affected lending behavior, highlighting the importance of a stable exchange rate.

Lastly, Ngoma and Chanda (2022) investigated the pass-through from the BoZ policy rate to commercial bank lending and deposit rates via the interbank market with attention solely on the inflation targeting period. Using a Johansen cointegration approach and VECM, the study found a high and complete pass-through from the policy rate to the interbank rate but incomplete to commercial bank interest rates. The pass-through was also found to be asymmetric, with lending rates responding faster to contractionary policy and deposit rates responding only to expansionary policy. The study suggests that while the interest rate channel of monetary policy transmission exists in Zambia, the pass-through becomes weaker during the second stage of transmission, indicating the strength of the policy rate signal may be lost along the way.

Overall, the existing literature suggests that there is full response of the interbank rate to policy rate adjustments. However, there is incomplete pass-through from the interbank rate to market interest rates in Zambia. There is a noticeable gap in the literature on the monetary policy transmission to the government securities yield rates in Zambia. Chileshe and Akanbi (2016) extended the assessment of monetary policy pass-through to government securities yield rates but only considered selected bond yield rates while using the 91-day Treasury bills rate as a policy-controlled interest in transmitting monetary policy. To the best of the authors' knowledge, no study has comprehensively investigated the monetary policy transmission to all the government securities yield rates in Zambia. Therefore, this study expands the discussion to include all Treasury bill yield rates (91-, 182-, 273-, and 364-day) and bond yield rates (2-, 3-, 5-, 7-, 10-, and 15-year) to address this limitation.

4 Model Specification and Estimation Strategy

The principal model illustrating the relationship between the market interest rates is denoted as (Scholnick, 1996; De Bondt, 2005; Marotta, 2009; Aziakpono and Wilson, 2013; Ojaghlou and Kaya, 2022):

$$mr_t = \alpha_0 + \alpha_1 pr_t + \varepsilon_t \tag{1}$$

where pr_t is the policy rate exogenously determined by BoZ; mr_t represents endogenously determined market interest rates (in this case dr, lr, tbr91, tbr182, tbr273, tbr364, br2, br3, br5, br7, br10 and br15 as described in table 1); ε_t is the stochastic error term; $\alpha_0$and α_1 are the long-run coefficients, respectively. According to Aziakpono and Wilson (2013), based on the cost-of-funds approach, the constant term, α_0, denotes the fixed markup/markdown on commercial bank retail interest rates (lr and dr). For the lending rate, the constant term includes the credit risk premium (Marotta, 2009; Aziakpono and Wilson, 2013).

Model Specification

Similar to Das (2015) and Ngoma and Chanda (2022), the study proposes a two-step approach in determining the extent of monetary policy pass-through to market interest rates outlined in equations 2 and 5 by making modifications to equation 1.

Step 1: Pass-Through to Interbank Rate from the Policy Rate

In step 1, the pass-through is determined from the policy rate to the interbank rate (operating target) as follows:

$$ibr_t = \beta_0 + \beta_1 pr_t + \varepsilon_t \tag{2}$$

$$\Delta ibr_t = \delta_0 ecm_{t-1} + \textstyle\sum_{K=0}^{N} \delta_1 \Delta ibr_{t-K} + \sum_{K=0}^{N} \delta_2 \Delta pr_{t-K} + \delta_3 dum + \mu_t \tag{3}$$

where ibr_t is the interbank rate; pr_t is the BoZ policy rate; β_1 is the coefficient measuring the pass-through from the policy rate to the interbank rate; $ecm_{t-1} = ibr_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 pr_{t-1}$ is the error correction term measuring period $t-1$ deviation from the long-run stationary relationship through coefficient δ_0; dum is a binary dummy variable capturing the episodes when the interbank rate deviated from the policy rate and breached the policy corridor; ε_t and μ_t are the error terms and Δ is the difference operator.

Equation 2 measures the long-run relationship while equation 3 is the short-run relationship for the two variables under study***.***

Equation 4 illustrates the average long-run elasticity of the interbank rate with respect to the policy rate:

$$\text{Long-run pass-through elasticity } = \beta_1 \frac{mean(Policy\ Rate)}{mean(Interbank\ Rate)} \tag{4}$$

Step 2: Pass-Through to Market Interest Rates from the Interbank Rate

Step 2 captures the extent of the pass-through from the interbank rate to market interest rates and is specified as follows:

$$mr_t = \theta_0 + \theta_1 ibr_t + \varepsilon_t \tag{5}$$

$$\Delta mr_t = \alpha_0 ecm_{t-1} + \sum_{K=0}^{K} \alpha_1 \Delta mr_{t-K} + \sum_{K=0}^{K} \alpha_2 \Delta ibr_{t-K} + dum + \mu_t \tag{6}$$

where mr_t is a measure of the market interest rate that include commercial bank retail rates (cbr_t), government bond yield rates (br_t) and Treasury bills yield rates (tbr_t); ibr_t is the interbank rate; θ_1 is the coefficient measuring the degree of pass-through from the interbank rate to market interest rates; *dum* is a binary dummy variable accounting for occurrences when the interbank rate deviated from the policy rate and breached the policy corridor as well as selected structural breaks, mostly pertaining to government securities yield rates; $ecm_{t-1} = mr_{t-1} - \theta_0 - \theta_1 ibr_{t-1}$ is the error correction term measuring period $t-1$ deviation from the long-run stationary relationship through coefficient θ_0; ε_t and μ_t are the error terms and Δ is the difference operator.

The long-run pass-through elasticity calculated in the first step (equation 4) is replicated in the second step as:

$$\text{Long-run pass-through elasticity } = \theta_1 \frac{mean(Interbank\ Rate)}{mean(market\ Interest\ Rates)} \tag{7}$$

As argued by Chileshe and Akanbi (2016), the response of market rates differs with respect to the type of policy (tight or loose) stance undertaken by the central bank. This asymmetric response to policy adjustment could be associated with prices being rigid downwards and relatively more flexible upwards. To analyse the asymmetric response of market rates to the BoZ policy rate, literature (Aziakpono, 2010; Chileshe and Akanbi, 2016; Ngoma and Chanda, 2022) suggests splitting the residuals from equation 5 into positive and negative as follows:

$$ecm_{t-1}^{+} = ecm_{t-1} \text{ if } ecm_{t-1} > \mu$$

$$ecm_{t-1} = 0 \quad \text{if} \quad ecm_{t-1} < \mu \tag{8}$$

and

$$ecm_{t-1}^{-} = ecm_{t-1} \text{ if } ecm_{t-1} < \mu$$

$$ecm_{t-1} = 0 \quad \text{if} \quad ecm_{t-1} > \mu \tag{9}$$

where μ is the mean of the residual from the cointegration equation. The asymmetric specifications in equations 8 and 9 are introduced as separate dummy variables in the error correction model to obtain an asymmetric short-run dynamic equation specified as:

$$\Delta mr_t = \alpha_0 + \sum_{K=1}^{K} \alpha_1 \Delta mr_{t-K} + \sum_{K=1}^{K} \alpha_2 \Delta ibr_{t-K} + \alpha_3 ecm_{t-1}^{+} + \alpha_4 ecm_{t-1}^{-} + \varepsilon_t \qquad (10)$$

where α_3 and α_4 are coefficients of the error correction term representing policy rate increases and declines, respectively. The Wald test is carried out to establish the equality between the coefficients of the two error correction terms (positive and negative). Asymmetry is confirmed if the null hypothesis of $\alpha_3 = \alpha_4$ is rejected at a particular significance level.

Consistent with Abou-Stait (2005), in instances where there was no cointegrating relationship (no long-run relationship), a VAR in first difference is estimated as shown in the equation 11.

$$\Delta mr_t = \alpha_0 + \sum_{K=1}^{K} \alpha_1 \Delta mr_{t-K} + \sum_{K=1}^{K} \alpha_2 \Delta ibr_{t-K} + \varepsilon_t \qquad (11)$$

Estimation Strategy

This study employed the cointegration approach similar to Mbotwe (2015), Das (2015) and Ngoma and Chanda (2022), to estimate equations 2 and 5. The appropriate lag length is chosen in accordance with the information criteria. Ordinary least squares (OLS) was used to estimate the short-run equations.

Cointegration techniques developed by Engle and Granger (1987) and Johansen and Juselius (1994) are widely used when variables are integrated of the same order. To this effect, the study used the Johansen cointegration method. As argued by Ngoma and Chanda (2022), unlike the Engle and Granger approach, which involves an estimator obtained in two stages where possible errors introduced in the first stage are transferred to the second stage, the Johansen cointegration method is based on estimates of the matrix rank and its eigenvalues are obtained in a single stage. Further, unlike the Engle-Granger approach to cointegration that is sensitive to normalization and can result in conflicting conclusions depending on the variable chosen as the dependent variable, the Johansen test results by contrast is invariant to the choice of the variable selected for normalization and this avoids conflicting of conclusions. It is also easy to derive an error correction model under this approach through a simple linear transformation, which integrates short-run adjustments with long-run equilibrium without losing long-run information.

