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## Article

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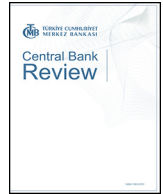
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# Revisiting interest rate and lending channels of monetary policy transmission in the light of theoretical prescriptions

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## ABSTRACT

Although theories on channels of monetary policy transmission emphasize indirect monetary policy effect on inflation and output, empirical literature is surprisingly rooted in a direct approach. The use of variants of vector autoregression, with theoretical ordering of variables, does not only fail to quantify the indirect effect, but are also fraught with disagreements on identification of shocks of monetary policy. We revisit the interest rate and lending channels of monetary policy transmission in an approach that is grounded in theory and elicits step-by-step transmission of monetary policy impulses and the eventual effect on inflation in South Africa. We find interest rate and lending channels to be operative in South Africa. For the interest rate channel, a percentage restriction in monetary policy increases lending rate by 0.29%; a percentage increase in the lending rate reduces investment by 0.063%; and a percentage fall in investment reduces inflation by 0.074%. For the lending channel, a percentage restriction of monetary policy reduces banking sector credit by 0.22%; a percentage fall in private sector credit reduces investment by 0.20%; and a percentage decline in investment reduces inflation by 0.086%. These results are robust to different samples and specifications.

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## 1. Introduction

The policy decisions of monetary authorities, either in response to deviations of macroeconomic fundamentals from their targets or systematic policy changes meant to achieve a macroeconomic outcome, may or may not generate the desired goals depending on the effectiveness of the channels of monetary policy transmission to the real economy. Imperatively therefore, policymakers require a succinct appreciation of the architecture and dynamics of the workings of these channels to be able to evaluate the timing and extent of impact of their decisions on the real economy (Cevik and Teksoz, 2012; and Boivin et al., 2010). Theoretically, the impulses of monetary policy are transmitted to the real economy through channels such as interest rate, credit, exchange rate and asset prices with an important role for components of aggregate demand to play in the transmission process (Boivin et al., 2010; and Mishkin, 1996). The monetary economics

literature, unsurprisingly, is inundated with empirical research on these channels of monetary policy transmission (see for example, Anwar and Nguyen, 2018; Afrin, 2017; Chen et al., 2017; Mandler et al., 2016; Amar et al., 2015; Fernald et al., 2014; and Cevik and Teksoz, 2012), with inconclusive results (see Senbet, 2016; Cevik and Teksoz, 2012; and Sims, 1992). The results are sensitive to the countries being studied, the span of data and the model used for estimation.

We argue that the inconclusiveness in the literature can largely be attributed to fundamental flaws in the approaches to transmission channel exposition. Literature has tended to ignore the role of the components of aggregate demand (such as investment, consumption, import and export) and consider monetary policy effect directly on the real economy using estimation techniques such as the vector error correction and the generalized method of moments in a single equation context (Tran, 2018; and Matousek and Solomon, 2018). Meanwhile, the theoretical prescriptions of the workings of the channels of monetary policy transmission are far from a direct monetary policy-real economy relationship. Theoretically the interest rate channel, for instance, works in a manner such that changes in monetary policy affects interest rates, then investment, then aggregate output or inflation. The same systematic transmission applies to

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the other channels (see [Mishkin, 1996](#); and [Boivin et al., 2010](#) for the theoretical prescriptions). Invariably, the effect of monetary policy on output or inflation is necessarily indirect through other intermediaries. To consider a direct relationship, as in the existing literature, is to obfuscate the underlying dynamics of the transmission mechanisms.

Phenomenal volumes of empirical works have relied on the vector autoregression (VAR) and its variants in the transmission exposition, with ordering of variables in the system informed by theory. In spite of such theoretical orderings of variables, substantial limitations exist. As argued by [Bernanke et al. \(2004\)](#), a key drawback of the widely used VAR in monetary policy studies is the disagreement among authors in monetary policy shock identification. The theoretical ordering of the variables remain subjective among authors, feeding into distinct inferences. In addition, whereas monetary policy can be systematic and tailored to achieve an outcome in the real economy, VAR only captures unanticipated or surprises in monetary policy ([Bernanke et al., 2004](#)).

Moreover, empirical literature using VAR also assume away the theoretically-prescribed role of aggregate demand components in delivering the monetary policy impulses to the real sector of the economy. Empirical studies simply stack a VAR or its variants with variables representing monetary policy, interest rate, output, inflation, exchange rate, asset prices and credit. They then report the impact of monetary policy on say interest rate (in pairs) and then the impact of interest rate on output or inflation as the interest rate channel (see for example, [Anwar and Nguyen, 2018](#); [Kim and Lim, 2018](#); [Tran, 2018](#); [Afrin, 2017](#); [Chen et al., 2017](#); [Zhang and Huang, 2017](#); [Mandler et al., 2016](#); [Senbet, 2016](#); [Amar et al., 2015](#); [Belke and Beckman, 2015](#); [Fernald et al., 2014](#); [Jain-Chandra and Unsal, 2014](#); [Cevik and Teksoz, 2012](#); and [Koivu, 2012](#) for different channels). Such an approach is inadequate, not only because it ignores the role of aggregate demand components, but also because it fails to quantify the eventual step-by-step effect of monetary policy beyond pairing of variables in the VAR system.

Although few studies exist on the impact of monetary policy on some components of aggregate demand such as [Owusu-Sekyere \(2017\)](#), [Koivu \(2012\)](#), and [Ncube and Ndou \(2011\)](#) on consumption; [Yang et al. \(2017\)](#) and [Ndikumana \(2016\)](#) on investment; [Vithessonthi et al. \(2017\)](#) on corporate investment; [Mukherjee and Bhattacharya \(2011\)](#) on consumption and investment; [Sariola \(2009\)](#) on imports and exports and [Aron et al. \(2014\)](#) on imports prices, but how such effects of monetary policy on these components eventually reflect in the ultimate variables of output and inflation remain unexplored.

