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Book

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Monetary Policy Effectiveness in the Face of Uncertainty: The Real Macroeconomic Impact of a Monetary Policy Shock in South Africa during High and Low Uncertainty States

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Monetary Policy effectiveness in the Face of Uncertainty

The real macroeconomic impact of a monetary policy shock in South Africa during high and low uncertainty states

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ABSTRACT

Economies all over the world operate monetary policy with the main objective to create stable macroeconomic environment for economic prosperity, with monetary policy typically the first line of defence against a number of internal and external shocks. This study addresses whether the effectiveness of monetary policy in South Africa is influenced by the prevailing degree of uncertainty in the domestic goods, stock and currency market as well as the degree of uncertainty in global markets. This is investigated through a Self-Exciting Interacted VAR (SEIVAR) methodology augmented with GARCH and EGARCH volatilities on monthly South African data, over the period 2000:02–2022:05 during which South Africa operated under an inflation targeting regime. Results point to the asymmetric effects of a monetary policy shock dependent on the uncertainty state and that monetary policy was less effective in the high uncertainty states. The results hold important policy implications for the policy makers, as it is imperative to understand how uncertainty alters the transmission of monetary policy through the economy.

JEL Classification: C32, E32, E52.

Keywords: Financial Markets, Generalized Impulse Response Function, Inflation, Monetary policy shocks, Non-Linear Self-Exciting Interacted Vector Auto-Regressions, Uncertainty.

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1. INTRODUCTION

Economies all over the world operate monetary policy with the main objective to create a stable macroeconomic environment for economic prosperity, with monetary policy typically the first line of defence against a number of internal and external shocks. As South Africa (SA) saw an improved political dispensation in the early 1990s and became globally more integrated, arising as a desirable emerging market destination for investors, a monetary policy regime change to inflation targeting (IT) was implemented during February 2000 (Aron & Muellbauer, 2009). At present, monetary policy in SA serves to keep the rate of inflation within the target band of 3% to 6%, and if the rate of inflation exceeds the upper limit of 6%, the South African Reserve Bank (SARB) will increase the official interest rate (the repo rate) in order to bring inflation down to within the target range – a practice common to many industrialised economies (Cesa-Bianchi *et al.*, 2016). Achieving its objective of price stability depends on the credibility of monetary policy, described as the degree to which various economic agents believe that the central bank will act to ensure that it meets its key policy objectives, and on whether monetary policy actions actually permeate the real sector of the economy[4] (Laopodis, 2013; Kabundi & Mlachila, 2019). The downward trend of inflation in SA since the adoption of an IT regime, associated with greater confidence in macroeconomic policies, has enhanced the scope for monetary policy as an effective tool to ensure macro-stability (Aron & Muellbauer, 2005, 2007, 2009).

The SARB has continuously sought to reduce uncertainty by: (i) increasing the clarity around the objectives of monetary policy to ensure price stability and the framework to achieve this objective (i.e., the inflation targeting regime); and (ii) protecting and enhancing financial stability by monitoring the environment and mitigating systemic risks that might disrupt the financial system – primarily done by applying a macroprudential monitoring framework[5], which includes stress-testing financial institutions. However, given the stark complexity of the real world, no amount of research effort can completely eliminate uncertainty, and there exists 'Knightian uncertainty' where policy makers cannot reasonably measure or anticipate an event. Uncertainty is an integral part of the monetary policy decision making process (Naraidoo & Raputsoane, 2015), and a popular quote from Alan Greenspan (2003) defining this phenomenon is: "uncertainty is not just an important feature of the monetary policy landscape, it is the defining characteristic." Bloom (2009) pointed

[4] See Aziakpono and Wilson (2013) for a discussion on the importance of the interest rate pass through in affecting price stability.

[5] For more information see https://www.resbank.co.za/en/home/what-we-do/financial-stability/macroprudential-policy.

out the phenomenon where uncertainty remains high after major shocks to the economy and this heightened uncertainty holds economic activity down. This was found to be applicable to SA (see, among others, Kisten, 2020; Balcilar *et al.*, 2021; Aye, 2021; and Ahiadorme, 2022). In the last 30 years, SA has experienced several periods of heightened uncertainty, including the 1998 Asian financial crisis, the 2007/8 GFC, the COVID-19 pandemic and the Russia-Ukraine war. During these episodes, policymakers implemented expansionary monetary policies to alleviate financial stress and help move the economy towards recovery. As such, there is clear interest for policymakers in having a better understanding of the impact of these episodes on the transmission mechanism of monetary policy and the macroeconomy.

During the novel COVID-19 pandemic, which generated a high level of uncertainty similar to that realised during the GFC, the SARB quickly intervened to inject liquidity in the system in an attempt of limiting the extent of the recession which will inevitably come. The concurrent occurrence of high uncertainty and policy interventions has revived the debate on the interferences of high levels of uncertainty on the transmission of monetary policy shocks to the business cycle. This provokes an analysis to determine the effectiveness of monetary policy in the face of uncertainty – a Machiavellian concern of policy makers (Tillmann, 2020). Aastveit *et al.* (2017) noted that recent research in macroeconomics has focused solely on how movements in uncertainty affect economic activity, while less attention has been directed to the empirical investigation into the role that uncertainty might play in influencing the effectiveness of monetary policy – a sentiment also held by Pellegrino (2021). The few studies that do exist primarily focus on advanced economies and there is much less work done on emerging markets, even though they tend to experience higher levels of uncertainty. This is due to them having less-diversified economies which are more exposed to price and output fluctuations of volatile goods such as commodities (Bloom, 2014), which is the case for SA. Only two other studies, by Wei and Han (2021) and Prabheesh *et al.* (2021) were identified that touched on this topic, with both these studies only focusing on the effectiveness of monetary policy transmission during COVID-19 in SA, only modelling over the COVID-19 period.

This study is one of the first to empirically investigates how different states of uncertainty (high vs low) in three domestic markets – stock, currency and goods markets – and uncertainty in the global market[6] alters the effectiveness monetary policy. First, the study explores the macroeconomic impact of a monetary policy shock in a reduced form VAR framework in order to test the effectiveness of policy for SA to establish a baseline. In order to improve the effectiveness of

[6] Global uncertainty is proxied by the U.S. economic policy uncertainty (EPU) index constructed by Baker *et al.* (2016).

monetary policies, central banks ideally should be able to identify the origin of uncertainties and how they impact the transmission channels of monetary policy. This is investigated through a non-linear Self-Exciting Interacted VAR (SEIVAR) methodology on monthly data, a technique that has not yet been implemented to investigate the impact of monetary policy. The analysis cover the period February 2000 – May 2022 during which SA operated under an IT regime. The IVAR model is augmented with the GARCH and EGARCH measures that proxy uncertainty within the domestic markets as well as a measure of global uncertainty – the U.S. EPU. A global measure of uncertainty is considered as SA is a small open economy vulnerable to conditions abroad and the fact that U.S. uncertainty is known to impact SA's macroeconomic variables (Trung, 2019; Gupta *et al.,* 2020) validates using the U.S. EPU as a proxy for global uncertainty[7]. This framework is particularly appealing to address the research question in that it enables us to estimate the economy's response conditional on uncertainty states in the different markets which will uncover the asymmetric effects. Findings show that that monetary policy is effective in SA, as it works to stabilise inflation. The SEIVAR analysis reveal that monetary policy is less effective in high uncertainty states in the different markets, uncovering the relevant asymmetric effects. These findings lend support for the SARB to implement more aggressive monetary stimuli in the face of high uncertainty events.

The rest of the paper is structured as follows. Section 2 contains a literature review on relevant empirical studies. Section 3 presents an analysis of the data and introduces the econometric framework. Empirical results are reported and discussed in Section 4, while Section 5 concludes.

2. LITERATURE REVIEW

A review of the literature shows that the effects of monetary policy shocks is one of the most studied empirical issues in all of macroeconomics (Cheng & Yang, 2020). Despite a half a century of empirical research and numerous econometric methodological advances, there is still a lot of uncertainty around the effects of monetary policy (Miranda-Agrippino & Ricco, 2021).

Researchers have disagreed on the best means of identifying monetary policy shocks. To determine what constitutes a monetary policy shock depends on the tools utilised by the central bank and whether they make use of conventional monetary policy – such as the policy interest rate – or unconventional monetary policy – including large scale asset purchases (quantitative easing (QE)),

[7] The U.S. EPU is used over other measures, such as the VIX, in order to get a broader measure of uncertainty – where the VIX only captures volatility in the financial markets of listed companies, the U.S. EPU captures a host of uncertainty aspects related to policy (Balcilar *et al.*, 2017).

forward guidance, term funding facilities, adjustments to market operations, and negative interest rates (Sims & Wu, 2020). For several decades, central banks in advanced economies typically used a policy interest rate as their tool for conducting monetary policy. In response to the GFC of 2007–2009 and the deep recession it caused in parts of the world, central banks in many advanced economies lowered their policy interest rates to near-zero levels. As economic growth remained weak, interest rates persisted at near-zero levels, leaving no room for conventional monetary policy, and some central banks resorted to 'unconventional' monetary policy measures to stimulate economic activity (Swanson, 2021). These unconventional measures have again become prominent as central banks around the world responded to the severe economic consequences of the COVID-19 pandemic, with a range of emerging market central banks joining in (Fowkes, 2022). Ramey (2016) provides an overview of the many recent innovations for identifying monetary policy shocks, including Cholesky decomposition, sign restrictions, high frequency identification and narrative methods, among others. In light of this, the monetary policy shock investigated in each study should be cognisant of the monetary policy tools used by the specific country's central bank. This study will focus on the monetary policy framework implemented in South Africa under inflation targeting from February 2000 which uses discretionary changes in the policy interest rate as its main policy instrument.