Data Description and Sources

The study used monthly data for the period April 2012 to July 2023 corresponding to the period the monetary policy regime changed to interest rate targeting from the previous monetary aggregate targeting framework. Data variables include the policy rate (represents the central bank's target interest rate and is a fundamental factor in understanding the transmission of monetary policy changes), interbank rate (reflect the cost of borrowing and lending between banks), lending rate (indicate the cost of borrowing for businesses and consumers, which is essential for assessing the real-world impact of policy changes), deposit rate[5] (influence savings and investment decisions making them a relevant factor in understanding the pass-through mechanism), Treasury bill yield rates (serve as a benchmark for short-term risk-free rates) and government bond yields rates (critical for evaluating longer-term interest rate movements and their effect on various sectors of the economy). The data source for all the variables was the BoZ.

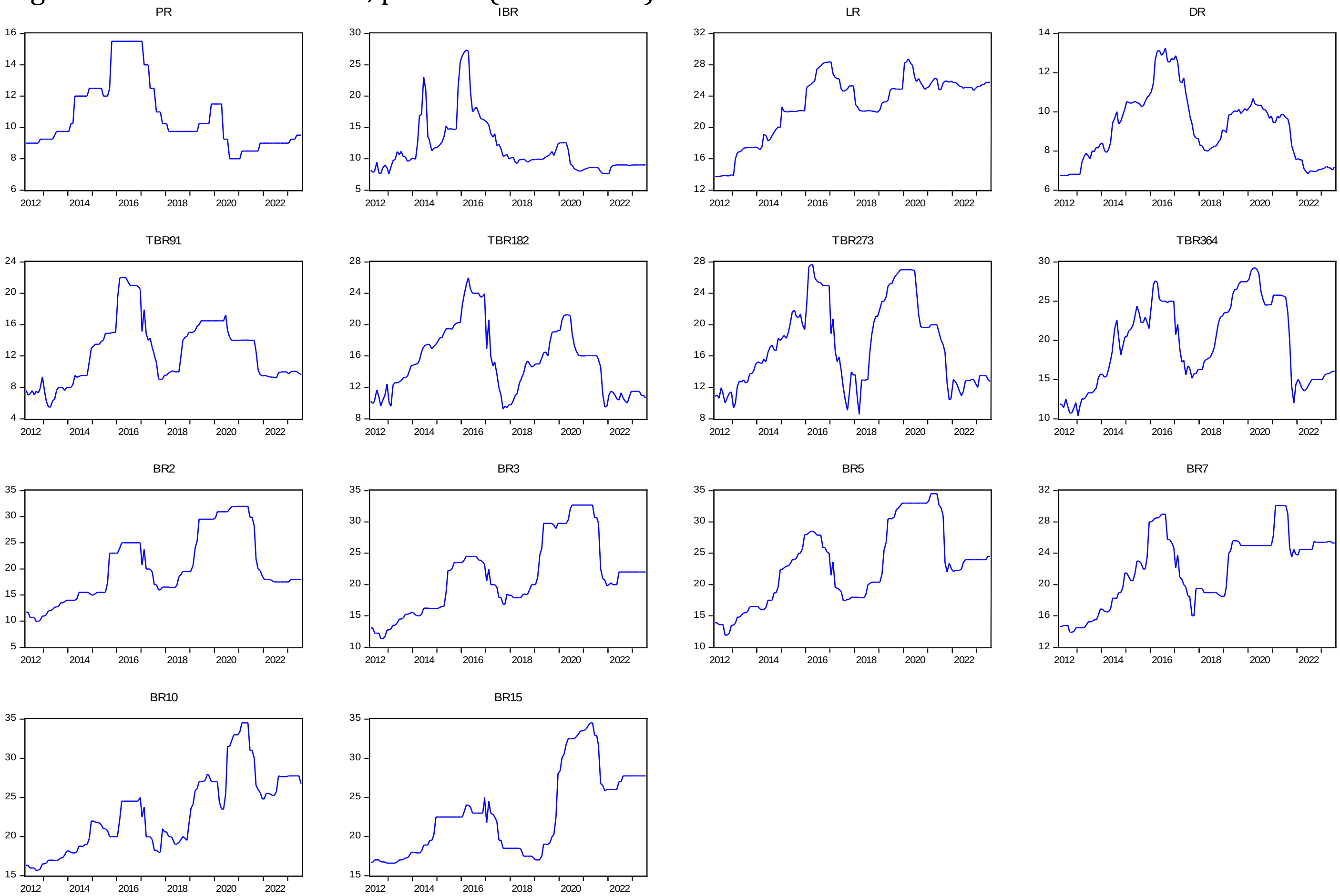
Table 1: Variable Description

Variable	Description
pr_t	policy rate
ibr_t	interbank rate
lr_t	lending rate
dr_t	deposit rate
tbr91	91-day Treasury bills yield rate
tbr182	182-day Treasury bills yield rate
tbr273	273-day Treasury bills yield rate
tbr364	364-day Treasury bills yield rate
br2	2-year government bond yield rate
br3	3-year government bond yield rate
br5	5-year government bond yield rate
br7	7-year government bond yield rate
br10	10-year government bond yield rate
br15	15-year government bond yield rate

Source: Bank of Zambia and Authors' compilation

[5] The 180-day deposit rate is used in the study as it is relatively more responsive to policy rate changes. The other deposit rates are the 30-,60-, 90- and 364-day deposit rates.

Figure 2: Interest rates data, percent (2012-2023)



Source: Bank of Zambia and Authors' compilation

A visual inspection of the time plots (at level) in Figure 2 shows that the policy rate and interbank rate have broadly trended downwards after peaking in between 2015 and 2016. Similarly, despite being relatively more volatile, the 180-day deposit rate has generally tracked movements in the policy rate and interbank rate. However, the average lending rate has maintained an upward trend over the sample period. For the Government securities yield rates, the movements in the 91- and 182-day treasury bill yield rates largely align with the monetary policy-controlled interest rates (policy rate and interbank rate) while the 273- and 364-day treasury bill yields rate have been relatively more volatile after 2015. The time plots also reveal that bond yield rates have broadly been on an upward trajectory over the sample period, recording sharp increases after 2018 before peaking around 2021.

5 Empirical Results and Discussion

To avoid establishing spurious relationships, unit root tests were conducted using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). They provide critical insights into the stationarity characteristics of the variables under investigation. Table 2 shows that all the variables are stationary at first difference, thus are integrated of order one (I(1)). This signifies that these variables exhibit non-stationary behavior at level, but become stationary after taking the first difference.

Table 2: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity results

	ADF (p-value)			PP (p-value)		
	Level	First Difference	Order of Integration	Level	First Difference	Order of Integration
pr	0.5694	0.0000***	I(1)	0.591	0.0000***	I(1)
ibr	0.4945	0.0000***	I(1)	0.388	0.0000***	I(1)
dr	0.6078	0.0000***	I(1)	0.5999	0.0000***	I(1)
lr	0.9315	0.0000***	I(1)	0.9109	0.0000***	I(1)
tbr91	0.5368	0.0000***	I(1)	0.5466	0.0000***	I(1)
tbr182	0.4779	0.0000***	I(1)	0.5328	0.0000***	I(1)
tbr273	0.5146	0.0000***	I(1)	0.5342	0.0000***	I(1)
tbr364	0.5643	0.0000***	I(1)	0.5947	0.0000***	I(1)
br2	0.6085	0.0000***	I(1)	0.6074	0.0000***	I(1)
br3	0.7127	0.0000***	I(1)	0.6796	0.0000***	I(1)
br5	0.7905	0.0000***	I(1)	0.6895	0.0000***	I(1)
br7	0.825	0.0000***	I(1)	0.7913	0.0000***	I(1)
br10	0.8267	0.0000***	I(1)	0.7977	0.0000***	I(1)
br15	0.7613	0.0000***	I(1)	0.7895	0.0000***	I(1)

****, **, and * imply 1 percent, 5 percent and 10 percent levels of significance, respectively. The deterministic terms for the unit roots tests were constant and trend.*
Source: Authors compilation.

It is pertinent to test for cointegration since the variables under examination are all integrated of order 1. In this case, the Johansen methodology is employed. The study primarily focuses on investigating the pass-through from the policy rate to the interbank rate and in turn to market interest rates.

The Johansen cointegration test involves the utilization of an unrestricted VAR. In the estimation of the VAR, lag length selection criteria are used to determine the optimal number of lags. This is to ensure that the model captures the dynamic relationships within the data effectively. The selection of the optimal lag length is conducted through the consideration of several information criteria. The study determines the lag structure that best fits the data while taking into account problems such as overfitting and underfitting. Tables 3 - 5 present lag lengths ranging from 2 to 5.