In the light of these deficiencies in the literature, the current study makes significant contributions to the monetary policy transmission literature. We revisit the monetary policy transmission mechanism through the interest rate and bank lending channels by accounting for the role of investment (a component of aggregate demand) which is at the heart of the workings of these two transmission channels. Substantially, we consider a more systematic approach to unearthing the workings of these channels and in particular we trace the theoretical prescription of monetary policy effect on inflation through investment.

Inspired by the works of [Nosier and El-Karamani \(2018\)](#) as well as [Tavares and Wacziarg \(2001\)](#), both in the context of indirect effect of democracy on growth through numerous channels, we rely on the three stage least square technique (3SLS) in a system of equations that trace the step-by-step effect of monetary policy on

inflation through different channels. By specifying a system of equations that are simultaneously estimated, our chosen approach enables us to determine how changes in monetary policy stance eventually impacts inflation through subcomponents of the respective channels. The technique is robust to endogeneity and delivers consistency and efficiency in our estimates. An important virtue of the 3SLS technique is the fact that it has the complement of comprehensive information which enhances its efficiency. The technique also takes into consideration the parameter restrictions in the distinct structural equations being considered ([Zellner and Theil, 1962](#)).

Given our focus on inflation, we consider interest rate and the bank lending channels in South Africa, a full-fledged inflation targeting country. The decision to focus on the interest rate and the bank lending channels is informed by the central role interest rate plays in the inflation targeting framework and the dominance of the banking sector in the African context. In the inflation targeting framework, the interest rate is a key policy instrument used to convey monetary policy stance and the banking sector is an important conduit for transmitting monetary policy impulses.

We find that the interest rate and the bank lending channels are operative in South Africa. For the interest rate channel, a percentage contraction in monetary policy reduces overall inflation by 0.0013% in South Africa. For the lending channel, a percentage monetary policy restriction reduces overall inflation by 0.004% in South Africa, implying that the lending channel is more prominent in the South African context. These results are robust to different samples and specifications. Sections 2 and 3 respectively deal with monetary policy framework and the banking sector of South Africa. Section 4 covers a brief theoretical literature. Methodology is covered in section 5 and the empirical results and analysis in section 6. Policy discussion is in section 7 and conclusion in section 8.

## 2. Monetary policy framework in South Africa

South Africa practices full-fledged inflation targeting, with price stability as the primary mandate of the South African Reserve Bank. The inflation targeting framework in South Africa was officially unveiled in February 2000, having been preceded by a public announcement in August 1999 of the desire to adopt the framework. The Reserve Bank uses repo rate as monetary policy instrument to achieve the announced inflation target range of 3%–6%. The inflation measure is headline as opposed to core, given the dominance and volatility of food and oil in the country. Although the country's constitution guarantees operational independence to the Reserve Bank, the announced target inflation range is determined by the government. The determination of the instruments for the achievement of the set target range, however, is the sole prerogative of the Reserve Bank. Thus, the Reserve Bank enjoys instrument independence as opposed to goal independence.

Monetary policy decisions meant to achieve the announced inflation target are made by the Monetary Policy Committee (MPC) which comprises of only the staff of the Reserve Bank, with the governor as the chairperson of the committee. Monetary policy decisions are arrived at on the basis of consensus ([Hammond, 2012](#)) after considering major economic developments that pose upside and downside risk to inflation. Such a decision is then made public to help foster transparency and anchor inflation expectations. The MPC meets at least six times in a year. The schedules and dates for these meetings are published

ahead of the year in question, although there is room for emergency meetings depending on the macroeconomic dynamics.

### 3. The banking sector of South Africa

In inflation targeting framework, interest rate is an important policy instrument in the formulation of monetary policy decisions. That places the financial system, and the banking sector in particular, in an important position to serve as the conduit for the transmission of monetary policy impulses to the real economy. Indeed, the workings of the monetary policy channels place significant premium on the financial sector as an important conduit. In this regard, we provide a brief on the banking sector of South Africa.

South Africa's banking sector has nineteen (19) registered banks and fifteen (15) local branches of foreign banks, bringing the total to 34 as of the end of 2018. The banking sector is characterized by dominance of five banks, namely Standard Bank of South Africa Limited, Absa Bank Limited, FirstRand Bank Limited, Nedbank Limited and Investec Bank Limited. These five banks, as of March 2019, controlled 90.5% of the total assets of the sector which stood at ZAR 5.654 trillion. Local branches of foreign banks controlled 5.6% while the remaining banks mustered only 3.8% (SARB, 2019).

The year 2017 saw a major reconfiguration of the regulatory set-up of South Africa's financial system. The desire to foster fair and safe financial system in the country saw the enactment of the Financial Sector Regulation Act 9 of 2017 on August 21, 2017 on the back of collaborative efforts of the Financial Services Board, the National Treasury and the South African Reserve Bank. The Act brought with it three major modifications to the financial system regulation in the country. The first modification is the provision of an explicit mandate of the stability of the financial system to the Reserve Bank. The second modification is the creation of Prudential Authority, a body tasked with prudential regulation and domiciled within the Reserve Bank. The mandate of the Prudential Authority encompasses the regulation of banks, derivative and securities market infrastructures, cooperative financial institutions, insurance companies and financial conglomerates. The third modification is the creation of the Financial Sector Conduct Authority charged with the regulation of the market conduct of financial institutions. This authority, unlike the Prudential Authority, is domiciled outside the Reserve Bank. Significantly, the Act is designed to harness the financial sector's positive effect on the economy while reducing the fiscal and social impact of failures of banks and other institutions. The Act is also meant to engender transformation of the financial sector, boost financial inclusion, foster innovation, stimulate competition and enhance financial sector diversity (SARB, 2017).

### 4. A brief theoretical literature

The mechanism of monetary policy transmission is understood to be the procedure by which decisions and actions of monetary policy authorities are reflected into price levels and income (Taylor, 1995). Mishkin (1996) groups the transmission mechanisms into the interest rate channel, the credit channel and the asset price channels, with exchange rate channel placed under the asset price channels. The theoretical frameworks, illustrated below, for the interest rate and lending channels of monetary policy are based on the works of Mishkin (1996) and Boivin et al. (2010).