To decipher the impact of a monetary policy shock, the literature emphasises five key transmission channels of monetary policy: the interest rate channel, the credit channel (bank lending channel and the balance sheet channel), the exchange rate channel, the asset price channel and the expectations channel (Mukherjee & Bhattacharya, 2011; Vo & Nguyen, 2017)[8]. These channels are not mutually exclusive in that more than one channel can work simultaneously to achieve the policy objective(s), and Cevik and Teksoz (2013) noted that the effectiveness of the channel transmission depends on: (i) the economic structure, (ii) the development of financial and capital markets, and (iii) the economic conditions at the time, among other factors. Given that these factors differ among developed and developing countries, monetary policy mechanism would likely differ for developed and developing countries (Mishra *et al.*, 2016).

In order to measure the effects of monetary policy shocks on macroeconomic variables, many researchers have followed the lead of Sims (1980) and Bernanke and Blinder (1992) and used the structural vector autoregression (SVAR) model (for a comprehensive literature review see Christiano *et al.,* 1999 and Ramey, 2016). Authors have also used different augmentations of the

[8] For a more detailed discussion on these channels see the prominent works of Romer and Romer (1989), Gertler and Gilchrist (1994), Bernanke and Gertler (1995) and Kashyap and Stein (2000). To understand the evolution over time of these channels see Boivin *et al.* (2010).

VAR to detect the impact of a monetary policy shock[9]. Most empirical studies investigating the impact of monetary policy shocks focus on developed economies: Romer and Romer (2004), Bernanke *et al.* (2005), Feldkircher and Hubar (2018), Cheng and Yang (2020), Swanson (2021), Miranda-Agrippino and Ricco (2021) investigate the U.S.; Champagne and Sekkel (2018) look at Canada; Rafiq and Mallick (2008), Arratibel and Michaelis (2014), Cloyne and Hürtgen (2016), Murgia (2020) focus on the Euro area; and Nagao *et al.* (2021) investigates Japan. Turning to emerging economies, Burdekin and Siklos (2008) study China; Khundrakpum (2017), Bhat *et al.* (2020) look at India; Berument and Dincer (2008), Ülke and Berument (2016) investigate Turkey; while Chuku (2009), Fasanya *et al.* (2013), and Ndikumana (2016) consider countries in Africa.

Literature that speaks to the effectiveness of SA's monetary policy is rather limited. Bonga and Kabundi (2009) provide evidence in support of the view that monetary policy dampens output while not being effective in impacting prices. Ajilore and Ikhide (2013) found that a monetary policy shock is growth dampening, while both anticipated and unanticipated shocks increase rather than moderate prices, causing these authors to doubt that inflation is a monetary phenomenon in SA. Mallick and Sousa (2012) investigate the BRICS countries and find that contractionary monetary policy has a strong and negative effect on output and that, in contrast to Bonga and Kabundi (2009), and Ajilore and Ikhide (2013), the contractionary monetary policy shocks do tend to stabilise inflation in these countries in the short term. They also found that a monetary policy shock produces a strongly persistent negative effect on real equity prices and generates an appreciation of the domestic currency. Ivrendi and Yildirim (2013) look at BRICS_T and corroborate the findings of Mallick and Sousa (2012). Gumata *et al.* (2013) find evidence that all five transmission channels work in SA, with their magnitudes and importance differing – suggesting that the interest rate channel is the most important transmitter of the shock. Ndou (2022) contrasts the effects of contractionary monetary policy shocks on output in SA and South Korea – an interesting case study as despite both countries being IT regime adopters, South Korea's economic growth has been consistently higher, inflation rates lower and the real growth recovers swiftly after economic crises such as the East-Asian financial crisis and the GFC. Findings show that for SA a contractionary monetary policy shock significantly depresses real output for a sustained period, while output declines insignificantly and transitorily in South Korea, indicating monetary neutrality. The author attributes this difference to the transitory responses of both the

[9] See Twinoburyo and Odhiambo (2018) for a review of the international literature.

monetary aggregate M2 and the exchange rate[10] to a monetary policy shock in South Korea compared to SA – implying that each country has a different monetary policy reaction function.

This study connects to a recent strand in the literature that explores the relationship between uncertainty and monetary policy. The theoretical discussion on the role of uncertainty on general policy effectiveness can be traced back to Brainard (1967). In the face of uncertainty, central banks can respond in two ways: the principle of attenuation, as discussed by Brainard (1967), puts forth that central banks' response is dampened when they are faced with uncertainty associated with the effect of rate changes and they adopt a 'wait-and-see' approach; while other authors such as Giannoni (2002) or Söderström (2002) have put forth the argument that monetary authorities may react more aggressively under uncertainty[11]. Whether central banks response is more subdued or aggressive, empirical and theoretical formulations of monetary policy should consider the quantitative relevance of uncertainty because it is a constant feature of monetary policy practice and cross-country studies generally supports the notion that there is a difference in how effective monetary policy is between normal times and crisis times (Burgard *et al.*, 2018). The theoretical literature establishes two important mechanisms in understanding how uncertainty can affect monetary policy's effectiveness: the nonlinearities in the interest rate and the credit transmission channel (Balcilar *et al.,* 2022).

The nonlinearities in the interest rate theory contends that the monetary policy efficiency diminishes through the course of high uncertainty states as a consequence of the following channels: real options effects, precautionary savings, productivity and risk premia channel and uncertainty-dependent price-setting mechanisms. According to the real options theory, in the face of high uncertainty firms adopt a wait-and-see approach and postpone their investment and hiring decisions (see, e.g., Dixit and Pindyck, 1994; Bloom, 2009, 2014 and Bloom *et al.,* 2018), which results in a more modest response of economic activity to a monetary policy expansion in times of high volatility. An analogous mechanism works through the precautionary savings theory which claims that investors prefer precautionary saving and shift their consumption to the future owing to present uncertainty circumstances (see, e.g., Basu and Bundick, 2017; and Fernandez-Villaverde *et al.,* 2015). Bloom (2014) argued that when uncertainty is high, productive firms are less aggressive in expanding and unproductive firms are less aggressive in contracting, stalling productivity growth

[10] The author attributes the insignificant output impact to the potency of foreign exchange interventions via the use of the Exchange Stabilization Fund by the Bank of Korea, whose objective is to achieve foreign exchange market stability.

[11] See Svensson and Woodford (2003, 2004) for a description of the theoretical foundation of the monetary policy rules that address these responses and Mendes *et al.* (2017) for a discussion of the guiding principles for central banks decision making under uncertainty.

as the productivity-enhancing reallocation of resources across firms is thwarted. Greater uncertainty also brings about increased risk premia. Lastly, the uncertainty-dependent price-setting mechanism attributes the decrease in the effectiveness of monetary policy to the continuous price adjustment of firms due to uncertainty (see, e.g., Vavra, 2014). Overall, in response to high uncertainty these channels argue that economic agents are less responsive to policy shocks. The evidence from various empirical studies confirms this view: looking at the U.S. is Bloom (2009), Vavra (2014), Eickmeier *et al.* (2016), Aastveit *et al.* (2017), Caggiano *et al.* (2017), Castelnuovo and Pellegrino (2018), Tillmann (2020), Pellegrino (2021); focussing on the Euro area is Abbassi and Linzert (2012), Bachmann *et al.* (2013), Balcilar *et al.* 2017, and Pellegrino (2018); looking at OECD countries Bouis *et al.* (2013), and Gupta and Jooste (2018); looking at a group of developed economies Bech *et al.* (2014); Lien *et al.* (2019) look at China; Nain and Kamaiah (2020), Kumar *et al.* (2021) and Pratap and Dhal (2021) look at India; and Pinshi (2020) look at the Democratic republic of Congo during COVID-19.

On the other hand, the credit transmission channel theory contends that monetary policy is more effective on economies during high uncertainty states – like an economic crisis – if a central bank is able to restore the functioning of the credit and interest rate channels. Firms and private households are more likely to be credit constrained during financial crises because of a decrease in the value of their financial assets and losses of collateral. In this situation, monetary policy may reduce the external finance premium by easing these constraints via the financial accelerator (see, among others, Bernanke *et al.,* 1999; and Mishkin, 2009). Furthermore, monetary policy can be more effective if it is able to raise confidence from very low levels, through providing signals about future economic prospects (Barsky & Sims, 2012) or by decreasing the probability of worst-case outcomes, as well as by improving the ability of agents to make probability assessments about future events (Ilut & Schneider, 2014). The evidence from various empirical studies confirms this view: Garcia and Schaller (2002), Lo and Piger (2005), Dahlhaus (2014), Engen *et al.* (2015), Fry-Mckibbin and Zheng (2016) consider the U.S.; Li and St-Amant (2010) look at Canada; Jannsen *et al.* (2019) study 20 advanced economies; Smets and Peersman (2001), Ciccarelli *et al.* (2013), and Burgard *et al.* (2019) investigate the Euro area; and Ren *et al.* (2020) considers China. An interesting finding of a recent study by Balcilar *et al.* (2022), who examined the monetary policy effectiveness of five major Asian economies[12], was that monetary policy shocks are more effective and potent on Asian economies during very low and very high uncertain times compared to normal economic periods.

[12] China, Hong Kong, India, Japan, and South Korea.