Table 3: VAR lag order selection criteria- Policy Rate, Interbank Rate and Commercial Bank Interest Rates

	lag	logl	lr	fpe	aic	sc	hq
pr to ibr	0	-580.27	0.00	24.87	8.89	8.93	8.91
	1	-313.30	521.71	0.45	4.87	5.01	4.93
	2	-292.20	40.58	0.35	4.61	4.837*	4.70
	3	-285.86	12.02	0.33	4.58	4.89	4.70
	4	**-273.46**	**23.09***	**0.295***	**4.440***	**4.84**	**4.61***
	5	-272.63	1.52	0.31	4.50	4.98	4.69
ibr to lr	0	-724.70	na	245.75	11.18	11.22	11.20
	1	-357.59	717.29	0.92	5.59	5.73*	5.65
	2	-350.80	13.05	0.88	5.55	5.77	5.64*
	3	-347.64	5.98	0.89	5.56	5.87	5.69
	4	-345.39	4.19	0.92	5.59	5.99	5.75
	5	**-338.26**	**13.03***	**0.87***	**5.54***	**6.03**	**5.74**
	6	-336.57	3.06	0.91	5.58	6.15	5.81
ibr to lr	0	-598.34	na	32.78	9.17	9.21	9.18
	1	-245.64	689.26	0.16	3.84	3.97*	3.90
	2	-236.13	18.28*	0.14	3.75	3.97	3.85*
	3	**-231.81**	**8.17**	**0.14***	**3.75***	**4.06**	**3.87**
	4	-228.35	6.44	0.14	3.761	4.15	3.92
	5	-224.60	6.86	0.14	3.76	4.24	3.96

Note: logl is log likelihood, lr is likelihood ratio, fpe is final prediction error, aic is akaike information criterion, sc is schwarz information criterion (or bic - bayesian information criterion) and hq is hannan-quinn information criterion.
Source: Authors compilation

Table 4: VAR lag order selection criteria- Interbank Rate and Treasury Bill Yield Rates

	lag	logl	lr	fpe	aic	sc	hq
Ibr to tbr91	0	-722.59	na	218.48	11.06	11.11	11.08
	1	-406.95	616.82	1.88	6.30	6.43*	6.36
	2	-399.54	14.26	1.78	6.25	6.47	6.34*
	3	-394.91	8.77	1.76	6.24	6.55	6.37
	4	-393.41	2.78	1.83	6.28	6.68	6.44
	5	**-384.43**	**16.46***	**1.69***	**6.20***	**6.69**	**6.40**
Ibr to tbr182	0	-707.98	na	174.79	10.84	10.88	10.86
	1	-428.92	545.34	2.62	6.64	6.77*	6.69
	2	**-420.53**	**16.13***	**2.45***	**6.57***	**6.79**	**6.66***
	3	-418.37	4.09	2.52	6.60	6.91	6.73
	4	-415.08	6.13	2.55	6.61	7.01	6.77
	5	-412.66	4.44	2.61	6.64	7.12	6.83
Ibr to tbr273	0	-769.49	na	447.04	11.78	11.82	11.80
	1	-459.46	605.84	4.18	7.11	7.24	7.16
	2	**-448.91**	**20.29***	**3.78***	**7.01***	**7.23***	**7.10***
	3	-447.11	3.41	3.91	7.04	7.35	7.16
	4	-445.55	2.91	4.06	7.08	7.47	7.24
	5	-442.52	5.56	4.12	7.09	7.57	7.29
ibr to tbr364	0	-770.74	na	455.71	11.80	11.84	11.82
	1	-436.28	653.61	2.93	6.75	6.88	6.81
	2	**-419.79**	**31.71***	**2.43***	**6.56***	**6.78***	**6.65***
	3	-416.58	6.08	2.46	6.57	6.88	6.70
	4	-414.32	4.22	2.52	6.60	7.00	6.76
	5	-411.31	5.52	2.56	6.62	7.10	6.81

Note: logl is log likelihood, lr is likelihood ratio, fpe is final prediction error, aic is akaike information criterion, sc is schwarz information criterion (or bic - bayesian information criterion) and hq is hannan-quinn information criterion.
Source: Authors compilation

Table 5: VAR lag order selection criteria- Interbank Rate and Government Bonds Yield Rates

	lag	logl	lr	fpe	aic	sc	hq
ibr to br2	0	-806.19	na	782.87	12.34	12.38	12.36
	1	-437.05	721.37	2.97	6.76	6.89*	6.82
	2	-428.36	16.71	2.76	6.69	6.91	6.78*
	3	-422.82	10.49*	2.70	6.67	6.98	6.79
	4	**-418.77**	**7.53**	**2.69***	**6.66***	**7.06**	**6.83**
	5	-416.44	4.28	2.77	6.69	7.18	6.89
ibr to br3	0	-795.04	na	660.32	12.17	12.21	12.19
	1	-424.13	724.83	2.44	6.57	6.70	6.62
	2	**-412.98**	**21.4***	**2.18***	**6.45***	**6.67***	**6.54***
	3	-411.11	3.54	2.26	6.49	6.80	6.62
	4	-407.30	7.10	2.27	6.49	6.89	6.65
	5	-405.35	3.56	2.34	6.52	7.01	6.72
ibr to br5	0	-800.76	na	720.67	12.26	12.30	12.27
	1	-432.97	718.75	2.79	6.70	6.83*	6.76
	2	**-424.28**	**16.72***	**2.59***	**6.63***	**6.85**	**6.719***
	3	-420.96	6.29	2.62	6.64	6.95	6.77
	4	-417.08	7.22	2.63	6.64	7.04	6.80
	5	-414.50	4.73	2.69	6.66	7.15	6.86
Ibr to br7	0	-756.05	na	364.14	11.57	11.62	11.59
	1	-419.60	657.48	2.28	6.50	6.62*	6.55
	2	**-410.72**	**17.10***	**2.11***	**6.42***	**6.64**	**6.512***
	3	-410.00	1.36	2.22	6.47	6.78	6.60
	4	-407.70	4.28	2.28	6.50	6.89	6.66
	5	-405.39	4.24	2.34	6.52	7.01	6.72
Ibr to br10	0	-766.79	na	429.02	11.74	11.78	11.76
	1	-425.04	667.84	2.47	6.58	6.712*	6.63
	2	**-415.33**	**18.68***	**2.26***	**6.49***	**6.71**	**6.58***
	3	-413.63	3.21	2.35	6.53	6.84	6.65
	4	-412.01	3.02	2.43	6.57	6.96	6.73
	5	-409.58	4.45	2.49	6.59	7.07	6.79
Ibr to br15	0	-781.75	na	539.06	11.97	12.01	11.98
	1	-407.39	731.56	1.89	6.31	6.44*	6.36
	2	-399.73	14.75	1.79	6.26	6.47	6.34
	3	**-392.26**	**14.14***	**1.69***	**6.20***	**6.51**	**6.32***
	4	-389.52	5.10	1.73	6.22	6.62	6.38
	5	-387.46	3.79	1.78	6.25	6.73	6.45

Note: logl is log likelihood, lr is likelihood ratio, fpe is final prediction error, aic is akaike information criterion, sc is schwarz information criterion (or bic - bayesian information criterion) and hq is hannan-quinn information criterion.

Source: Authors compilation

The trace test results in Tables 6 show that there is a cointegrating relationship between the policy rate and interbank rate. There is also cointegration between the interbank rate and commercial bank retail rates (Table 6) as well as with Treasury bill yield rates (Table 7). However, except for the 2-year bond, the results indicate that there is no cointegrating relationship between the interbank rate and yields on government bonds (Table 8).