#### 4.1. The interest rate channel (The money view)

The fundamental Keynesian ISLM model for the interest rate channel for the mechanism of monetary policy transmission can be illustrated as follows:

$$M \uparrow \rightarrow i_r \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

Such that  $M \uparrow$  represents monetary policy expansion which causes real interest rates to fall (thus  $i_r \downarrow$ ), thereby making cost of capital cheaper and which in turn spurs on investments (thus  $I \uparrow$ ) with its positive impact on aggregate demand and eventual increase in economic output (thus  $Y \uparrow$ ) (Mishkin, 1996).

#### 4.2. The credit channel (The credit view)

The concept of the credit view is that a greater percentage of firms and individuals do not have access to any source of finance except through bank credit. As a result of friction of information, such firms and individuals find it extremely expensive to raise finance through issuance of stocks or other securities in the capital markets and thus depend heavily on bank loans (Gertler and Gilchrist, 1993). This implies that any shock to bank lending affects investment spending of these firms directly. Since banks are required to maintain a certain portion of deposits received as reserve requirement, central banks then have the leverage to directly influence the quantity of money that banks can have. The credit channel is made up of sub-channels such as bank lending, balance sheet and the risk-taking channels. Given the dominance of the banking sector in Africa, we focus on the lending sub-channel.

##### 4.2.1. Bank lending sub-channel

This channel is based on the idea that banks are better placed to surmount the problem of information asymmetry inherent in the financial markets. This therefore gives banks a critical role to play in the credit channel. The bank lending channel operates on condition that bank deposits cannot be perfectly substituted for other avenues of raising funds. In this regard, when a central bank embarks on an expansionary monetary policy, loanable funds increases or bank loan increases since bank deposits and reserves become more available. As the amount of bank loans increase, and since firms and consumers depend on bank loans, consumer and firm investment spending increases (Mishkin, 1996).

Schematically,  $M \uparrow \rightarrow \text{bank deposits} \uparrow \rightarrow \text{bank loans} \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow$ .

The key feature of the bank lending channel is that changes in monetary policy would significantly impact businesses that depend more on bank loans as compared to businesses that can raise finance from the capital markets and can therefore protect their portfolio when monetary policy changes. Similarly, the loan portfolio of banks that are unable to raise funds for lending apart from deposits would be significantly impacted as compared to banks that are able to raise funds from other sources (Mishkin, 1996; Boivin et al., 2010).

The crux of these theoretical frameworks is to the effect that the impact of monetary policy on output or inflation is necessarily through a number of intermediary variables which have been ignored in the literature. The use of direct approach in the empirical literature is therefore puzzling and may well be the source of the inconclusiveness in the literature.

## 5. Methodology

### 5.1. Data and data sources

We use quarterly data from 2000 to 2018, with the launch of inflation targeting framework 2000 informing the start of the data in that year. We obtain data on repo rate (monetary policy variable), interbank rate, gross fixed capital formation, private sector credit, deposit, inflation (seasonally-adjusted) and monetary aggregates (M2) from the South African Reserve Bank. M2 was originally in monthly series but converted to quarterly series using simple averages. Lending rate and deposit rate were obtained from the IMF's International Financial Statistics. Data on the exchange rate of the Rand to the Dollar was obtained from Datastream. GDP growth (seasonally-adjusted) was obtained from Statistics South Africa.

### 5.2. Description of variables

Investment (GFCF): measured as natural log of real gross fixed capital formation.

Monetary Policy (MPR): measured as repo rate.

Exchange rate (EXCH): measured as real exchange rate of the Rand to the United States dollar.

Bank loans (PSC): measured as the natural log of the total banking sector credit to the private sector.

Lending rate (LNDR): measured in percentage. It represents the weighted average of the interest rates charged by banks for lending purposes.

Inflation (INF): measured as quarterly inflation rate.

Deposit rate (DPSR): measured in percentage. It represents interest paid on deposits by banks.

GDP growth (GDPG): measured in percentage. It represents growth in output in a particular quarter from the same quarter in the previous year.

Money supply (M2): measured as natural log of broad money (M2).

### 5.3. Summary statistics

### 5.4. Estimation technique (three-stage least square)

As existing studies have largely failed to capture the step-by-step effect of monetary policy on inflation through components of aggregate demand such as investment inherent in the theoretical stipulations of the channels of transmission of monetary policy impulses, we rely on the three-stage least square (3SLS) technique to capture such effect.

Following the works of [Nosier and El-Karamani \(2018\)](#) and [Zellner and Theil \(1962\)](#), we provide a brief description of our estimation technique. The ordinary least square technique (OLS) fundamentally assumes that the variables on the right hand side of the model (regressors) are necessarily exogenous, implying absence of correlation with the errors. A violation of this assumption then renders estimates from the OLS inconsistent and biased. A way to deal with such a weakness is to employ the two-stage least square approach in a simultaneous equation set-up which delivers consistent estimates even in the presence of endogeneity of the regressors. However, that is only to the extent that the errors in the specified simultaneous equations are not themselves correlated. Where the errors are correlated, then the two-stage least square technique lacks efficiency although the estimates can still be consistent. In the presence of such correlations between the errors, an estimation technique that ameliorates the weakness is the seemingly unrelated regression as it accounts for these correlations and still deliver efficient estimates. But that is also to the extent that the right hand side variables are not endogenous. Where there are endogenous right hand side variables, then the seemingly unrelated regression must necessarily be complemented with a method of instrumental variables under the two-stage least square. Such complementation then yields an estimation technique known as the three-stage least square approach which we use for our study.

The three-stage least square technique delivers estimates that are superior to the two-stage least square because even though they both maintain consistency, the former churns out estimates that are efficient asymptotically as it utilizes information inherent in the correlations among the errors within the structural equations specified ([Nosier and El-Karamani, 2018](#)). There are three steps in the three-stage least square set-up. The first step involves the estimation of the coefficients of the reduced form specifications. The second step entails the application of the two-stage least square to the respective structural equations for the estimation of the structural coefficients. The last step involves the use of generalized least square technique to estimate the entire system's structural coefficients with the aid of the covariance matrix of the structural equations' errors obtained from the residuals in the two-stage least square ([Nosier and El-Karamani, 2018](#)). The generalized least square technique, unlike the OLS, relaxes the homoscedasticity assumption. A virtue of the three-stage least square technique is the fact that it has the complement of complete information which enhances its efficiency and it takes into consideration the parameter restrictions in the distinct structural equations being considered ([Zellner and Theil, 1962](#)).