This study is closely related to the work of Aastveit *et al.* (2017), Balcilar *et al.* (2017) and Pellegrino (2018, 2021) who utilise the Interacted Vector Autoregressive (IVAR) methodology developed by Tobin and Weber (2013) and Sá *et al.* (2014) treating uncertainty as an exogenous interaction variable. Most of the literature thus mentioned focuses on the broadly defined uncertainty measures and does not study the interaction of monetary policy with uncertainty. Aastveit *et al.* (2017) investigate the macroeconomic influence of monetary policy changes during different uncertainty states in the U.S. These authors also extend their analysis by estimating how the U.S.-based uncertainty measures interact with the transmission of monetary policy shocks in Canada, the UK, and Norway. This is done based on the growing debate that domestic financial conditions are increasingly determined by developments in the rest of the world, particularly developments in the U.S. – which spill over to other economies through global financial cycles and work to override the efforts of local monetary policy to steer domestic financial conditions (Georgiadis & Mehl, 2016; Walerych & Wesołowski, 2021). Their findings provide evidence that that the impact of monetary policy on an economy weakens significantly during periods of increased uncertainty, particularly for Canada and the U.S. On a similar note, Balcilar *et al.* (2017) examine the role of the U.S. economic policy uncertainty (EPU) on the effectiveness of monetary policy in the Euro area and findings suggest that U.S. EPU has a significant bearing on the response of macro variables to monetary policy shocks in the Euro area, dampening the effect of monetary policy shocks, with both price and output reacting more significantly to monetary policy shocks when the level of U.S. EPU is low. Pellegrino (2018) show that monetary policy is less effective in the Euro area in periods of high uncertainty. Focusing on the U.S., Pellegrino (2021) reveal that monetary policy shocks are significantly less powerful during uncertain times – where the peak reactions of a battery of real variables being about two-thirds milder than those during tranquil times.

While the theoretical mechanisms that detail how uncertainty can impact on the effectiveness of policy, empirical evidence on its macroeconomic importance in SA is very limited. Studies that have touched on this topic for SA are restricted to only considering the impact that COVID-19 has had on the effectiveness of monetary policy. Wei and Han (2021) use event-study methodology to estimate the impact of COVID-19 on the transmission of monetary policy to financial markets (government bond, stock, exchange rate and credit default swap markets) based on a sample of 37 countries, including SA. Their results suggest that the emergence of the pandemic has weakened the transmission of monetary policy to financial markets to a more significant degree. During the period following the outbreak of COVID-19, neither conventional nor unconventional monetary policies were found to significantly affect the financial markets. Prabheesh *et al.* (2021) considered the effectiveness of monetary policy transmission in 14 emerging economies, one of which was SA, during the COVID-19 pandemic using the VIX as a measure of uncertainty. The study found that: (i) in most economies, the monetary policy transmission to inflation is weakened due to the uncertainty created by the COVID-19 pandemic, including SA; (ii) in a few economies, the transmission is found to be effective in stabilising credit and output, including SA; and (iii) the outbreak of the COVID-19 pandemic induced economic agents to follow a "cautionary" or "wait-and-see" approach. This confirms earlier findings by Naraidoo and Raputsoane (2015) who found that uncertainty has led to a more cautious monetary policy stance by the SARB MPC consistent with the principle of attenuation of Brainard (1967) that recognises that an excessively activist policy can increase economic instability. Given the scant literature on the topic, this study will be the first to employ the IVAR method in the SA context to determine the effectiveness of monetary policy at different states of uncertainty in three key domestic markets – stock, currency and goods – as well as in the global market, using U.S. EPU as done in Balcilar *et al.* (2017) and Aastveit *et al.* (2017).

3. DATA AND METHODOLOGY

3.1. Data series used and stylised facts

This study is based on SA monthly data for the period February 2000 to May 2022, containing 268 observations, procured from the SARB database, the IMF International Financial Statistics (IFS) database and Bloomberg. The following macroeconomic variables are included in the analysis: real industrial production (IP) which is used as a proxy for real GDP[13], real investment (I), real consumption (C), inflation (CPI), broad money (M3), the 3-month treasury bill rate (TB3) and the policy rate (R). Real activity is captured by IP, I and C to allow investigation into the different transmission mechanism of monetary policy shocks through these channels. This real data was converted from quarterly series into a monthly series using a linear conversion method. The policy rate is expressed in percentage terms and is considered as an indicator of the monetary policy stance. Financial market variables include the share price index (SP) and the nominal effective exchange rate (NEER). The uncertainty measures used in this study include measures of uncertainty in the domestic stock, currency and goods markets[14] and a measure of U.S. EPU developed by Baker *et al.* (2016)[15] to account for global developments. This index is constructed

[13] Data on industrial production is collected on a monthly basis whereas GDP data is collected on a quarterly basis, making industrial production as output measure more suitable for this study.
[14] See van der Westhuzien *et al.* (2022, 2023) for a construction of the respective uncertainty measures.
[15] Available at http://www.policyuncertainty.com/us_monthly.html.

from three types of underlying components: newspaper coverage of policy-related economic uncertainty, the number of federal tax code provisions set to expire and disagreement among economic forecasters.

Data series at a monthly frequency are used, as quarterly data does not capture the information content of changes in the variables of interest and make analysis during crisis periods less useful as crises often tend to be relatively short-lived, whilst daily data contains too much noise to analyse which leads to defective estimation results (Ramchand & Susmel, 1998). The starting point of the analysis is chosen to coincide with the beginning of the IT regime in SA. Prior to this, the SARB implemented different monetary policy frameworks, including exchange rate controls and broad money supply controls. A sample starting before the IT regime will likely be affected by a structural break since the purpose of the analysis is to study the average response of the economy to a monetary policy shock (conditional on the state of uncertainty, high versus low). The period where the SARB implemented different monetary policy regimes needs to be excluded so that shocks to the short-term interest rate (policy rate) can be used as a consistent measure of a monetary policy shock (Bianchi *et al.,* 2016; Kim & Lim, 2018; Pellegrino, 2018, 2021). Given the sample end point of May 2022, the data encompasses a range of global events, such as the GFC, the COVID-19 pandemic and the Russia-Ukraine war.

Figure 1 displays developments in the policy rate and inflation rate from February 2000 when the SARB implemented an explicit IT regime by setting a short-term policy rate targeting and an inflation band of between 3-6% (emphasising recently it would like inflation close to the 4.5% midpoint of the range)[16]. This was also accompanied by a free-floating exchange rate, where before the SARB had implemented fixed exchange rates in the 1960s and 1970s and experimented with managed floating rate regimes of various forms in the 1980s and 1990s (Mtonga, 2011). This is important as the effectiveness of monetary policy and its transmission is also dependent on the exchange rate regime, and since SA does not intervene in the currency market, this transmission

[16] See Figure A1 in the Appendix A for a graphical depiction of the other variables.

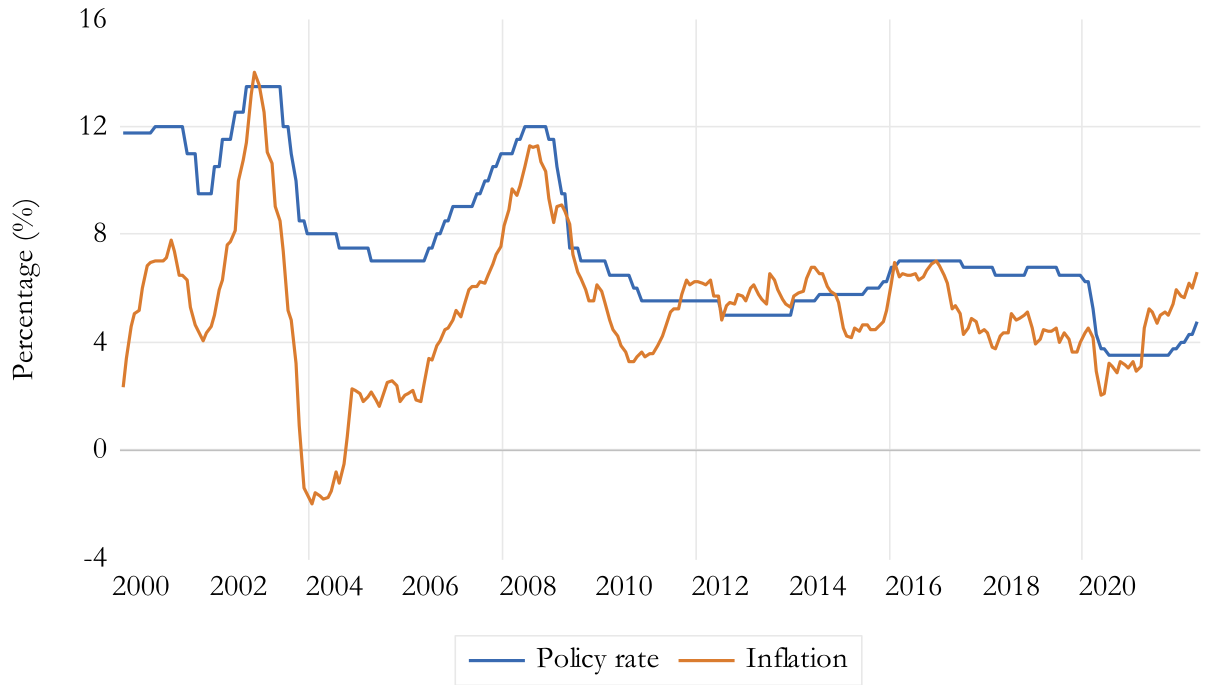

Figure 1: Policy rate and inflation for South Africa, 2000:02–2022:05

Source: SARB database.

channel is not distorted (Mallick & Sousa, 2012)[17]. Furthermore, the adoption of an IT regime in a more open economy aims to enhance policy transparency, accountability and predictability, and align monetary policy more closely with widespread international practice (Aron & Muellbauer, 2009; Weber, 2018; Kabundi and Mlachila, 2019). As can be seen in Figure 1, the policy rate and inflation generally move in tandem, both experiencing their peaks in 2002 and around the 2008/2009 GFC.