Table 6: Cointegration Test for Commercial Bank Retail Rates

unrestricted cointegration rank test (trace)

	Null Hypothesis	Alternative hypothesis	Eigenvalue	Statistics	95% critical value
pr to ibr	$r = 0$	$r > 1$	0.21	35.50	20.26
	$r < 1$	$r > 2$	0.03	4.05	9.16
ibr to lr	$r = 0$	$r > 1$	0.20	35.90	25.87
	$r < 1$	$r > 2$	0.05	6.88	12.52
ibr to dr	$r = 0$	$r > 1$	0.12	20.27	15.49
	$r < 1$	$r > 2$	0.02	2.78	3.84

Source: Authors compilation

Table 7: Cointegration Test for Treasury Bill Yield Rates

unrestricted cointegration rank test (trace)

	Null Hypothesis	Alternative hypothesis	Eigenvalue	Statistics	95% critical value
ibr to tbr91	$r = 0$	$r > 1$	0.24	41.08	20.26
	$r < 1$	$r > 2$	0.04	5.98	9.16
ibr to tbr182	$r = 0$	$r > 1$	0.14	27.18	20.26
	$r < 1$	$r > 2$	0.05	6.87	9.16
ibr to tbr273	$r = 0$	$r > 1$	0.18	32.71	20.26
	$r < 1$	$r > 2$	0.05	6.52	9.16
ibr to tbr364	$r = 0$	$r > 1$	0.15	31.16	25.87
	$r < 1$	$r > 2$	0.06	8.84	12.52

Source: Authors compilation

Table 8: Cointegration Test for Government Bond Yield Rates

unrestricted cointegration rank test (trace)

	Null Hypothesis	Alternative hypothesis	trace statistic	Statistics	95% critical value
ibr to br2	$r = 0$	$r > 1$	0.11	22.43	20.26
	$r < 1$	$r > 2$	0.05	6.66	9.16
ibr to br3	$r = 0$	$r > 1$	0.05	10.40	15.49
	$r < 1$	$r > 2$	0.03	3.65	3.84
ibr to br5	$r = 0$	$r > 1$	0.05	9.99	15.49
	$r < 1$	$r > 2$	0.03	3.40	3.84
ibr to br7	$r = 0$	$r > 1$	0.05	10.19	15.49
	$r < 1$	$r > 2$	0.03	3.67	3.84
ibr to br10	$r = 0$	$r > 1$	0.05	11.32	15.49
	$r < 1$	$r > 2$	0.03	3.81	3.84
ibr to br15	$r = 0$	$r > 1$	0.06	11.11	15.49
	$r < 1$	$r > 2$	0.02	2.77	3.84

Source: Authors compilation

With the exception of the normality test in the deposit rate and 2-year bond rate equations, the models generally passed all diagnostic tests (Table 9). Despite this, the findings are appropriate for policy use as the Johansen cointegration method can withstand non-normal errors (Diouf, 2007).

According to Engle and Granger (1987), an error correction model (ECM) is estimated in cases where a cointegrating relationship is established. Table 9 depicts that in the long-run, the interbank rate adjusts fully in response to the policy rate increase. This result is similar to Sande and Okello (2013) for Uganda, Chileshe and Akanbi (2016) and Ngoma and Chanda (2022) for Zambia. The complete pass-through is due to the BoZ active use of open market operations in steering the interbank as close as possible to the policy rate (Chanda and Ngoma, 2022). The policy rate coefficient of 1.34 percent in the interbank rate equation, which corresponds to a long-run pass-through elasticity of 1.24 percent, indicates overpass-through. This implies that commercial banks tend to charge each other higher interest rates to offset counterparty risks resulting from asymmetric information rather than reduce the supply of loans (Aziakpono and Wilson, 2013; Chipili, et al., 2019). This finding underscores the importance of understanding the dynamics of interest rate pass-through in monetary policy formulation and its implications for the broader economy (Gurkaynak et al., 2010).

Table 9: Long-Run Cointegration Test Results

	constant	β	long-run pass-through elasticity	level of pass-through
Policy Rate Pass-Through to Interbank Rate				
	2.74	1.34(19.2) ***	1.24	over pass-through
Interbank Rate Pass-Through to Commercial Bank Retail Rates				
dr	3.15	0.52(6.10) ***	0.66	incomplete pass-through
lr	8.69	0.70(8.42) ***	0.36	incomplete pass-through
Interbank Rate Pass-Through to Treasury Bills Yield Rates				
tbr91	6.26	0.87(17.5) ***	0.81	incomplete pass-through
tbr82	5.66	0.72(7.53) ***	0.55	incomplete pass-through
tbr273	8.73	0.46(4.57) ***	0.31	incomplete pass-through
tbr364	11.76	0.32(3.11) ***	0.19	incomplete pass-through
Interbank Rate Pass-Through to Bond Yield Rates				
br-2	21.54	0.25(1.12)	0.23	weak pass-through
br-3	no cointegrating relationship			no pass-through
br-5	no cointegrating relationship			no pass-through
br-7	no cointegrating relationship			no pass-through
br-10	no cointegrating relationship			no pass-through
br-15	no cointegrating relationship			no pass-through

ibr equation, LM serial correlation test: F-stat=0.48 [0.75], Normality test: $\chi^2(1)$ =3.74 [0.05]**, and Heteroskedasticity test: F-stat =0.63 [0.84]; lr equation, LM serial correlation test: F-stat=0.58 [0.68], Normality test: $\chi^2(1)$ =38.41[0.00]***, and Heterosekedasticity test: F-stat =0.90 [0.87], dr equation, LM serial correlation test: F-stat=1.43 [0.22], Normality test: $\chi^2(1)$ =0.02[0.89], and Heterosekedasticity test: F-stat =0.75 [0.74], tbr91 equation, LM serial correlation test: F-stat=1.43 [0.22], Normality test: χ^2 (1) =0.02[0.89], and Heteroskedasticity test: F-stat =0.75 [0.74]; tbr182 equation LM serial correlation test: F-stat=0.89 [0.47], Normality test: χ^2 (1) =3.76 [0.05]**, and Heterosekedasticity test: F-stat =1.40 [0.13]; tbr273 equation, LM serial correlation test: F-stat=0.94 [0.44]; Normality test: χ^2 (1) =24.70 [0.00]***; and Heterosekedasticity test: F-stat =1.46 [0.19]; tbr364 equation, LM serial correlation test: F-stat=0.91 [0.46], Normality test: $\chi^2(1)$ =3.76 [0.05]**, and Heterosekedasticity test: F-stat =1.06 [0.39]; Br2 equation, LM serial correlation test: F-stat=0.83 [0.65], Normality test: $\chi^2(1)$ =14.68 [0.02]**, and Heterosekedasticity test: F-stat =1.11 [0.51]. VAR stability test-Appendix, Table II.

****, **, and * imply 1 percent, 5 percent and 10 percent levels of significance, respectively; ( ) represent t-statistic; [] represent p-value.*

Source: Authors compilation

The pass-through to commercial bank retail rates (lending and deposit rates) is incomplete in contrast to the interbank rate full response to the policy rate. Consistently, this result reinforces that lending and deposit rates are sticky (Aziakpono and Wilson, 2013; Zgambo and Chileshe, 2014; Das, 2015; Mbowe, 2015; Ngoma and Chanda, 2022). The respective coefficients on lending and deposit rates of 0.70 percent and 0.52 percent correspond to average long-run pass-through elasticities of 0.36 percent and 0.66 percent (Table 9). As argued by Ngoma and Chanda (2022), this implies that commercial banks consider other factors rather than shifts in the interbank rate as more important in setting lending and deposit rates. Therefore, elasticities of less than 1 percent signify that commercial banks may only partially transmit changes in the interbank rate to lending rates, which is consistent with incomplete pass-through dynamics (Ehrmann et al., 2001; Jimenez et al., 2008). This can be explained by commercial banks' market power, which tends to lessen the pass-through as low competition in the banking sector reduces available substitutes for bank loans and deposits making their demand more inelastic. Commercial banks with high market power may maintain lending rates when the policy rate is reduced to increase profitability (Maravalle and Pandiel, 2022). The average long-run pass-through elasticity on the deposit rate is greater than that of lending rate as expected owing to the difference in maturities. The heterogeneity in pass-through is correlated with maturity since the relationship between the policy rate and commercial bank rates tends to be weaker with longer maturities (Beyer, et al., 2024). Longer-term loans are impacted by various factors, including term premia[6]. For instance, the deposit rate in this study is for 180 days while loans typically have longer maturities. Deposit rates are typically a component of a bank's cost of funds which has an impact on lending costs. On the other hand, lending rates are influenced by factors beyond monetary policy such as term premia on longer maturities.

Similar to the pass-through from the interbank rate to lending and deposit rates, Treasury bill yield rates exhibit incomplete pass-through (Table 9). This result is consistent with Ojaghlou and Soztanaci (2022). The pass-through is strongest at the lower end of the Treasury bill yield curve and weakens as the tenor increases. This suggests that Treasury bills with longer maturities experience a more subdued response to interbank rate fluctuations, which is in line with the idea that longer-term instruments may be strongly influenced by other factors affecting their return. The return on longer dated Treasury bills is broadly impacted by term premia. Factors associated with term premia may include fiscal risk based on the following: structural variables that set the natural interest rate, cyclical factors that follow the business cycle, and likelihood that nations will be able to meet their debt obligations (Michelson & Stein, 2023). This also applies to the government bonds.
As a result, in the case of the government bonds, as demonstrated by Ojaghlou and Soztanaci (2022), Table 9 shows that there is generally no pass-through from the interbank rate to government bonds. Broadly, the results reveal that there is no cointegrating relationship between the interbank rate and government bond yield rates except for the 2-year tenor. Despite having a cointegrating relationship, the long-run coefficient in the 2-year bond equation is statistically insignificant thus pointing to a weak pass-through. The lack of pass-through in this case may also in part be attributed to underdeveloped financial market in Zambia, which generally limits arbitrage opportunities. The primary means of transmitting the policy rate to bond yields is through bond market arbitrage. From a bank's perspective, an increase in the monetary policy controlled short-term interest rate such as interbank rates (caused, for instance, by contractionary open market operations) would result in less liquidity available for banks to purchase bonds, leading to higher bond yield rates (Ma, 2017). The transmission will be quicker in a developed financial market with plenty of efficient arbitrage instruments resulting in arbitrage between bonds with different maturities (Ma, 2017). This implies that with arbitrage, changes in the policy rate targeted at short-term interest rates can be swiftly transferred to yield rates on bonds with medium- and long-term maturities.