#### 5.4.1. Model specification and estimation

As indicated earlier, we consider the interest rate and bank lending channels of monetary policy transmission. We therefore

**Table 1**  
Descriptive statistics.

	INF	GFCF	LNDR	EXCH	PSC	MPR	GDPG
Mean	6.146053	26.89649	11.45285	9.230263	28.11710	7.990132	2.771129
Median	5.800000	27.01596	10.50000	8.050000	28.31854	7.000000	2.830961
Maximum	16.30000	27.19182	17.00000	15.42000	28.91791	13.50000	5.752676
Minimum	0.400000	26.32949	8.500000	5.730000	27.01055	5.000000	−1.8384
Std. Dev.	2.959119	0.288327	2.420489	2.695055	0.600167	2.515101	1.846231
Skewness	1.039017	−0.81632	0.707084	0.795106	−0.4583	0.738881	−0.3365
Kurtosis	4.412504	2.101800	2.291021	2.360356	1.831311	2.257739	2.778584
Observations	76	76	76	76	76	76	76

Notes: MPR is monetary policy rate, INF is inflation rate, GFCF is gross fixed capital formation, LNDR is lending rate, EXCH is exchange rate, PSC is private sector credit and GDPG is gross domestic product growth.



specify simultaneous equations for each of these channels based on the theoretical stipulations.

#### 5.4.1.1. The interest rate channel.

$$INF_t = \alpha_0 + \alpha_1 GFCF_t + \alpha_2 LND R_t + \alpha_3 EXCH_t + \varepsilon_t \quad (1)$$

$$GFCF_t = \beta_0 + \beta_1 LND R_t + \beta_2 PSC_t + \beta_3 INF_t + \varepsilon_t \quad (2)$$

$$LND R_t = \gamma_0 + \gamma_1 MPR_{t-k} + \gamma_2 GDPG_t + \gamma_3 EXCH_t + \gamma_4 DPSR_t + \varepsilon_t \quad (3)$$

where  $INF_t$  in equations (1) and (2) is inflation rate at time  $t$ ,  $GFCF_t$  in equations (1) and (2) represents investment (gross fixed capital formation) at time  $t$ ,  $LND R_t$  in equations (1)–(3) represents the lending rate,  $EXCH_t$  in equations (1) and (3) is the exchange rate of the Rand to the United States dollar at time  $t$ ,  $PSC_t$  in equation (2) represents private sector credit at time  $t$ ,  $GDPG_t$  in equation (3) represents growth of gross domestic product at time  $t$ ,  $DPSR_t$  represents deposit rate at time  $t$ ,  $\varepsilon_t$  is the standard error and  $MPR_{t-k}$  in equation (3) is a two-period lag of monetary policy (see Table 1). The lag in monetary policy is informed by the fact that monetary policy is expected to impact the real economy with a lag. The choice of two lags is informed by the lag selection criteria. We estimate a VAR and specified a maximum lag. All the lag selection criteria (in Table 2) indicate two (2) as the optimal lag for monetary policy.

The theoretical stipulation of the interest rate channel is to the effect that changes in monetary policy rate affects market rates which in turn affects investments and eventually output or inflation. Given our focus on inflation, we consider inflation as opposed to output. We therefore specify three simultaneous equations to capture the stages of the transmission of monetary policy impulses to inflation. Equation (1) is the inflation equation which captures the effect of investment and other control variables on inflation. Equation (2) is the investment equation which captures the effect of interest rate (in our case lending rate) and other control variables on investment. We chose the lending rate on the basis of the dominance of the banking sector in South Africa and the fact that many firms and, to a large extent, households depend on bank loans for capital projects and large investments. Equation (3) is the lending rate equation which captures the effect of monetary policy and other control variables on lending rate.

The theoretical expectation is that a tightening of monetary policy (increase in policy rate) in equation (3) should exert positive effect on the lending rate of banks thereby making cost of borrowing expensive. That positive effect is captured by  $\gamma_1$  in

equation (3). An increase in the lending rate is then expected to discourage borrowing by firms and therefore a decline in investment. The lending rate is thus expected to have a negative effect on investment (equation (2)) and captured by  $\beta_1$ . A decline in investment is expected to slow down economic activities and therefore reduce inflation (equation (1)) and this is captured by  $\alpha_1$ . The effect of monetary policy on inflation through investment is then captured by the product of  $\gamma_1$ ,  $\beta_1$  and  $\alpha_1$  (see Nosier and El-Karamani, 2018). Determining the statistical significance of monetary policy's eventual effect on inflation, following the multiplication of the coefficients, requires the estimation of the standard errors. Following the work of Nosier and El-Karamani (2018), we employ the delta method in equations (4) and (5) to estimate the standard errors (Oehlert, 1992) under the assumption of zero covariance between  $\hat{\alpha}$ ,  $\hat{\beta}$  and  $\hat{\gamma}$ .

$$SE(\hat{\vartheta}) = \sqrt{\hat{\beta}_1^2 SE(\hat{\gamma}_1^2) + \hat{\gamma}_1^2 SE(\hat{\beta}_1^2)} \quad (4)$$

$$SE(\hat{\phi}) = \sqrt{\hat{\alpha}_1^2 SE(\hat{\vartheta}^2) + \hat{\vartheta}^2 SE(\hat{\alpha}_1^2)} \quad (5)$$

Given that our channel dynamics is one step more than what was considered in Nosier and El-Karamani (2018), we adapt to suit our present situation. We first estimate the effect of monetary policy on investment ( $\hat{\vartheta}$ ) through lending rate such that  $\hat{\gamma}_1 \times \hat{\beta}_1 = \hat{\vartheta}$  and the associated standard errors in equation (4) and then the eventual effect on inflation ( $\hat{\phi}$ ) through investment such that  $\hat{\vartheta} \times \hat{\alpha}_1 = \hat{\phi}$  and the associated standard errors in equation (5).