During the GFC, SA was not severely affected by liquidity disruptions as the domestic banking system was relatively well insulated and hence did not require any unconventional monetary policy measures. However, during the COVID-19 pandemic there was heightened risk-off sentiment which led to a sell-off of financial assets globally – which had implications for emerging markets, and SA in particular, as investor appetite for rand-denominated equities and bonds remained weak. The SARB cushioned the blow with a 275 basis point cut over the four months January to July of 2020, bringing the policy rate to a record low of 3.5%, whilst also introducing liquidity measures to ensure smooth functioning of the financial system. Liquidity measures included: intraday

[17] Emerging market economies grapple with surges in net capital inflows, in particular increased portfolio investment, and central banks resort to intervention in the foreign exchange market in an attempt to manage this. This intervention usually takes the form of preventing currency appreciation and as a result generating inflationary pressure. This type of intervention undermines the exchange rate channel as an adjustment mechanism (Mallick & Sousa, 2012).

overnight supplementary repurchase operations, end-of-day standing facility rates, main refinancing operations, purchases of government bonds in the secondary market and the Prudential Authority[18] also introduced relief measures (SARB Quarterly Bulletin, 2020). SA has been cited as implementing QE, however the SARB has opposed that portrayal and emphasised that the purchasing of government bonds was intended to preserve bond-market functioning rather than delivering stimulus. Fowkes (2022) highlights that QE is less effective than the policy interest rate tool in SA as the zero lower bound is not binding in SA, with rates bottoming out at 3.5% during the COVID-19. He further notes that QE is unnecessary and inappropriate to adopt in SA due to: (i) the risk or creating moral hazard, diluting the incentive for fiscal consolidation without removing the need to consolidate; (ii) QE would transfer risk to the central bank's balance sheet, undermining the fiscal authority's prudent pre-COVID-19 debt management strategy of issuing mostly long-term debt; and (iii) government is already able to replicate the QE effect of lower borrowing costs by issuing more short-term debt, a tactic National Treasury used successfully during 2020.

Headline inflation decelerated markedly to a low of 2.1% in May 2020, suppressed mainly by a marked slowdown in fuel price inflation and the impact of the strict domestic lockdown on demand. Inflation remained broadly unchanged at around 3% up to March 2021, until global inflationary pressures increased sharply with inflation accelerating to 5.9% in December, following the easing of the COVID-19 lockdowns in the second half of 2020 and driven largely by the significant increase in international crude oil prices. This saw the MPC implementing three consecutive 25 basis points increases in the policy rate between November 2021 and March 2022, after it had remained at a record low of 3.5% since July 2020. Inflationary pressures were further exacerbated by Russia's invasion of Ukraine in February 2022, which elevated agricultural commodity prices,[19] adding a substantial risk premium to already high energy prices. The inflation rate breached the upper limit of the 3–6% inflation target range for the first time in four years when it accelerated to 6.5% in May 2022. It then increased further to a 13-year high of 7.8% in

[18] The Prudential Authority is responsible for the regulation of the financial sector and operates as a juristic person within the administration of the SARB and consists of the following four departments: the Financial Conglomerate Supervision Department; the Banking, Insurance and Financial Market Infrastructures Supervision Department; the Risk Support Department; and the Policy, Statistics and Industry Support Department.

[19] Although the increase in international food prices was broad-based, it has largely been driven by higher grain prices, especially wheat and maize, which are staple foods in many countries. International vegetable oil prices have also increased significantly over the past two years. With Russia and Ukraine both being major global producers of wheat, maize and sunflower seed, and with the blockage of Ukraine's Black Sea ports, the prices of these commodities have increased significantly. Fears of global shortages in certain oil seeds have led to export bans by some countries, which caused a further surge in vegetable oil prices.

July[20]. Consumer fuel prices reverted from a year-on-year decrease of 25.8% in May 2020 during the COVID-19 restrictions to an increase of 56.2% in July 2022 – the highest since 2008. Consumer fuel price inflation was primarily impacted by the increase in the international price of Brent crude oil, from an average of US$29.5 per barrel in May 2020 to an average of US$122.8 per barrel in June 2022. This reflected higher global demand following the easing of COVID-19 lockdown restrictions, and later supply constraints following the sanctions on Russian petroleum products, with Russia being the third-largest crude oil producer in the world. In the face of this, the price of inland 95-octane petrol increased by 97.8% from May 2020 to June 2022, while the price of diesel more than doubled over the same period. This has a ripple effect as most goods are transported by road, and increased transport costs leads to price increases of consumer goods. To address surging inflation, the MPC increased the policy rate by 50 basis points to 4.75% per annum in May 2022, further tightening monetary policy by 75 basis points in both July 2022 and September 2022. The ongoing conflict in Ukraine and the sanctions imposed on Russia by many countries have also exacerbated and prolonged the global supply chain disruptions, adding further upward pressure on consumer prices in most economies.

In order to gain insight into the univariate time series properties of the data series, descriptive statistics are presented in Table 1. Considering the monetary measures graphed in Figure 1, the mean of the policy rate and inflation over the period 2000:02–2022:05 is 7.5% and 5.2%, respectively, with similar standard deviations of 2.66 and 2.62, respectively. Inflation reached a maximum of 14.01% in November 2002 on the back of price pressures initially stemming from a steep depreciation of the exchange rate, coupled with higher trending wage settlements and elevated oil prices. As a result of these developments, the MPC hiked the policy rate by 400 basis points during the course of 2002 in an effort to anchor inflation, and the policy rate hit its maximum of 13.5% in 2002. Considering the domestic uncertainty measures, the stock market exhibits the highest mean and volatility, followed by the currency market. The goods market uncertainty exhibits the lowest mean and volatility, on the back of the IT regime that has seen stabilisation of inflation, associated with greater confidence in macroeconomic policies. Most of the variables in Table 1 exhibit positive skewness which implies that the distributions have a long right tail, while only industrial production, investment and consumption display negative skewness which implies that these distributions have a long left tail. Furthermore, if the variable's kurtosis is less than 3 the distribution is platykurtic or short-tailed with respect to the normal, while if the

[20] https://www.resbank.co.za/content/dam/sarb/publications/quarterly-bulletins/quarterly-bulletin-publications/2022/september/01Full%20Quarterly%20Bulletin%20(2).pdf.

variable's kurtosis is greater than 3 the distribution is leptokurtic or heavy-tailed with respect to the normal distribution. The Jarque-Bera statistic for all the variables indicate that the null hypothesis of the normal distribution is rejected at the 1% level of significance.

Table 1: Descriptive statistics of macroeconomic variables and uncertainty measures for South Africa, 2000:02–2022:05

Variable[21]	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	Jarque-Bera
Industrial production	96.07	6.48	49.4	109.9	-1.82	12.95	1248.94 (0.0000)
Investment	162,452.3	36168.43	89,074.0	210,388.0	-0.80	2.25	34.58 (0.0000)
Consumption	619,466.2	108,937.8	406,180.3	799,270.0	-0.46	1.96	21.54 (0.0000)
Inflation rate	5.21	2.62	-2.0	14.01	0.16	4.64	31.09 (0.0000)
Broad money (M3)	2,170,269	1,159,797	476,619.0	4,467,812	0.20	1.91	14.86 (0.0000)
3-month treasury bill rate	7.31	2.18	3.45	12.74	0.49	2.69	11.92 (0.0003)
Policy rate	7.51	2.66	3.5	13.5	0.66	2.50	22.55 (0.0000)
Share price index	33,468.07	18,506.91	7,191.36	68,970.78	0.08	1.64	20.42 (0.0000)
Nominal effective exchange rate	135.35	39.14	74.3	220.37	0.25	1.81	18.52 (0.0000)
Stock market uncertainty[22]	26.61	17.13	7.97	117.9152	2.50	11.33	1027.13 (0.0000)
Currency market uncertainty[23]	12.29	13.68	1.64	140.7384	5.17	40.04	16508.73 (0.0000)
Goods market uncertainty[24]	0.25	0.16	0.11	1.0739	2.3201	8.9418	634.67 (0.0000)
U.S. EPU	138.05	66.15	504.0	45.0	1.9379	8.9666	565.27 (0.0000)

Note: Values in parenthesis are p-values.
Jarque-Bera is the test statistic for testing whether a time series is normally distributed. The test statistic is computed as $JB = \frac{N-k}{\sigma}\left(skew^2 + \frac{1}{4}(kur-3)^2\right)$
where skew is skewness, kur is kurtosis, N is the number of observations and k is the number of estimated coefficients.

[21] Industrial production is the volume of production with index: 2015=100. Investment and consumption are measured in constant 2015 prices in R millions.
[22] See Van der Westhuizen *et al.* (2022) for construction of stock market uncertainty measure.
[23] See Van der Westhuizen *et al.* (2022) for construction of currency market uncertainty measure.
[24] See Van der Westhuizen *et al.* (2023) for construction of inflation (goods market) uncertainty measure.

3.2 Methodology

In this section, the econometric techniques that this study implements are detailed. First, the reduced form VAR framework used to analyse the macroeconomic impact of a monetary policy shock is detailed in Section 3.2.1. Thereafter, the non-linear SEIVAR model specification, augmented with GARCH and EGARCH volatilities is detailed in Section 3.2.2. This technique is used to assess the macroeconomic impact of a monetary policy shock in different uncertainty states (high versus low) within the three domestic markets and the global market. This method further allows the identification of time-varying uncertainty affects in the transmission of monetary and the identification of asymmetries.

3.2.1 Reduced form VAR

The following reduced form of the VAR model is considered:

$$Y_t = \sum_{j=1}^{L} A_j Y_{t-j} + \mu_t \qquad (18)$$

where Y_t is an $(n \times 1)$ vector of the endogenous variables, A_j are $(n \times n)$ matrices of coefficients, and μ_t is the $(n \times 1)$ vector of error terms, $E(\mu_t) = 0$ and $E(\mu_t \mu_t') = \Omega$. The endogenous variables included in $Y = [R, TB3, M3, CPI, IP, I, C, SP, NEER]$. The real variables and financial variables are taken in logs and multiplied by 100, which implies that their VAR responses can be interpreted as percent deviations from trend[25]. The VAR order were chosen conducting the lag length criterion test and the Schwarz Information Criterion (SIC) and the Hannan-Quinn Information Criterion both suggest 2 lags.