In the short-run, the policy rate has a contemporaneous effect on the interbank rate bearing a coefficient of 0.68 percent while its own lags have a cumulative positive effect of 0.50

[6] This term premium is typically the extra return (or risk premium) that investors want to offset the risk attached to a long-term financial asset.

percent (Table 10)[7]. This aligns with the conventional understanding of central bank policy influencing short-term interest rates (Kashyap et al.,1993). Furthermore, the pace at which the interbank rate returns to equilibrium after a shock is relatively fast, at 61 percent each month, indicating that deviations from the long-term equilibrium are eliminated quite quickly. The ability of interbank market to efficiently return to equilibrium over time is implied by this adjustment process (Bollerslev and Mikkelsen, 1996).

The short-run results show mixed implications of interbank rate changes for lending rates (Table 10). Interbank rate fluctuations contemporaneously raise the lending rate[8], but dampen it at lags 1 and 3. Conversely, at significant lags of 1 and 3, changes in the interbank rate have surprising negative associations with lending rates. This may be due to stickiness in lending rates that may tend to reluctantly respond to expansionary monetary policy in the short-run. This conflicts findings by Bollerslev and Mikkelsen (1996) and Ngoma and Chanda (2022). However, the weak impact of the interbank rate on lending rates is consistent with Ngoma and Chanda (2022) despite the contradictory negative relationship with lags. The results also reveal that the deposit rate tends to be contemporaneously impacted by the interbank rate. Further, the study confirms Ngoma and Chanda's (2022) finding that loan rates increased by over 60 basis points (0.6 percentage points) during the sample period due to the interbank rate notable departure from the corridor. Some significant deviation of the interbank rate from the policy rate were observed in 2014, 2015 and 2016, and are captured by dum_lr[9]. Furthermore, the speed of adjustment to equilibrium for lending and deposit rates after a shock is weak at 21 percent and 9 percent per month, respectively. In comparison with Ngoma and Chanda (2022), despite remaining weak, the results show that the speed of adjustment for lending rates has relatively improved while that of deposit rates remains the same[10].

[7] The reduction of the general model to obtain a parsimonious model was executed using autometrics, a computer-automated general-to-specific modeling approach in the oxmetric software under PCgive modelling.

[8] This relationship is in line with economic theory, which suggests that commercial banks often adjust their lending rates in response to changes in the interbank rate to maintainprofitability and manage risk (Peek and Rosengren, 1997).

[9] The economy faced severe inflationary pressures during the aforementioned periods, which were mostly caused by supply shocks and the sharp depreciation of the Kwacha, the country's currency. As a result, the central bank purposefully avoided engaging in expansionary open market operations even though the interbank rate increased and crossed the designated policy rate corridor. This was done to maintain tight liquidity conditions and reduce demand for foreign currency (Ngoma and Chanda, 2022).

[10] This study covers a wider sample space relative to Ngoma and Chanda (2022) of 2012-2019.

Table 10: Short-Run VECM for Commercial Bank Rates

Δpr to Δibr		Δibr to Δlr		Δibr to Δdr	
c	-025(2.88) *				
Δibr_{t-1}	0.34(5.61) *	Δlr_{t-3}	0.08(-0.744)	Δibr	0.05(2.93)**
Δibr_{t-3}	0.16(2.4) ***	Δibr	0.09(-2.53)**	ecm_dr	-0.09(5.38) ***
Δpr	0.68(3.93) ***	Δibr_{t-1}	-0.11(2.61) **		
Δpr_{t-1}	0.74(4.18) ***	Δibr_{t-3}	-0.12(2.94) **		
ecm_ibr	-0.61(11.0) ***	ecm_lr	-0.21(6.58) ***		
dum_ibr	4.20(8.22) ***	dum_lr	-0.64(4.16) ***		
LM Test	*0.60 [0.73]*	*LM Test*	*1.73 [0.12]*	*LM Test*	*2.02 [0.11]*
ARCH 1 test	*1.20[0.31]*	*ARCH 1 test*	*0.51[0.80]*	*ARCH 1 test*	*0.64[0.70]*
JB Normality test	3.41[0.18]	*JB Normality test*	17.56[0.02]**	*JB Normality test*	6.43[0.04]**
RESET test	0.85[0.43]	*RESET test*	0.35[0.71]	*RESET test*	2.30[0.11]

*t-values in brackets and p-values in parenthesis; ***, **, and * imply 1percent, 5percent and 10percent levels of significance.*

Source: Authors compilation

Regarding Treasury bill yield rates, the results in Table 11 show that monetary policy, measured by interbank rate fluctuations, has broadly a positive statistically significant contemporaneous and lagged impact on the Treasury bill yield curve. This is consistent with Ghartey (2005) and Kovanen (2011) in the case of Ghana. The contemporaneous statistically significant interbank rate coefficients for the 182-day and 273-day Treasury bill yield rates of 0.16 percent and 0.15 percent, respectively, support this. In addition, the interbank rate has a positive effect on the 91-day Treasury bill yield rate at the second lag.Treasury bill yield rates are also influenced by own past values. For instance, evidence shows a significant positive relationship for the 273-day and the 364-day Treasury bill yield rates with their past values at lag 2 while the 91-day and 182-day display a positive and statistically significant relationship with their past values at the initial lag. Counterintuitively, the study establishes a negative impact between the 91-day tenor and its fourth lag as well as the 182-day and its third lag. This may be attributed to varying investor expectations of future macroeconomic influences. The unbiased expectations hypothesis postulates that long-term interest rates are equal to the average of the current and expected short-term rates for the future (Hardisty, 2006). This could also be explained by the fact that yield rates are not entirely established by the market in the government securities primary auction. Given the nature of government securities auction system in Zambia, the government may select the cut-off of bids depending on financing needs, which may override prevailing monetary policy direction at that time[11]. Generally, the significance of dummy variables also shows that episodes of fiscal deterioration contributed to Treasury bill yield rates fluctuations.

The speed of adjustment to equilibrium following a shock range from 0.14 percent to 0.34 percent for Treasury bill yield rates. This is more aligned to the adjustment by lending rates relative to deposit rates. This in part is confirmation that Treasury bill yield rates are a key

[11] The method of single price auction is used to issue government bonds in Zambia. According to this approach, all successful bidders per tenor in a competitive auction are subject to the cut-off price with respect to Government's funding requirements (Nyirenda, 2022).

consideration in setting interest rates. Thus, the impact from monetary policy is similar to lending rates (Chileshe and Akanbi, 2016).

For the Government bonds, the interbank rate positively impacts the 2-year yield rate at lag 3 and 4 (Table 11). The speed of adjustment of 8 percent per month is similar to deposit rates. For the rest of the government securities yield rates, despite not having a long-term relationship with the interbank rate, their short- run fluctuations are mainly influenced by their own lagged values aside from the 7-year bond rate (Table 12). This exception shows that the change in the interbank rate has a contemporaneously positive impact on the 7-year bond rate in the short-run.