#### 5.4.1.2. The bank lending channel.

$$INF_t = \partial_0 + \partial_1 GFCF_t + \partial_2 LND R_t + \partial_3 EXCH_t + \varepsilon_t \quad (6)$$

$$GFCF_t = \delta_0 + \delta_1 PSC_t + \delta_2 LND R_t + \delta_3 INF_t + \varepsilon_t \quad (7)$$

$$PSC_t = \varnothing_0 + \varnothing_1 MPR_{t-k} + \varnothing_2 GDPG_t + \varnothing_3 EXCH_t + \varnothing_4 DPSR_t + \varepsilon_t \quad (8)$$

where all the variables (dependent and independent) as well as the choice of the lag of monetary policy are as previously described under the interest rate channel. Theoretically, the bank lending channel works in such a way that changes in monetary policy affects how much banks can lend and, in particular, banks that heavily depend on deposits. An effect on bank credit in turn affects investments by firms and especially firms that rely heavily on bank loans. Changes in investment then affects economic activities and inflation eventually. To capture these stages of policy transmission, we specify three simultaneous equations. Equation (6) is the inflation equation which captures the effect of investment and other control variables on inflation. Equation (7) is the investment equation which captures the effect of bank lending to the private sector and other control variables on investment. Equation (8) is the bank credit equation which captures the effect of monetary policy and other control variables on bank lending to the private sector (see Afrin, 2017).

The theoretical expectation is that a tightening of monetary policy reduces how much credit banks can extend to the private sector. Such a negative effect is captured by  $\varnothing_1$  in equation (8). A decline in credit to the private sector then induces a reduction in

**Table 2**  
Lag selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−154.7036	NA	5.706718	4.579519	4.612159	4.592452
1	−69.29908	165.7853	0.476719	2.097032	2.162311	2.122897
2	−53.78184	29.66530*	0.311061*	1.670054*	1.767974*	1.708853*
3	−53.45186	0.621149	0.317277	1.689760	1.820320	1.741492
4	−52.33849	2.062998	0.316262	1.686426	1.849625	1.751091
5	−51.90337	0.793464	0.321623	1.703040	1.898879	1.780638
6	−50.76923	2.034778	0.320443	1.699095	1.927574	1.789625
7	−50.51267	0.452752	0.327646	1.720961	1.982079	1.824424
8	−50.20929	0.526445	0.334585	1.741450	2.035208	1.857846

The \* represents the lag order chosen by the criterion. HQ: Hannan-Quinn information criterion; SC: Schwarz information criterion; AIC: Akaike information criterion; FPE: Final prediction error; LR: sequential modified LR test statistic (each test at 5% level).

investment by these firms (positive effect) which is captured by  $\delta_1$  in equation (7). A fall in investment then slows the economy down and overall inflation reduces. That positive effect is captured by  $\partial_1$  in equation (6). The eventual effect of monetary policy on inflation through investment in the bank lending channel is then captured by the product of  $\partial_1$ ,  $\delta_1$  and  $\hat{\pi}$ , such that  $\partial_1 \times \delta_1 = \hat{\pi}$  and  $\hat{\pi} \times \hat{\pi} = \hat{\tau}$ .

We follow the logic and steps under the interest rate channel in equations (4) and (5) to estimate the standard errors in equations (9) and (10) to be able to determine the statistical significance of monetary policy's eventual effect on inflation through the bank lending channel.

$$SE(\hat{\pi}) = \sqrt{\hat{\delta}_1^2 SE(\hat{\partial}_1^2) + \hat{\partial}_1^2 SE(\hat{\delta}_1^2)} \quad (9)$$

$$SE(\hat{\tau}) = \sqrt{\hat{\delta}_1^2 SE(\hat{\pi}^2) + \hat{\pi}^2 SE(\hat{\delta}_1^2)} \quad (10)$$

## 6. Empirical results and analysis

We present the empirical findings for the interest rate channel in Table 3 and the results on the bank lending channel in Table 4.

### 6.1. The interest rate channel

We begin with the effect of monetary policy on lending rates of banks, thus lending rate equation in column 4 of Table 3. We find that bank lending rates increase by approximately 0.29% following a percentage restriction in monetary policy stance and the effect is significant statistically at 1% significance level. Increases in monetary policy rate expectedly increase market interest rates which increases the opportunity cost of funds at the disposal of banks. Interest rates or coupons on gilts equally see an upward trajectory when market interest rates begin to rise in order to attract investors to patronize government securities. Given that gilts are safer relative to lending to firms, it would take a higher interest rate (lending rate) for banks to lend to firms as opposed to putting the available funds in gilts. Increases in market interest rates also increases the cost of overnight borrowing for banks that borrow to cover their positions or to on-lend to clients. Unsurprisingly, therefore, monetary policy tightening delivers an upward adjustment in the bank lending rates consistent with the theoretical prescription.

Lending rate increases, theoretically, are expected to negatively

impact investment as businesses find borrowing cost to be prohibitive. We therefore ascertain the effect of lending rates on investment. We find that investment, represented by gross fixed capital formation, shrinks by 0.063% following a percentage hike in the bank lending rate and the effect is significant at 1% significance level. Businesses are largely driven by margins and increasing borrowing costs and the associated servicing burden substantially shave off such margins, particularly for businesses that sell goods with high price elastic demand and incapable of passing on all costs to clients. Such businesses necessarily limit capital investments in the face of increasing interest rates in the economy.

When such investments by businesses decline in the face rising borrowing costs, the expectation is that it slows down economic activities in the economy and inflation would potentially tumble. We find that inflation falls by 0.074% in the wake of a percentage fall in investment. A fall in investment implies a cut back in the productive capacity of the firms and the entire economy by extension. A decline in the economy's productive capacity then implies some degree of increase in unemployment. This exacts two consequences. There is an initial decline in firm productivity and the accompanying unemployment reduces consumer spending with potential second round effect on firms' desirability to increase production given the weak demand in the economy. The combined effect is a decline in the inflation rate of the economy and economic activities slow down.