In this study it is of interest to know the responses of the endogenous variables in the Y vector (inflation, industrial production, etc.) to an impulse in the policy interest rate, R. In a dynamic system, an innovation to a variable disrupts that variable and in addition is transmitted to all of the additional endogenous variables in the system through the dynamic (lag) structure of the VAR. An impulse response function traces the impact of a once-off shock to one of the innovations on current and future values of the endogenous variables (Gil-Lafuente *et al.*, 2012). If there is a response of one variable to an impulse/innovation in another variable, then the latter variable is defined as being causal for the former variable. If the structural innovations, ε_t, are contemporaneously uncorrelated, the interpretation of the impulse response is straightforward: the *i-th* innovation $\varepsilon_{i,t}$ is simply a shock to the i-*th* endogenous variable in vector Y. However, innovations are generally correlated, and probably contain a mutual component, which should not

[25] As done in Aastveit et al. (2017), Balcilar *et al.* (2017), Pellegrino (2018, 2021) and Ndou (2022). Bootstrap standard errors are used.

be related with an explicit variable. In this case, it is routine to apply a transformation to the innovations in order for the impulses to become uncorrelated so that one can interpret them. This paper implements generalised impulse response functions (GIRFs) proposed by Koop *et al.* (1996) as they have two important advantages. First, they allow for composition dependence in multivariate models, in that the effect of a shock to the policy rate is not isolated from having a contemporaneous impact on the other endogenous variables in the VAR and *vice versa* (see Lee & Pesaran, 1993; and Pesaran & Shin, 1996). Second, they are invariant to the reordering of the variables in a multivariate model, and fully consider the historical patterns of correlations observed amongst the different shocks (Pesaran & Shin, 1998). That is, 'causal priority' is avoided which ultimately ensures that an ordering of the inflation and inflation uncertainty within the VAR does not have any bearing on the outcomes of the impulse responses. Pesaran and Shin (1998) show that the maximum likelihood estimator of the GIRFs is $\sqrt{T}$-consistent and asymptotically normally distributed.

3.2.2 The Self-Exciting Interacted VAR

To test non-linear effects, this study employs the Self-Exciting Interacted VAR (SEIVAR) model, developed by Towbin and Weber (2013) and Sa *et al.* (2013), to empirically study whether the real effects of monetary policy shocks are different across high and low uncertainty regimes in the three markets. This model augments an otherwise standard linear VAR with an interaction term, which involves two endogenously modelled variables: the variable used to identify a monetary policy shock (the policy rate) and the uncertainty measure. This latter variable will serve as a conditioning variable allowing us to obtain the impact of monetary policy shocks during high and low uncertainty states.

The estimated SEIVAR model used in this study follows the Pellegrino (2021) specification:

$$Y_t = \alpha + \sum_{j=1}^{L} A_j Y_{t-j} + \left[\sum_{j=1}^{L} c_j R_{t-j} \cdot unc_{t-j}^{k}\right] + \mu_t \quad (19)$$

$$unc_t = e'_{unc} Y_t \quad (20)$$

$$R_t = e'_R Y_t \quad (21)$$

$$E(\mu_t \mu'_t) = \Omega \quad (22)$$

where Y_t is the $(n \times 1)$ vector of the endogenous variables comprising inflation, industrial production, investment, consumption, the policy rate and a measure of uncertainty. α is the $(n \times 1)$ vector of constant terms, A_j are $(n \times n)$ matrices of coefficients, and μ_t is the $(n \times 1)$ vector of error terms, whose variance-covariance matrix is Ω. The interaction term in brackets makes an otherwise standard VAR a SEIVAR model. It includes a $(n \times 1)$ vector of coefficients, c_j, a measure of uncertainty, unc_t^k, and the policy rate, R_t. The uncertainty measure, unc_t^k with $k = \{stock\ market, currency\ market, goods\ market, global\ market\}$, are the different uncertainty measures for the South African stock, currency and goods market[26] and a measure of global uncertainty, U.S. EPU, to account for global developments. e_y is a selection vector for the endogenous variable y in Y. An important distinction of this methodology, that is novel compared to other studies employing IVAR, is that both interaction terms (policy rate and uncertainty) are treated as endogenous as it is important to compute monetary policy effectiveness conditional on high/low uncertainty, along with the fact that uncertainty may endogenously move after the policy shock (as monetary shocks themselves may affect uncertainty and uncertainty may irrespectively mean revert). This latter possibility is what generates a feedback effect which makes the model self-exciting in the iteration after a monetary policy shock (Pellegrino, 2021). This IVAR represents a special case of a Generalised Vector Autoregressive (GVAR) model (Mittnik, 1990), and the choice of working only with the $(R_{t-j} \cdot unc_{t-j})$ interaction term enables this study to focus on the possibly nonlinear effects of uncertainty shocks due to different levels of the policy rate while preserving stability[27]. The lag length criteria stipulate 2 lags according to the Schwarz information criterion.

To evaluate the importance of the interaction effects, following Balcilar *et al.* (2017) and Aastveit *et al.* (2017), the estimated impulse responses of monetary policy shocks are computed at two different levels of the uncertainty indicator. This study adopts the sign restriction of above and below the mean of the historical distribution of the uncertainty measure, denoted by $unc^{k,high}$ and $unc^{k,low}$, to report on the high and low uncertainty states within the markets under consideration – stock, currency, goods and global market. The estimated VAR then reduces to:

$$Y_t^{high} = \widehat{D}_0^{high} + \sum_{j=1}^{L}\left(\widehat{D}_j^{high} R_{t-j}\right) + \hat{\mu}_t \tag{23}$$

$$Y_t^{low} = \widehat{D}_0^{low} + \sum_{j=1}^{L}\left(\widehat{D}_j^{low} R_{t-j}\right) + \hat{\mu}_t \tag{24}$$

26 See van der Westhuizen *et al.* (2022, 2023) for the construction of the respective uncertainty measures.

27 In principle, GVAR models may feature higher order interaction terms, however multivariate GAR models have been shown to become unstable when higher powers of the interactions terms are included among the covariates (as pointed out by Mittnik (1990), Granger (1998), Aruoba *et al.* (2013) and Ruge-Murcia (2015).

where $\widehat{D}_0^{high} = \hat{\alpha} + \sum_{j=1}^{L} \hat{A}_j Y_{t-j}^{high}$ [28] and $\widehat{D}_0^{low} = \hat{\alpha} + \sum_{j=1}^{L} \hat{A}_j Y_{t-j}^{low}$.

Similarly, $\widehat{D}_j^{high} = \hat{c}_j unc_{t-j}^{high}$ and $\widehat{D}_j^{low} = \hat{c}_j unc_{t-j}^{low}$.

To correctly account for the feedback effect, this study implements GIRFs which consider the fact that, in a fully non-linear model, the state of the system and therefore system's future evolution can vary endogenously after a shock. As a result, GIRFs return fully non-linear empirical responses that depend nontrivially on the initial conditions in place when the system is shocked (as well as on the sign and size of the shock). Theoretically, the GIRF at horizon h of the vector Y to a shock in date t, δ_t, computed conditional on an initial history (or initial conditions), $\varpi_{t-1} = \{Y_{t-1}, \dots, Y_{t-L}\}$, is given by the following difference of conditional expectations between the shocked and non-shocked paths of Y:

$$GIRF_{Y,t}(h, \delta_t, \varpi_{t-1}) = E[Y_{t+h} | \delta_t, \varpi_{t-1}] - E[Y_{t+h} | \varpi_{t-1}] \qquad (25)$$

In principle there are as many history dependent GIRFs referring to a generic initial quarter $t-1$ as there are quarters in the estimation sample. Once these GIRFs are averaged, per each horizon, over a particular subset of initial conditions of interest, the state dependent GIRFs are obtained, which reflect the average response of the economy to a monetary policy shock in a given uncertainty state. Theoretically, the state dependent GIRFs can be defined as:

$$GIRF_{Y,t}\left(h, \delta_t, \Omega_{t-1}^{high}\right) = E\left[GIRF_{Y,t}\left(h, \delta_t, \varpi_{t-1} \in \Omega_{t-1}^{high}\right)\right] \qquad (26)$$

$$GIRF_{Y,t}\left(h, \delta_t, \Omega_{t-1}^{low}\right) = E\left[GIRF_{Y,t}\left(h, \delta_t, \varpi_{t-1} \in \Omega_{t-1}^{low}\right)\right] \qquad (27)$$

where Ω_{t-1}^{i} denotes the set of histories characterizing regime $i = \{high;\ low\}$.

As Pellegrino (2021) points out, this method contributes to the literature in two respects: (i) it represents a novel and more general framework in the IVAR literature that allows to endogenise conditioning variables, and (ii) application-wise, it contrasts with the strategy employed by recent VAR analyses on the uncertainty-dependent effectiveness of monetary policy shocks .e.g., Aastveit *et al.* (2017), Eickmeier *et al.* (2016) and Castelnuovo and Pellegrino (2018), which work with non-linear VAR models featuring an exogenous conditioning variable and therefore compute conditionally linear IRFs for a fixed value of the uncertainty proxy. This enables a consideration

[28] Important to note is that unc is modelled as an endogenous variable within the Y vector, so Y_{t-j}^{high} refers to when the uncertainty measure in the corresponding markets $k = \{stock\ market, currency\ market, goods\ market, global\ market\}$ is in the high uncertainty state, while Y_{t-j}^{low} refers to when the uncertainty measure is in the low uncertainty state.

of both the possibly endogenous move of uncertainty (our conditioning indicator) after the policy shock and its feedbacks on the dynamics of the system.

To identify the monetary policy shocks[29], this study follows the literature and adopt the conventional short-run restrictions implied by the Cholesky decomposition. The vector of endogenous variables is ordered in the following way: $Y = [R, Unc, CPI, IP, I, C, SP, NEER]'$, containing the policy rate, an uncertainty proxy, inflation, industrial production, investment, consumption, the share price and the nominal effective exchange rate. The results presented in Section 4 are robust when the order of the variables in the Y vector are changed.