Table 11: Parsimonious Short-Run VECM for Government Securities

Δibr to Δtbr91		Δibr to Δtbr182		Δibr to Δtbr273		Δibr to Δtbr364		Δibr to Δbr2	
						c	-0.34(3.06)	c	-0.29(2.66)***
$\Delta tbr91_{t-2}$	0.08(0.95)	$\Delta tbr182_{t-1}$	-0.0871(1.11)	$\Delta tbr273_{t-1}$	0.21(2.79)**	$\Delta tbr364_{t-1}$	0.30(3.96)***	$\Delta br2_{t-1}$	-0.01(0.92)
$\Delta tbr91_{t-4}$	-0.16(2.14) **	$\Delta tbr182_{t-2}$	0.1417(1.82)*	Δibr_t	0.15(2.09) *	ecm_tbr364	-027(5.95)***		
Δibr_{t-2}	0.06(2.06) **	$\Delta tbr182_{t-3}$	-0.1379(1.77) *	ecm_tb273	-0.28(6.27)***	dum_tbr364	1.41(5.50)***	Δibr_{t-3}	0.03(0.459)***
Δibr_{t-4}	-0.13(2.42) **	Δibr_t	0.1598(2.63)***	dum_tbrr273	1.67(5.93)***			Δibr_{t-4}	0.07(1.02)***
ecmtbr91	-0.14(5.66) ***	ecm_tbr182	-0.3446(4.16) ***					dum_br2	1.01(5.76)***
dum_tbr91	0.76(5.25)***	dum_tbr91	0.7783(6.58) ***					ecm_br2	0.08(4.58)***
LM Test	*0.76[0.62]*	*LM Test*	*1.34[0.24]*	*LM test*	*1.99[0.06]*	*LM test*	*0.95[0.48]*	*LM test*	*0.50[0.80]*
ARCH 1 test	*0.96[0.47]*	*ARCH 1 test*	*1.98[0.06]*	*ARCH 1*	*1.65[0.11]*	*ARCH 1*	*1.45[0.193]*	*ARCH 1*	*0.19[0.99]*
JB Normality test	*65.760[0.00] ****	*JB Normality test*	*44.01[0.00]****	*JB Normality test*	*30.01[0.0000] ****	*JB Normality test*	*23.31[0.00] ****	*JB Normality test*	*137.42 [0.00]****
RESET test	*1.23 [0.30]*	*RESET test*	*1.89 [0.16]*	*RESET test*	*0.47 [0.62]*	*RESET test*	*0.18[0.84]*	*RESET test*	*0.72[0.18]*

*t-values in brackets; ***, **, and * imply 1 percent, 5 percent and 10 percent levels of significance, respectively.*
Source: Authors compilation

Table 12: Parsimonious VAR in First Difference for Government Bond Yield Rates

Δibr to Δbr3		Δibr to Δbr5		Δibr to Δbr7		Δibr to Δbr10		Δibr to Δbr15	
$\Delta br3_{t-1}$	0.23(2.43)**	$\Delta br5_{t-2}$	0.19(2.18)*	Δibr_br7	0.17(2.81)**	$\Delta br10_{t-1}$	0.18.(2.01)*	$\Delta br15_{t-2}$	0.31(3.77)***
$\Delta br3_{t-3}$	0.19(2.19)*	$\Delta br5_{t-3}$	0.19(2.16)*	dum_br7	0.34(2.72)**				
LM test	*0.54 [0.80]*	*LM test*	*0.99[0.44]*	*LM test*	*1.68 [0.12]*	*LM test*	0.71[0.66]	*LM test*	*0.57[0.77]*
ARCH 1	*0.19 [0.99]*	*ARCH 1*	*0.66 [0.70]*	*ARCH 1*	*0.40 [0.90]*	*ARCH 1*	0.52[0.82]	*ARCH 1*	*0.19[0.98]*
JB Normality test	*137.42[0.00]****	*JB Normality test*	*93.33[0.00]***	*JB Normality test*	*81.96[0.00]****	*JB Normality test*	115.18[0.00]**	*JB Normality test*	*312.93[0.00]***
RESET test	*1.72[0.18]*	*RESET test*	*2.38 [0.09]*	*RESET test*	*0.69 [0.50]*	*RESET test*	0.21[0.64]	*RESET test*	*0.46 [0.63]*

*t-values in brackets; ***, **, and * imply 1 percent, 5 percent and 10 percent levels of significance, respectively.*
Source: Authors compilation

The aforementioned findings originate from symmetrical models, which postulate the same response of interest rates to changes in monetary policy. Nonetheless, prior empirical research on the pass-through from the monetary policy rate to interest rates in Zambia has shown that economic agents react differently to a tight and loose stance (Chileshe and Akanbi, 2016; Ngoma and Chanda, 2022). To determine whether or not there is asymmetry in the adjustment of market rates, the Wald test is used to compare the positive and negative residual coefficients in the asymmetric error correction model to examine if they are statistically equal.

Generally, the Wald test results in Tables 13 and 14 reveal the existence of asymmetry in terms of the pass-through from the interbank rate to commercial bank retail rates and Government securities yield rates. Table 13 shows that the lending rate speed of adjustment coefficients of 0.37 percent for an expansionary and 0.12 percent for a contractionary monetary policy stance are both statistically significant. In general, Wald test in Tables 13 and 14 show that there is asymmetry in the way changes in the interbank rate are transmitted to retail rates and yield rates on government securities. The loan rate speed of adjustment of 0.12 percent for a contractionary monetary policy stance and 0.37 percent for an expansionary stance are both statistically significant (Table 13). This shows that when the interbank rate rises, lending rates adjust faster than when it falls.

Table 13: Asymmetric Short-Run VECM for Commercial bank Retail Rates

Δibr to Δlr		Δibr to Δdr	
c	0.28(3.28)**	*c*	
Δlr_{t-2}	-0.07(-0.82)	Δibr	0.05(2.93)**
Δlr_{t-3}	-0.07(-0.82)	ecm_dr+	0.07(1.62)
Δibr_{t-3}	-0.07(-1.97)	ecm_dr-	-0.09(-5.11)**
$ECM\_LR +$	0.37(5.52)**		
ecm_lr-	-0.12(-3.10)**		
dum_lr	0.77(4.67)**		
LM test:	*0.81 [0.56]*	*LM test:*	*2.01[0.07]*
ARCH 1 test	*0.40[0.87]*	*ARCH 1 test*	*0.48 [0.82]*
JB Normality test	*13.76[0.00]***	*JB Normality test*	*6.97 [0.03]***
RESET test	*0.37[0.69]*	*RESET test*	*3.46[0.07]*

*t-values in parentheses; probability values in brackets; ** imply 5 percent levels of significance.*

Source: Authors compilation

Table 14: Asymmetric Short-Run VECM for Government Securities

Δibr to Δtbr91		Δibr to Δtbr182		Δibr to Δtbr273		Δibr to Δtbr364		Δibr to Δbr2	
c	0.36(3.26)***	*c*		*c*		c	-0.48(-2.14)**	c	
$\Delta tbr91_{t-4}$	-0.17(-2.08)**	$\Delta tbr182_{t-1}$	-0.06(-0.79)	$\Delta tbr273_{t-1}$	0.20(2.72)**	$\Delta tbr364_{t-1}$	0.29(3.93)***	$\Delta br2_{t-2}$	0.24(2.84)***
Δibr_{t-4}	-0.09(-1.73)*	$\Delta tbr182_{t-2}$	0.14(1.75)*	Δibr	0.17(2.31)**	Δibr	0.13(2.18)**	ecm_br2+	0.12(3.21)***
ecm_tbr91+	0.23(6.83)***	Δibr	0.16(2.57)**	ecm_tbr273+	0.26(5.53)***	ecm_tbr364+	0.23(4.09)***	dum_br2	0.86(3.06)***
ecm_tbr91-	-0.04(-0.72)	ecm_tbr182+	0.22(4.43)***	ecm_tbr273-	-0.3(-5.83)***	ecm_tbr364-	-0.29(-4.32)***	ecm_br2-	-0.09(-1.37)
dum_tbr91	0.94(6.15)***	ecm_tbr182-	-0.25(-3.21)***	dum_tbr273	1.69(6.01)***	dum_tbr364	1.42(5.38)***		
		dum_tbr91	0.78(3.84)***						
wald test (ecm+=ecm-) p-value	0.05**	wald test (ecm+=ecm-) p-value	0.26	wald test (ecm+=ecm-) p-value	0.00***	wald test (ecm+=ecm-) p-value	0.05*	wald test (ecm+=ecm-) p-value	0.02**
LM test:	*0.84[0.56]*	*LM test:*	*1.89 [0.08] ***	*LM test:*	*1.98[0.06]**	*LM test:*	*0.61[0.75]*	*LM test:*	*0.73[0.64]*
ARCH 1 test	*0.46[0.86]*	*ARCH 1 test*	*1.91 [0.06] ***	*ARCH 1 test*	*1.75[0.11]*	*ARCH 1 test*	*1.15[0.34]*	*ARCH 1 test*	*0.33[0.94]*
JB Normality test	*46.61 [0.00]***	*JB Normality test*	*47.30 [0.00] ****	*JB Normality test*	*29.57[0.00]***	*JB Normality test*	*22.28[0.00] ****	*JB Normality test*	*134.27[0.00] ***
RESET test	*0.92[0.40]*	*RESET test*	*0.46[0.63]*	*RESET test*	*1.37[0.26]*	*RESET test*	*2.22[0.14]*	*RESET test*	*0.88[0.42]*

*t-values in parentheses; probability values in brackets; ***, **, and * imply 1 percent, 5 percent and 10 percent levels of significance, respectively.*

Source: Authors compilation

The only statistically significant coefficient is the error correction term for the deposit rate linked to expansionary monetary policy similar to Ngoma and Chanda (2022). This result implies that deposit rates do not follow the predicted path of the monetary policy stance, which may help to explain why they have stayed low for the course of the sample period. This outcome is comparable to findings in other regions noted by Das (2015), Mbowe (2015) and Aziakpono and Wilson (2014) in India, Tanzania and South Africa, respectively. As argued by Ngoma and Chanda (2022), profit maximization plays a crucial role in commercial bank interest rate determination, which could account for this asymmetric behavior. Therefore, to preserve their profit margins, commercial banks may delay changing deposit and lending rates during periods of expansionary and contractionary monetary policy, respectively.