The monetary policy effect on inflation through the interest rate channel, as prescribed earlier under the theoretical foundations, is necessarily through other intermediaries. Having provided the step-by-step workings of the transmission, we now look at the overall eventual effect of monetary policy. The result, reported in column 2 of Table 3, indicates that the monetary policy overall effect on inflation is  $-0.0013$ . That is, a percentage tightening of monetary policy in South Africa reduces inflation by 0.0013% and the effect is statistically significant at 1%. Clearly, the interest rate channel is operative in the country. Our theoretically inclined approach provides quantifiable monetary policy effect in a step-by-step fashion and the eventual effect that is more intuitive compared to the widely used VAR technique where only impulse responses and variance decompositions are reported. Although authors who use structural VAR are capable of ordering the variables based by theoretical assumptions, they fall short of providing a quantitative overall eventual effect of monetary policy on inflation. Indeed, our approach enables monetary policymakers to ascertain more quantitatively the effect of monetary policy at the various stages of the transmission process.

**Table 3**  
The interest rate channel.

	Inflation Equation	Investment Equation	Lending Rate Equation
GFCF	0.074*** (8.68)		
LNDR	0.011*** (11.47)	−0.063*** (−5.08)	
EXCH	−0.0013** (−2.24)		−0.020 (−0.87)
PSC		0.287*** (8.05)	
INF		6.034*** (5.29)	
MPR			0.286*** (6.51)
GDPG			0.123*** (5.65)
DPSR			0.855*** (16.00)
Constant	−2.040*** (−8.70)	19.20*** (17.77)	2.469*** (7.42)
R-squared	0.53	0.85	0.97
<b>Eventual Effect of MPR on inflation</b>	<b>−0.0013*** (−3.736)</b>		

In the parenthesis are the t-statistics. 1%, 5% and 10% significance levels are respectively denoted by \*, \*\* and \*\*\*.

**Table 4**  
Bank lending channel.

	Inflation Equation	Investment Equation	Bank Credit Equation
GFCF	0.086*** (9.51)		
LNDR	0.012*** (11.83)	–0.086*** (–6.29)	
EXCH	–0.0013*** (–2.74)		0.046*** (3.20)
PSC		0.202*** (4.69)	
INF		7.684*** (6.68)	
MPR			–0.217*** (–7.82)
GDPG			–0.078*** (–5.71)
DPSR			0.097*** (2.86)
Constant	–2.386*** (–9.49)	21.773*** (16.75)	28.94*** (137.46)
R-squared	0.49	0.78	0.77
<b>Eventual Effect of MPR on inflation</b>	<b>–0.004*** (–3.703)</b>		

In the parenthesis are the t-statistics. 1%, 5% and 10% significance levels are respectively denoted by \*, \*\* and \*\*\*. DPSR is deposit rate. All the others are as previously defined.

## 6.2. The bank lending channel

In the bank lending channel, we considered the monetary policy effect on bank credit to the private sector, then the effect of bank credit to the private sector on investment and eventually the effect of investment on inflation. For the bank credit equation where we capture the effect of monetary policy on credit, we find that private sector credit declines by 0.22% following a percentage tightening of monetary policy. Monetary policy tightening affects banks' ability to extend credit. This is more pronounced for banks that rely heavily on deposits for loans. In South Africa, deposits play a substantial role in the financing of banking sector assets. In 2017, deposits and liabilities such as other creditors and current accounts amounted to 86.4% of the liabilities of the sector (driven chiefly by deposits). Indeed, it was even higher in 2016, accounting for 87.6% of the liabilities of the banking sector (SARB, 2017).

A reduction in banking sector credit, following monetary policy tightening is expected to lead to a decline in investment. Such a decline in investment is even more prominent in countries where firms rely heavily on bank loans as external financing source. We ascertain the effect of private sector credit on investment in the investment equation. We find that a percentage fall in private sector credit reduces investment by 0.20%.

A fall in investment is expected to occasion a decline in economic activities and eventually the price level in the economy. We therefore considered the effect of investment on inflation in the inflation equation. The results indicate that inflation declines by 0.086% (approximately 0.1%). As explained under the interest rate channel, a fall in investment slows down economic activities, fuels unemployment and exerts downward pressure on inflation.

To obtain the overall eventual effect of monetary policy on inflation, we follow the same procedure as in the interest rate channel. We find that a percentage tightening of monetary policy reduces inflation by 0.004% through the lending channel. There is therefore an operative bank lending channel in South Africa. Comparing the interest rate and bank lending channels, we find that the lending channel delivers a larger reduction in inflation following a percentage tightening of monetary policy compared to the interest rate channel. While inflation reduces by 0.001% in the interest rate channel following a percentage tightening of monetary policy, inflation in the context of the lending channel reduces by 0.004% following a percentage tightening of monetary policy.

The eventual effect of monetary policy on inflation in both the interest rate (0.0013%) and lending (0.004%) channels are relatively small. That is not surprising given the coefficients at the various stages of our estimations for both channels. In the interest rate channel, for instance, the coefficient of monetary policy effect on lending rate is 0.29% which is between 0 and 1. The effect of lending

rate on investment is 0.063% and then the effect of investment on inflation is 0.074%. Multiplying these coefficients between 0 and 1 to obtain the eventual effect of monetary policy on inflation would necessarily make the overall coefficient smaller. [Cevik and Teksoz \(2012\)](#) estimated varying coefficients for GCC countries ranging from 0.01 to 31.08 in a contemporaneous structural VAR for different shocks. [Tran \(2018\)](#) also reported a coefficient of 1.675 for monetary policy effect on inflation in Vietnam which was even positive representing price puzzle. However, these coefficients estimated by these authors represent the effect between two variables at a time and not step-by-step as we did. They essentially assumed away the intermediary role of the aggregate demand components.

Given the high R-squared in a number of the equations in both channels, we tested for multicollinearity using the variance inflation factor (VIF). The results, in [Table 5](#), indicate that our estimates do not suffer multicollinearity problems as the VIF values are far less than the threshold of 10.