4. EMPIRICAL RESULTS

Section 4.1 presents the results of the impact of a monetary policy shock on the real economy in the reduced form VAR framework with GIRFs. Section 4.2 provides the estimation results of the SEIVAR model and reports the GIRFs which represent the effectiveness of monetary policy in the face of different uncertainty states (high versus low) within the three domestic markets – stock, currency and goods markets – as well as the global market.

4.1 Reduced form VAR results

Figure 2 contains the GIRFs which detail the macroeconomic impact of a monetary policy shock, in order to test policy effectiveness for SA. This serves as a baseline to compare with the results that follow in section 4.2 where the impact of uncertainty is explored.

As can be seen, inflation exhibits an initial increase as a contractionary monetary policy shock takes effect − evidence of the well-documented "price puzzle", first documented by Sims (1992) and subsequently confirmed by other authors (reported by Romer & Romer (2004), Cloyne & Hurtgen (2016), Aastveit (2017) and Murgia (2020))[30]. After 4 months, the trend starts to decline and the contractionary policy shock lowers inflation. This is in line with the study of Ndou (2022) who

[29] This study also considered the sign-restriction approach of Uhlig (2005) to identify monetary policy shocks. The identifying assumption here was that a monetary policy shock was associated with an increased interest rate and a fall in the price level. The Uhlig (2005) sign restriction method has become very popular at present, but not many previous studies investigated the issues in small open economies by using such a method, which makes the current study more interesting (Kim & Lim, 2018). However, application of the method revealed an increasing trend in inflation in some of the IRFs, which is not feasible.

[30] Employing the Uhlig (2005) sign restriction avoids this by design.

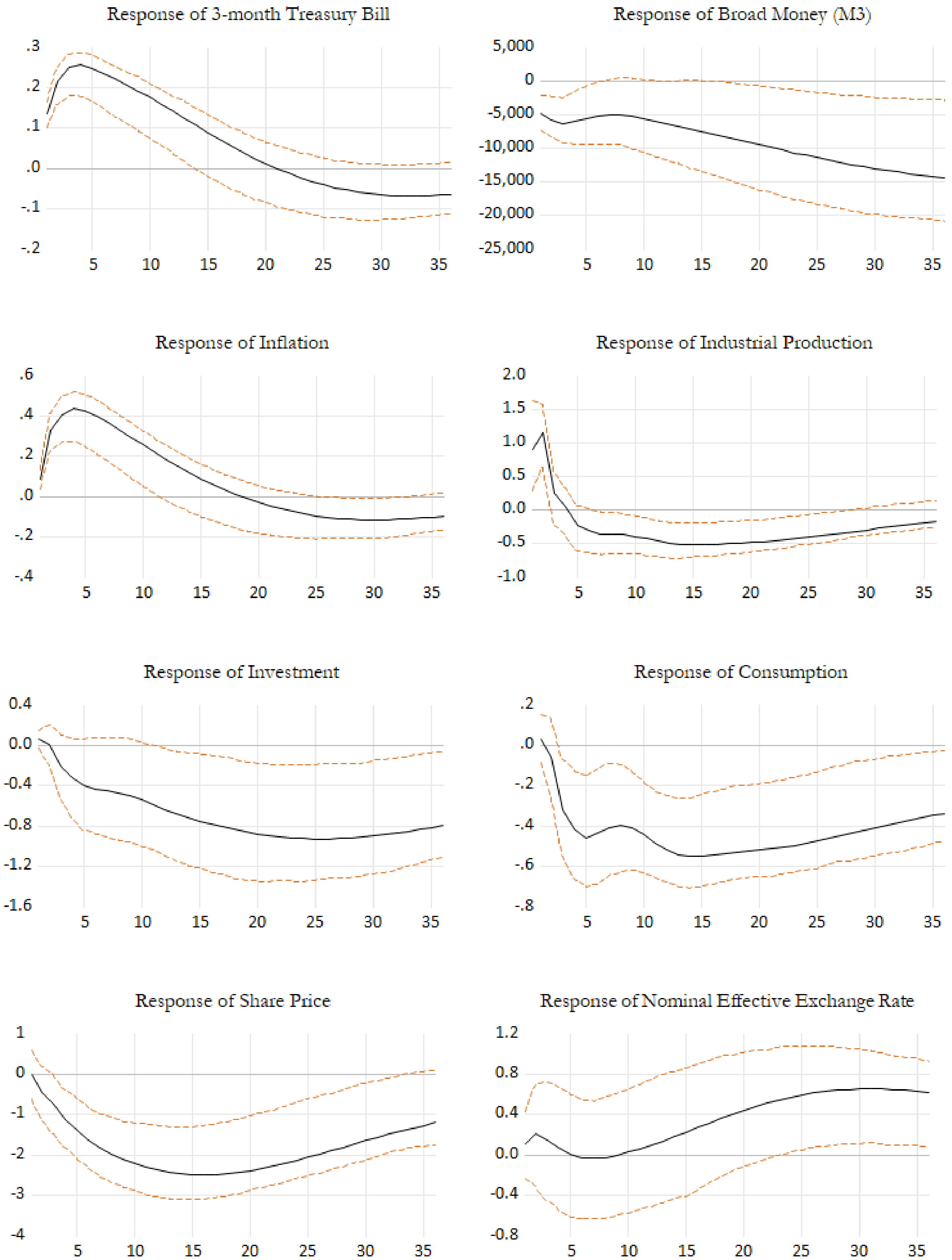

Figure 2: Response of real macroeconomic variables to a monetary policy shock

Notes: The solid line reports the mean, and the dotted lines report the 90% confidence intervals computed using bootstrapping with 1,000 replications.

who confirms the effectiveness of contractionary monetary policy shocks in lowering inflation, while being in contrast to Bonga and Kabundi (2009) and Ajilore and Ikhide (2013) who found monetary policy to be ineffective at impacting inflation. Inflation rises incrementally for about 4 months, after which it starts its downward trend. This declining effect is significant for about 10 months.

Broad money (M3) outcomes are in line with priori expectations which suggests that a contractionary monetary policy shock should lead to a fall in M3, consistent with the liquidity effect, while the 3-month treasury bill rate follows the trend of the policy rate.

Output rises for the first 2 months, and then starts its downward trend with the impact being significant (baring months 2-5) remaining depressed for several quarters. This finding is in line with Bonga and Kabundi (2009) who found output rising for around 7 months after which it starts to decline, and with Ndou (2022) who found that output contracts for a few quarters in response to a monetary policy contraction. Output then displays a sluggish adjustment taking over a year before the full effects are felt. This is consistent with the monetarist view that the economy responds gradually to monetary policy shocks. Investment and consumption also see a declining trend, with the effect becoming significant after 10 months for investment and after only two months in consumption. This finding show that a contractionary monetary policy shocks have real effects in SA.

There is a negative impact on stock markets, shown by the decline in the share price. This result shows that monetary policy actions affect stock prices, with its link to the real economy through the asset price transmission channel which exerts influence on consumption and investment spending. This finding is in line the theories of monetary policy-stock market nexus including Modigliani's life cycle model, which postulates a direct relationship between the lifetime resources of consumers and stock prices, and the Tobin q's Model, which postulates a direct relationship between investment spending and stock prices (Tobin, 1969; Modigliani, 1971; Miskin, 2001).

A contractionary monetary policy shock generates an appreciation of the domestic currency – which gives rise to the idea that monetary policy is interested not only in optimal monetary conditions but also in external stability (Knedlick, 2006). Within a floating exchange rate regime, such as SA, the domestic currency becomes a shock absorber. This is in line with findings of Ndou (2022) who found a persistent and prolonged appreciation following the policy intervention. The exchange rate provides information on the pass-through channel into the cost of imported intermediate inputs and impacts on the traditional interest rate channel in which monetary policy has immediate effects on changing the return on assets denominated in different currencies (Rafiq

& Mallick, 2008). The appreciation of the domestic currency will make SA exports more expensive and less competitive globally, which will push down aggregate demand.

Overall, these results are in line with the literature and it can be concluded that monetary policy is effective in SA.

4.2 SEIVAR results

Figure 6 display the response of inflation and industrial production to a contractionary monetary policy shock within the different markets. The responses of the other variables in the SEIVAR can be found in Appendix A (Figures A2-A5). Throughout Figures 3 to 6 below, we see that in both the high and low volatility scenarios, there is a "price puzzle" as prices initially increase in response to the monetary tightening. Interestingly to note is that the initial positive inflation response is practically insensitive to the level of uncertainty. The figures in the Appendix show that investment and consumption generally see declining trends in response to a contractionary