Regarding the Government securities yield rates, there is a significant asymmetry in the adjustment process similar to commercial bank retail rates in response to monetary policy changes (Table 14). This result is consistent with Kovanen (2011) and Akosah (2015) for Ghana. Despite significant error correction terms for the 273-day and 364-day Treasury bill yield rates, the Wald test indicates that the coefficients for both rates are statistically different, indicating an asymmetric response. The speed of adjustment coefficients associated with the expansionary monetary policy stance are statistically significant for the 91-day Treasury bill and 2-year bond yield rates. This evidence suggests that monetary policy is more influential in controlling government securities yield rates with lower maturities during times of tightening. The monetary policy weak/lack of influence on longer term yield rates, in particular government bonds, can be attributed to absence of arbitrage in the underdeveloped financial markets in Zambia.

Robustness Check

As a robustness check, a long-run direct estimation is assessed from the policy rate to commercial bank retail rates, as well as Treasury bill and bond yield rates. The results do not significantly defer from the two-step estimation approach. The pass-through from the policy rate to commercial bank retail rates is incomplete, with coefficients on the lending rate closer to 1 than that of the deposit rate (Table 15). This signifies a strong pass-through as expected given that lending rates are composed of the policy rate plus other risk factors. The transmission to the Treasury bills decays along the yield curve consistent with the two-step estimation via the interbank rate. The coefficient for the 273-day Treasury bill is statistically insignificant while no cointegration is established in the case of the 364-day, both scenarios reflecting no pass-through. Similarly, no cointegration is established for the bond yield curve.

Table 15: Policy Rate Pass-Through to Market interest Rates

	constant	β	long-run pass-through elasticity	level of pass-through
Policy Rate Pass-through to Commercial Bank Retail Rates				
lr	11.14	0.91 (2.95)***	0.46	incomplete pass-through
dr	3.31	0.56(2.26)***	0.71	incomplete pass-through
Policy Rate Pass-through to Treasury bills yield rates				
tbr91	4.01	0.79 (5.40)***	0.74	incomplete pass-through
tbr82	11.16	0.61(2.43)***	0.46	incomplete pass-through
tbr273	14.12	0.32 (1.07)	0.21	weak pass-through
tbr364	no cointegrating relationship			no pass-through
Policy Rate Pass-through to Bond yield rates				
br-2	no cointegrating relationship			no pass-through
br-3	no cointegrating relationship			no pass-through
br-5	no cointegrating relationship			no pass-through
br-7	no cointegrating relationship			no pass-through
br-10	no cointegrating relationship			no pass-through
br-15	no cointegrating relationship			no pass-through

*t-values in brackets; ***, **, and * imply 1 percent, 5 percent and 10 percent levels of significance; ( ) represent t-statistic.*

Source: Authors compilation

6 Conclusion

This study examined monetary policy transmission in Zambia by extending Ngoma and Chanda's (2022) investigation to the term structure of government securities yield rates beyond commercial bank retail rates. Specifically, the study focused on uncovering evidence regarding how commercial bank retail rates and government securities yield rates respond to monetary policy adjustments. The empirical analysis was conducted in two stages: the first phase examined how the interbank rate responds to changes in the policy rate, and the second phase investigated how commercial bank retail rates and government securities yield rates respond to changes in the interbank rate resulting from a change in monetary policy. In this manner, it is possible to understand the immediate impact, short- and long-term effects of a change in the policy rate on market interest rates.

A Johansen cointegration approach was carried out to establish the long-run relationship using monthly data from April 2012 to July 2023. The study used the vector error correction model where cointegration was established to determine short-run dynamics. In cases of no cointegration, a vector autoregression in first difference was applied.

According to the empirical estimates, the interbank rate responds fully to policy rate adjustments consistent with previous research conducted in Zambia (Chileshe and Akanbi, 2016; Ngoma and Chanda, 2022). The over pass-through is attributed to the Bank of Zambia active utilization of open market operations to synchronize the interbank rate with the policy rate. However, there is incomplete pass-through to the commercial bank retail rates (lending and deposit rates). The results are comparable to findings by Aziakpono and Wilson (2013), Zgambo and Chileshe (2014), Das (2015), Mbowe (2015), Ngoma and Chanda (2022). This finding consistently underscores the inflexibility of lending and deposit rates and highlights that commercial banks consider other factors other than changes in the interbank rate when setting lending and deposit rates. The incomplete pass-through to lending rates can be attributed to commercial banks' market power, those with substantial market power may maintain stable lending rates when the policy rate decrease to enhance profits.

Similar to commercial bank retail rates, pass-through to Treasury bill yield rates is incomplete consistent with Ojaghlou and Soztanaci (2022) in Ghana. The pass-through is stronger for shorter-term Treasury bills and decays as the tenor increases, suggesting that longer-term bills may have other factors affecting their return. In contrast, there is no evidence of pass-through from the interbank rate to government bond yield rates. The only exception is the 2-year tenor, which has a cointegrating relationship, but with a statistically insignificant long-run coefficient, indicating weak pass-through. These results may be attributed to the underdeveloped financial market in Zambia, which restricts arbitrage opportunities. In a well-developed financial market, policy rate changes can swiftly impact bond yields, particularly for medium- and long-term maturities, through arbitrage mechanisms where increasing the policy rate reduces liquidity for banks to purchase bonds and in turn increases bond yield rates (Ma, 2017).

In the short-run, the study revealed that the policy rate has an immediate effect on the interbank rate, aligning with established views of central bank policy influence on short-term interest rates (Kashyap et al., 1993). The interbank rate quickly returns to equilibrium after a shock, reflected in the speed of adjustment of 61 percent each month (Bollerslev and Mikkelsen, 1996). Lending rates display mixed responses to changes in the interbank k rate. Interbank rate fluctuations contemporaneously raise the lending rate, but dampen it at lags 1 and 3. On the other hand, shifts in the interbank rate unexpectedly reduces lending rates at lags 1 and 3, conflicting with prior research by Bollerslev and Mikkelsen (1996) and Ngoma and Chanda (2022). The deposit rate is contemporaneously impacted by the interbank rate. Monetary policy, reflected in interbank rate fluctuations, also impacts Treasury bill yield rates (Ghartey, 2005; Kovanen, 2011; Akosah, 2015). The speed of adjustment for Treasury bill yield rates resembles that of lending rates. Government bond yield rates show varied responses, with the 2-year bond mainly influenced by lagged interbank rates and a relatively slow adjustment rate while other government securities yield rates depend on their own lagged values, except for the 7-year bond, which exhibits a short-term positive impact from the interbank rate.

The limitation of the study is that primary yield rates are used in place of secondary yield rates. Securities are created in the primary market (new government securities as well as re-issuances) while the secondary market is where they are traded among investors. In the primary market, the Government (issuer) determines the price of the securities based on financing needs, market conditions and demand. Conversely, in the secondary market, yield rates are broadly determined by demand and supply among investors. Thus, yield rates in the secondary market may reflect more information.

Regarding policy, the analysis shows that the influence of monetary policy beyond the interbank money market is weak. This may reflect lack of competition or other structural weaknesses in the financial system in Zambia. This reinforces the need for the Bank of Zambia to continue implementing structural reforms to enhance competition in the banking sector and interbank money market to improve the flow of funds among commercial banks

The influence of monetary policy on Government securities yield curve is more indirect through its impact on expectations of market participants about the future path of the policy rate (the signaling channel) and financing conditions. Thus, the weak or no pass-through from the policy rate to Government securities yield rates points to limited monetary policy influence on market expectations and ultimately long-term inflation expectations, thus impeding on the central bank's effective implementation of monetary policy.

It is therefore, imperative to implement measures to develop and deepen financial markets in Zambia as it is crucial for improving the transmission of monetary policy to government securities, especially for long-term bonds. This entails expanding the range of financial instruments available and enhancing the efficiency of arbitrage mechanisms. In a well-developed financial market with ample arbitrage opportunities, the transmission of policy rate changes to government bond yield rates, especially for longer-term maturities, can become more efficient. In addition, strategies to increase liquidity in the bond market to further facilitate smoother and more efficient arbitrage activities can be explored. Such measures are essential for changes in the policy rate to have a more pronounced impact on government securities yield rates.