## 6.3. Robustness checks

To test the consistency of our findings, we undertake some robustness exercises. We reckon that some other factors such as government spending and money supply are important in inflation dynamics and therefore we vary the specifications in both the interest rate and bank lending channels. In the inflation equation, we include central government expenditure and money supply which is proxied by monetary aggregates (M2). In addition, instead of measuring exchange rate as Rand to the dollar, we consider the real effective exchange rate of the Rand against a weighted basket of currencies of major trading partners. Moreover, we considered a change in the sample size by starting the data from 2002.

Given that we are considering a different sample size, we necessarily had to test the optimal lag length of monetary policy. The results, in [Table 6](#), indicate that the optimal lag of monetary policy based on different lag selection criteria is two (2). We therefore take two lags of the monetary policy variable for the purposes of the robustness estimation.

Having determined the lag selection, changed the measure of exchange rate and varied the specifications and the samples, we estimated the interest rate and bank lending channels again. The results for the interest rate channel are reported in [Table 7](#) and the results for the bank lending channel are reported in [Table 8](#). In the interest rate channel, all the variables of interest maintain their theoretically expected sign and are also significant statistically. A percentage restriction of monetary policy eventually reduces inflation by 0.0004%, although the said effect is not significant statistically. For the bank lending channel, we find that inflation



**Table 5**

Variance inflation factor test results.

	VIF: Inflation Equation	VIF: Investment Equation	VIF: Lending Rate Equation	VIF: Bank Credit Equation
GFCF	2.22			
LNDR	1.86	4.59		
EXCH	1.28		1.71	1.71
PSC		3.18		
INF		2.40		
MPR			5.41	5.41
GDPG			1.35	1.35
DPSR			4.85	4.85

**Table 6**

Lag selection criteria for robustness.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−124.2177	NA	3.324787	4.039280	4.073588	4.052750
1	−53.47251	136.9261	0.350492	1.789436	1.858053	1.816377
2	−38.75759	28.00581*	0.225196*	1.347019*	1.449945*	1.387430*
3	−38.75759	1.31e-05	0.232603	1.379277	1.516511	1.433159
4	−38.51038	0.454537	0.238362	1.403561	1.575104	1.470913
5	−37.99197	0.936489	0.242156	1.419096	1.624948	1.499918
6	−37.71852	0.485160	0.247987	1.442533	1.682693	1.536826

The \* represents the lag order chosen by the criterion. HQ: Hannan-Quinn information criterion; SC: Schwarz information criterion; AIC: Akaike information criterion; FPE: Final prediction error; LR: sequential modified LR test statistic (each test at 5% level).

eventually falls by 0.01% following a percentage contraction in monetary policy. We also observe that consistent with the earlier results, the bank lending channel is relatively more effective.

The presence of food, fuel and energy items in the headline

inflation measure (overall CPI inflation) may affect an accurate estimation of monetary policy effect on overall inflation, as these items may exhibit volatilities. For the purpose robustness, we use a seasonally-adjusted core inflation rate obtained from Statistics South Africa. The measure of core inflation, as per Statistics South Africa, is CPI inflation that excludes food, non-alcoholic beverages, fuel and energy. The results, reported in [Tables 9 and 10](#) for the interest rate and bank lending channels respectively, confirm our earlier findings.

## 7. Policy discussions

Monetary policy decisions are made not for their own sake but for the achievement of real sector targets. This in turn is a function of how monetary policymakers accurately gauge the transmission of such impulses to the real economy. It is therefore well acknowledged in academic and policy circles that comprehending

**Table 7**

Interest rate channel.

	Inflation Equation	Investment Equation	Lending Rate Equation
GFCF	0.105*** (3.19)		
LNDR	0.015*** (14.19)	−0.015** (−1.98)	
REER			0.009 (1.33)
M2	−0.185*** (−7.93)		
CGE	0.535*** (7.18)		
PSC		0.373*** (14.37)	
INF		1.541** (2.48)	
MPR			0.261*** (4.88)
GDPG			0.097*** (4.21)
DPSR			0.873*** (13.30)
Constant	−12.18*** (−9.46)	16.51*** (21.24)	1.622*** (2.62)
R-squared	0.76	0.91	0.97
<b>Eventual Effect of MPR on inflation</b>	<b>−0.0004 (−1.672)</b>		

In the parenthesis are the t-statistics. 1%, 5% and 10% significance levels are respectively denoted by \*, \*\* and \*\*\*. Note: REER is real effective exchange rate, M2 is money supply (monetary aggregates), CGE is central government expenditure and all others are as previously defined.

**Table 8**

The bank lending channel.

	Inflation Equation	Investment Equation	Lending Rate Equation
GFCF	0.073** (2.47)		
LNDR	0.015*** (15.69)	−0.010 (−1.32)	
REER			−0.014*** (−4.05)
M2	−0.172** (−7.46)		
CGE	0.545*** (7.76)		
PSC		0.396*** (14.93)	
INF		0.945 (1.47)	
MPR			−0.177*** (−6.21)
GDPG			−0.056*** (−4.63)
DPSR			0.074** (2.13)
Constant	−11.976*** (−9.53)	15.835*** (19.94)	30.466*** (92.68)
R-squared	0.79	0.91	0.80
<b>Eventual Effect of MPR on inflation</b>	<b>−0.01** (−2.310)</b>		

In the parenthesis are the t-statistics. 1%, 5% and 10% significance levels are respectively denoted by \*, \*\* and \*\*\*. Note: REER is real effective exchange rate, M2 is money supply (monetary aggregates), CGE is central government expenditure and all others are as previously defined.