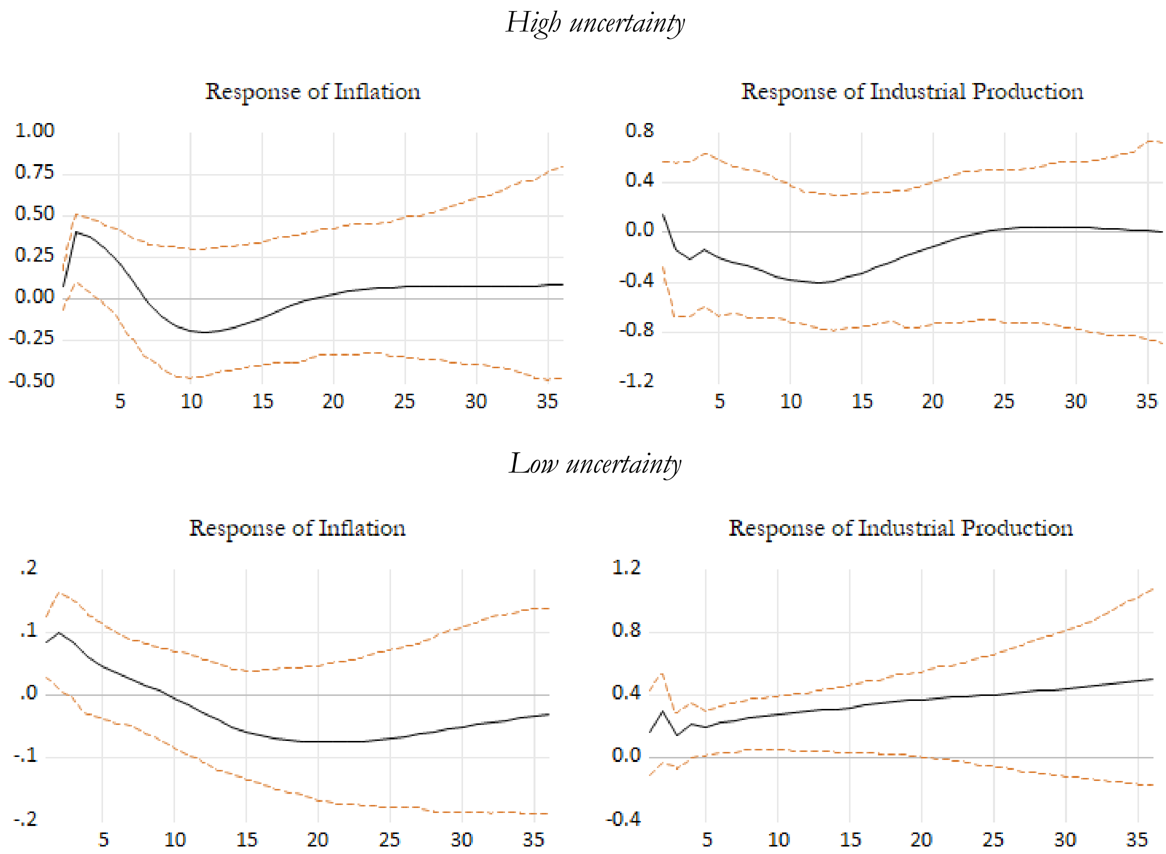

Figure 3: Impact of a monetary policy shock – Stock market

Notes: The solid line reports the mean, and the dotted lines report the 90% confidence intervals computed using bootstrapping with 1,000 replications.

monetary policy shock in the face of uncertainty, in line with the real options effect and precautionary savings effect, where the impact is generally more pronounced in low uncertainty states.

Figure 3 displays the response of inflation and industrial production to a monetary policy shock within the high and low uncertainty states in the stock market. The figure plots responses for three years (36 months) after the shock. As can be seen, inflation increase for two periods and then start to decline in the high uncertainty state. In the low uncertainty state, inflation has a downward trend. In both uncertainty states, the impact on inflation is only significant for 2 or 3 months. Industrial production sees a downward trend in the high uncertainty state that lasts about a year after which it starts to normalise, with the effect being insignificant. In the low uncertainty state, industrial production starts to see a significant upward trend after 5 months.

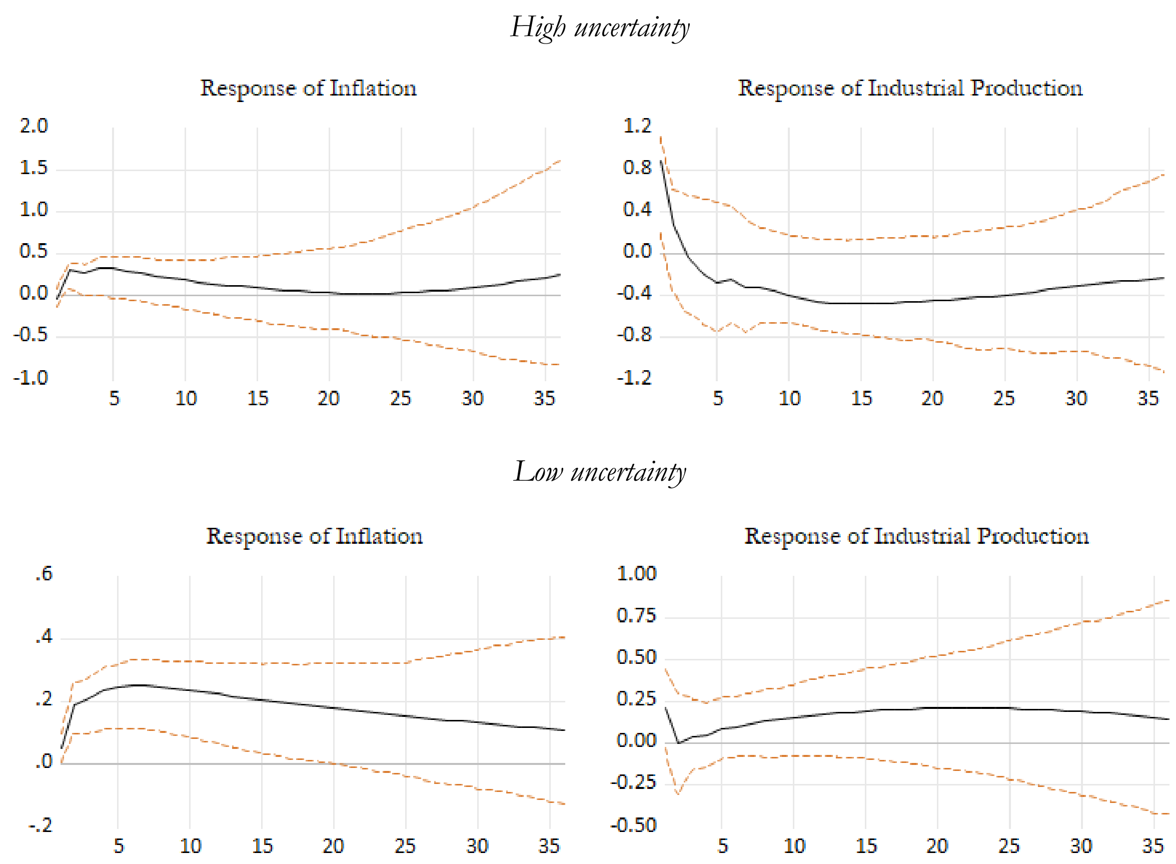

Figure 4: Impact of a monetary policy shock – Currency market

Notes: The solid line reports the mean, and the dotted lines report the 90% confidence intervals computed using bootstrapping with 1,000 replications.

Figure 4 displays the response of inflation and industrial production to a monetary policy shock within the high and low uncertainty states in the currency market. The impact on inflation is short-lived as the decline is borderline significant for only a short period of 5 months in the high uncertainty state, while the impact remains significant for a much longer period in the low uncertainty state (up to 20 months). Notably, the share price sees a significant declining trend from 10 months (see Appendix A, Figure A2).

Figure 5 displays the response of inflation and industrial production to a monetary policy shock within the high and low uncertainty states in the currency market. While the initial impact on inflation is more pronounced in the high uncertainty state, it only remains significant for a short period of 5 months, where the impact remains significant for a longer period of about a year in the low uncertainty state. Industrial production sees a significant decline after about 4 months in the high uncertainty state, while the initial impact is significant in the low uncertainty state.

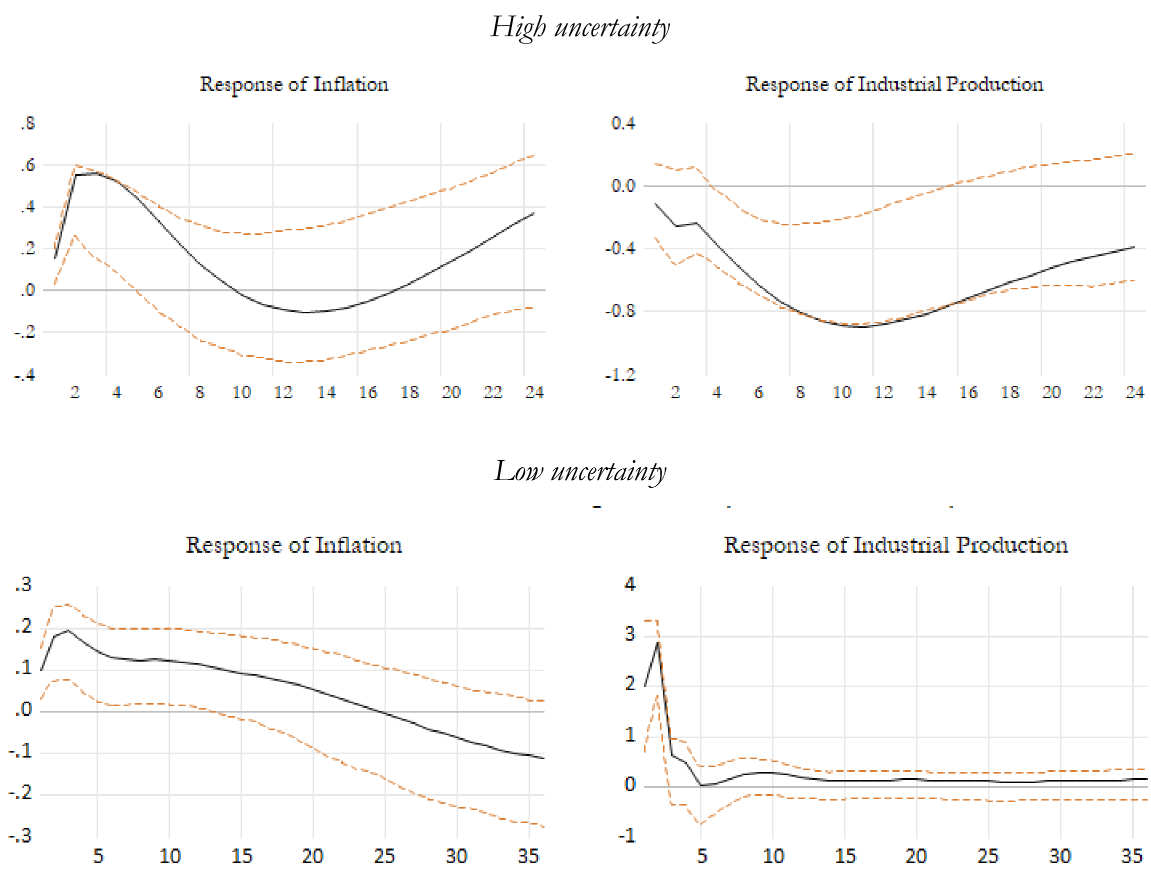

Figure 5: Impact of a monetary policy shock – Goods market

Notes: The solid line reports the mean, and the dotted lines report the 90% confidence intervals computed using bootstrapping with 1,000 replications.