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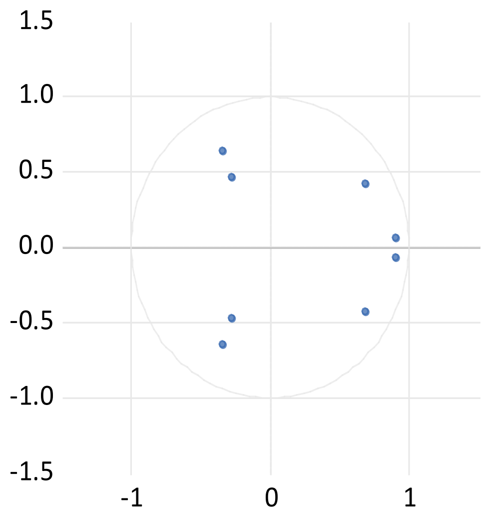
Appendix

Table I: VAR Stability Tests

Ibr pr

Inverse Roots of AR Characteristic Polynomial



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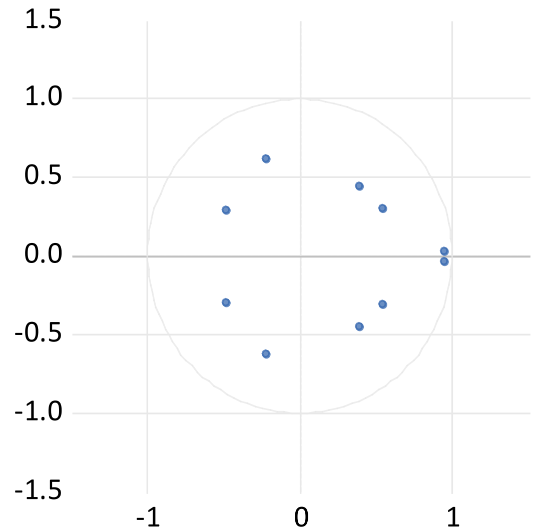
Inverse Roots of AR Characteristic Polynomial



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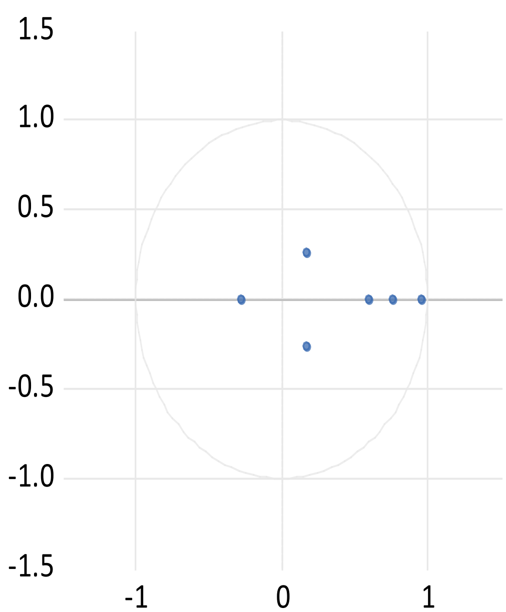
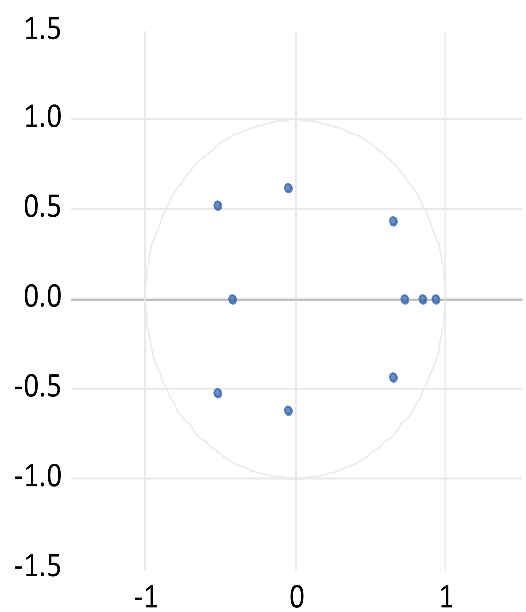
Inverse Roots of AR Characteristic Polynomial



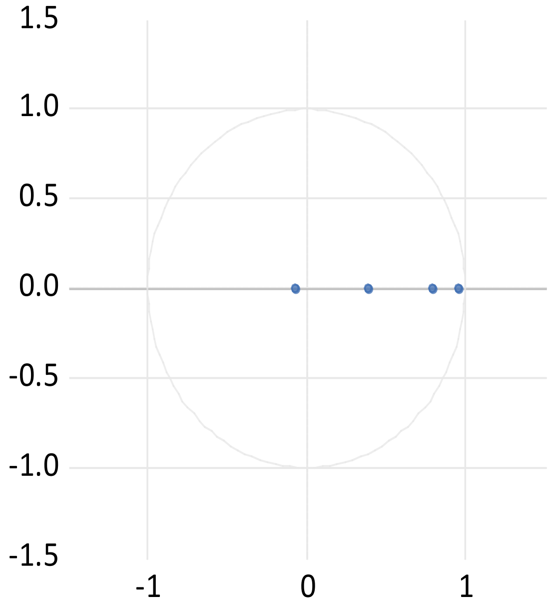
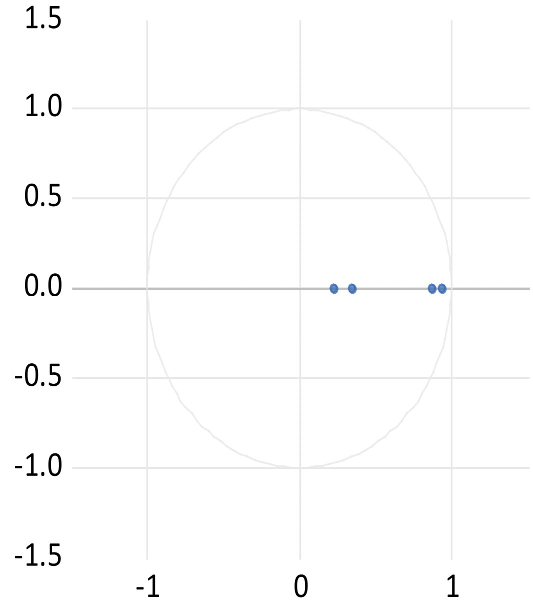
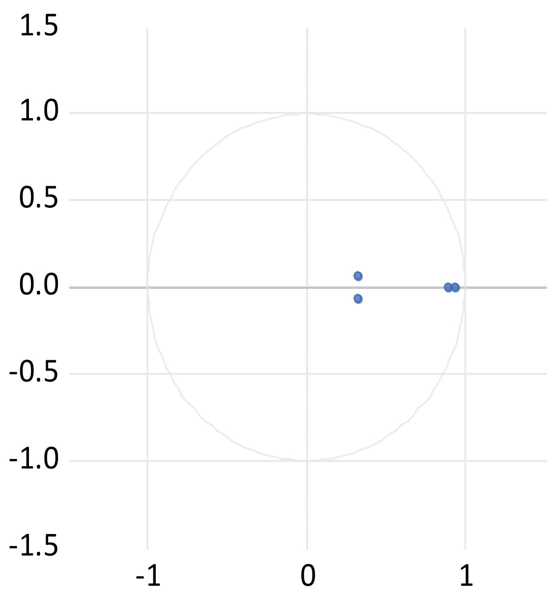
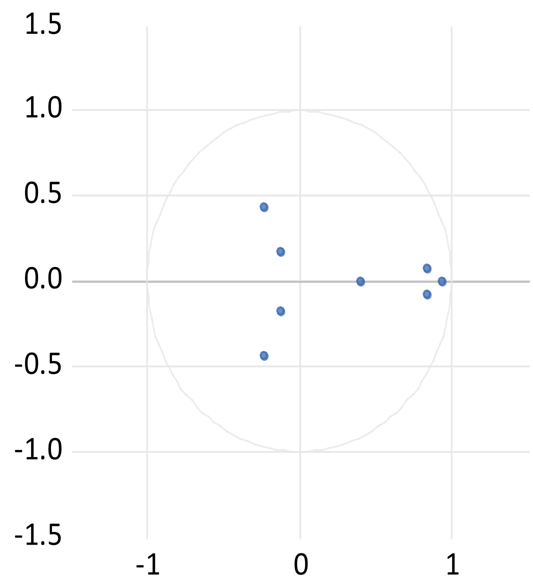
tbr91 ibr

Inverse Roots of AR Characteristic Polynomial



Source: Authors compilation

Table II: VAR Stability Tests

tbr182 ibr Inverse Roots of AR Characteristic Polynomial 	tbr273 ibr Inverse Roots of AR Characteristic Polynomial 
tbr364 ibr Inverse Roots of AR Characteristic Polynomial 	br2 ibr Inverse Roots of AR Characteristic Polynomial 

Source: Authors compilation

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