**Table 9**  
Interest rate channel.

	Core Inflation Eq.	Investment Equation	Lending Rate Equation
GFCF	0.150*** (13.84)		
LNDR	0.005*** (5.13)	–0.013** (–2.40)	
EXCH	–0.002*** (–3.15)		–0.029 (–1.44)
PSC		0.210*** (6.05)	
CINF		3.950*** (6.50)	
MPR			0.257*** (6.17)
GDPG			0.081*** (4.29)
DPSR			0.776*** (16.70)
Constant	–4.044*** (–13.85)	21.04*** (21.01)	3.361*** (10.47)
R-squared	0.76	0.91	0.97
<b>Eventual Effect of MPR on inflation</b>	<b>–0.001** (–2.357)</b>		

In the parenthesis are the t-statistics. 1%, 5% and 10% significance levels are respectively denoted by \*, \*\* and \*\*\*. Note: CINF is core inflation and all others are as previously defined.

**Table 10**  
The bank lending channel.

	Core Inflation Eq.	Investment Equation	Lending Rate Equation
GFCF	0.157*** (13.69)		
LNDR	0.005*** (4.99)	–0.010** (–2.05)	
EXCH	–0.002*** (–3.71)		0.067*** (6.46)
PSC		0.226*** (6.70)	
CINF		3.683 (6.32)	
MPR			–0.176*** (–8.15)
GDPG			–0.043*** (–4.42)
DPSR			0.133** (5.54)
Constant	–4.235*** (–13.70)	20.557*** (21.08)	28.157*** (169.10)
R-squared	0.75	0.92	0.84
<b>Eventual Effect of MPR on inflation</b>	<b>–0.01*** (–4.813)</b>		

In the parenthesis are the t-statistics. 1%, 5% and 10% significance levels are respectively denoted by \*, \*\* and \*\*\*. Note: CINF is core inflation and all others are as previously defined.

the structure, dynamics and workings of transmission channels is a policy imperative. Although literature has, thus, dedicated substantial attention to the workings of monetary policy transmission channels, the approaches are far from the theoretical prescriptions and with simplistic assumptions that ignore complexities in the real world interactions. Our theoretically motivated approach and findings present significant policy ramifications.

We unearth a step-by-step flow of monetary policy impulses to the target variable (inflation). The link from one stage to another has a telling on the overall effect. Essentially therefore, such systematic and stage-by-stage exposition of the transmission informs policymakers at what stage the transmission has the greatest effect and where the effect is less prominent. Understanding the strength or otherwise of the linkages between the policy decision and the overall effect on the real economy then presents a road map for policymakers to exact the desired effect.

Given the collaborative set up in the workings of inflation targeting framework South Africa, where the Reserve Bank works closely with their fiscal counterpart (ministry of finance) in the determination of the inflation target, our findings unearth the complementary roles that monetary and fiscal authorities can play to achieve the inflation target. In South Africa, the target is set by the fiscal authorities. Essentially therefore, the fiscal authorities are tied to the targeting framework. In this regard, while the monetary authorities can streamline the workings of the financial systems to effectively carry the monetary policy impulses to the real sector, the fiscal authorities have a critical role to play in the aspect that links the investment component to the eventual target variable of inflation. The creation of enabling business environment for firms through a number of targeted fiscal policies can go a long way to ensure that other intervening factors in the economy do not distort the effect of the monetary policy impulses carried through the

financial systems to the firms and inflation eventually. Moreover, our findings that the lending channel is more effective in South Africa present policy ramifications. As indicated earlier, over 86% of assets in the banking sector is financed chiefly by deposits and other forms of liabilities. That presents substantial leverage to the South African Reserve Bank to influence how much credit the banks can extend and that can help in regulating liquidity in the economy and inflation eventually.

## 8. Conclusion

The extent to which monetary policy decisions exact the desired results in the real economy is essentially a function of the effectiveness of the channels of monetary policy transmission. Comprehending the workings of these channels is thus critical for the monetary policymakers as it helps them to determine how and when their decisions eventually impact the real economy. Given such relevance, empirical literature is, unsurprisingly, replete with phenomenal volumes of work on transmission channels of monetary policy. However, whereas the theoretical foundations of these channels point to the effect of monetary policy on inflation and output through components of aggregate demand, empirical literature has largely ignored these components. Even those that use VAR with some theoretical assumptions in the ordering of the variables in the system, fail to quantify the theoretically-prescribed step-by-step eventual effect of monetary policy as the focus is on impulses responses of pairs of variables. We therefore revisited the monetary policy transmission mechanism through the interest rate and bank lending channels by accounting for the role of investment (a component of aggregate demand) which is at the heart of the workings of these two transmission channels. Substantially, we consider a more systematic approach to unearthing the workings of

these channels and in particular we trace the theoretical prescription of the eventual effect of monetary policy on inflation through investment. We relied on the three stage least square technique (3SLS) in a system of equations that trace the eventual effect of monetary policy on inflation through different channels. By specifying a system of equations that are simultaneously estimated, our chosen approach enables us to determine how changes in monetary policy stance eventually impacts inflation through sub components of the respective channels. The technique is robust to endogeneity and delivers consistency and efficiency in our estimates.

We find that the interest rate and the lending channels are operative in South Africa. For the interest rate channel, a percentage contraction in monetary policy reduces overall inflation by 0.0013%. Specifically, a percentage restriction in monetary policy in South Africa increases lending rate by 0.29%; a percentage increase in the lending rate reduces investment by 0.063%; and a percentage fall in investment reduces inflation by 0.074%. For the lending channel, a percentage monetary policy restriction reduces overall inflation by 0.004%. Specifically, a percentage restriction of monetary policy in South Africa reduces banking sector credit by 0.22%; a percentage fall in private sector credit reduces investment by 0.20%; and a percentage decline in investment reduces inflation by 0.086%. We observed that the lending channel is more effective relative to the interest rate channel in South Africa. These results are robust to different samples and specifications. The findings present important policy paradigms as to the systematic exposition of the flow of the policy impulses that helps the monetary policymakers to identify the stages at which the policy decisions exact more impact and stages where the policy effects are less prominent. Tailor-made interventions can then by instituted by the monetary and fiscal authorities in a complementary fashion to achieve the target set by the fiscal authorities. The study could not consider the asset price and exchange rate channels which future studies may look at. Future studies may also consider the eventual effect of monetary policy on inflation through consumption which is an important aggregate demand component in the interest rate channel in particular.

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