Figure 6 displays the response of inflation and industrial production to a monetary policy shock within the high and low uncertainty states in the global market. The impact on inflation is only significant in the low uncertainty state, signifying that uncertainty in the U.S. dampens the effect of monetary policy shocks in SA.

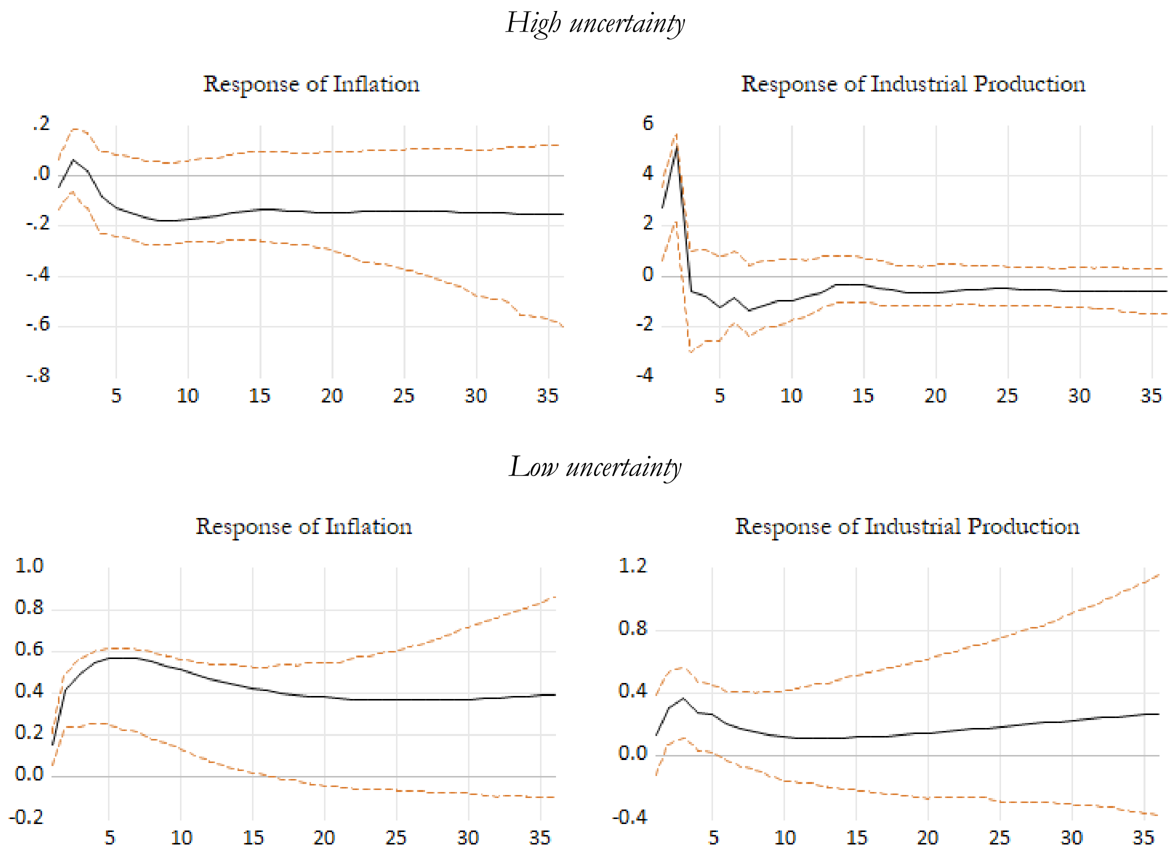

Figure 6: Impact of a monetary policy shock – Global market

Notes: The solid line reports the mean, and the dotted lines report the 90% confidence intervals computed using bootstrap with 1,000 replications.

Overall, these findings suggest that the effectiveness of monetary policy is generally weaker in the high uncertainty states in the different markets considered, seen by the lower impact on inflation which also tends to be short-lived when compared to the low uncertainty state. This finding is in line with the nonlinearities in the interest rate theory also found by other studies implementing the IVAR framework – those of Aastveit et al. (2017), Balcilar et al. (2017) and Pellegrino (2018, 2021). Results also point to the asymmetric effects of a monetary policy shock dependent on the uncertainty state.

5. CONCLUSION

This study investigated the impact of a monetary policy shock on macroeconomic variables as well as the efficiency of monetary policy in South Africa conditional on different uncertainty states in the goods, stock, currency and global market. This was investigated over the IT regime in SA from 2000:02–2022:05.

The impact of a contractionary monetary policy shock (a hike in the policy rate) is investigated through a reduced form VAR and analysing the GIRF. Results reveal that this type of shock: (i) stabilises inflation; (ii) has a negative effect on output; (ii) produces a liquidity effect and reduces broad money; (iii) has a negative impact on stock markets; and (iv) generate an appreciation of domestic currency. This points to the effectiveness of monetary policy in influencing the real economy and provides support for IT as a monetary policy regime.

The effectiveness of a monetary policy shock was analysed through a non-linear Self-Exciting Interacted VAR (SEIVAR) methodology, which allows investigation into how uncertainty states in markets affect the effectiveness of policy. Results found that monetary policy is weaker in the high uncertainty states in the domestic markets which is evidence of the non-linearities in the interest rate theory. Furthermore, heightened uncertainty in the U.S. also serves to dampen the effect of monetary policy in SA. This shows that when policy makers are faced with high uncertainty, they experience a trade-off between acting decisively and acting correctly, and this study lends support to theoretical studies that recommend more aggressive stimuli in uncertain times (see, e.g., Bloom, 2009; Bloom *et al.*, 2018). Even after endogenising uncertainty, monetary policy is found to be less effective in high uncertainty states, although to a lesser extent than what was found in previous studies.

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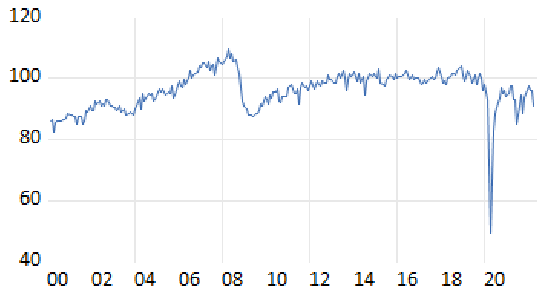
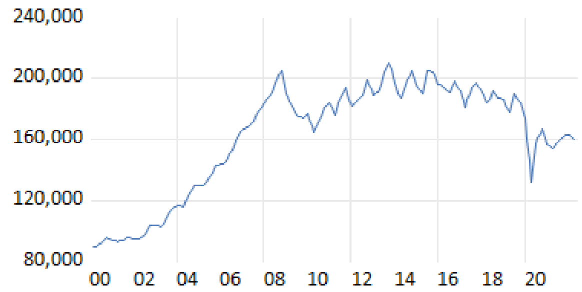
APPENDIX A

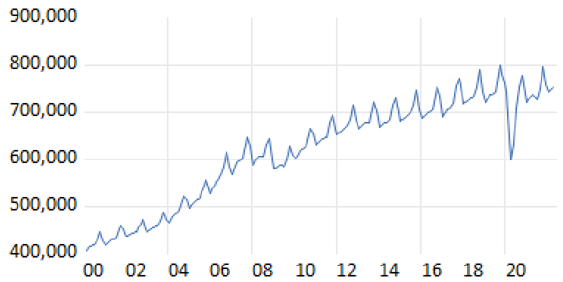
Industrial Production



Investment

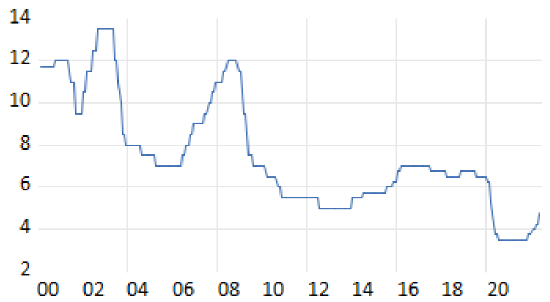


Consumption

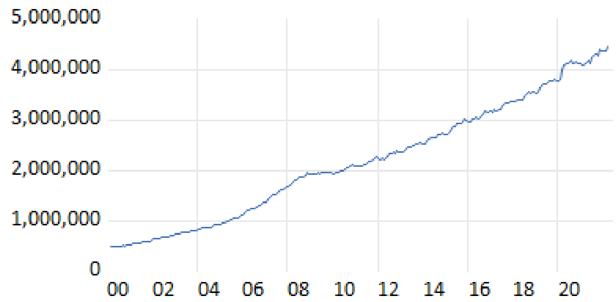


Inflation

Policy Rate

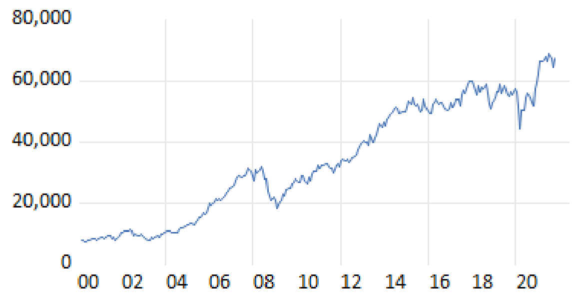


Broad Money (M3)



3-Month Treasury Bill

Share Price Index



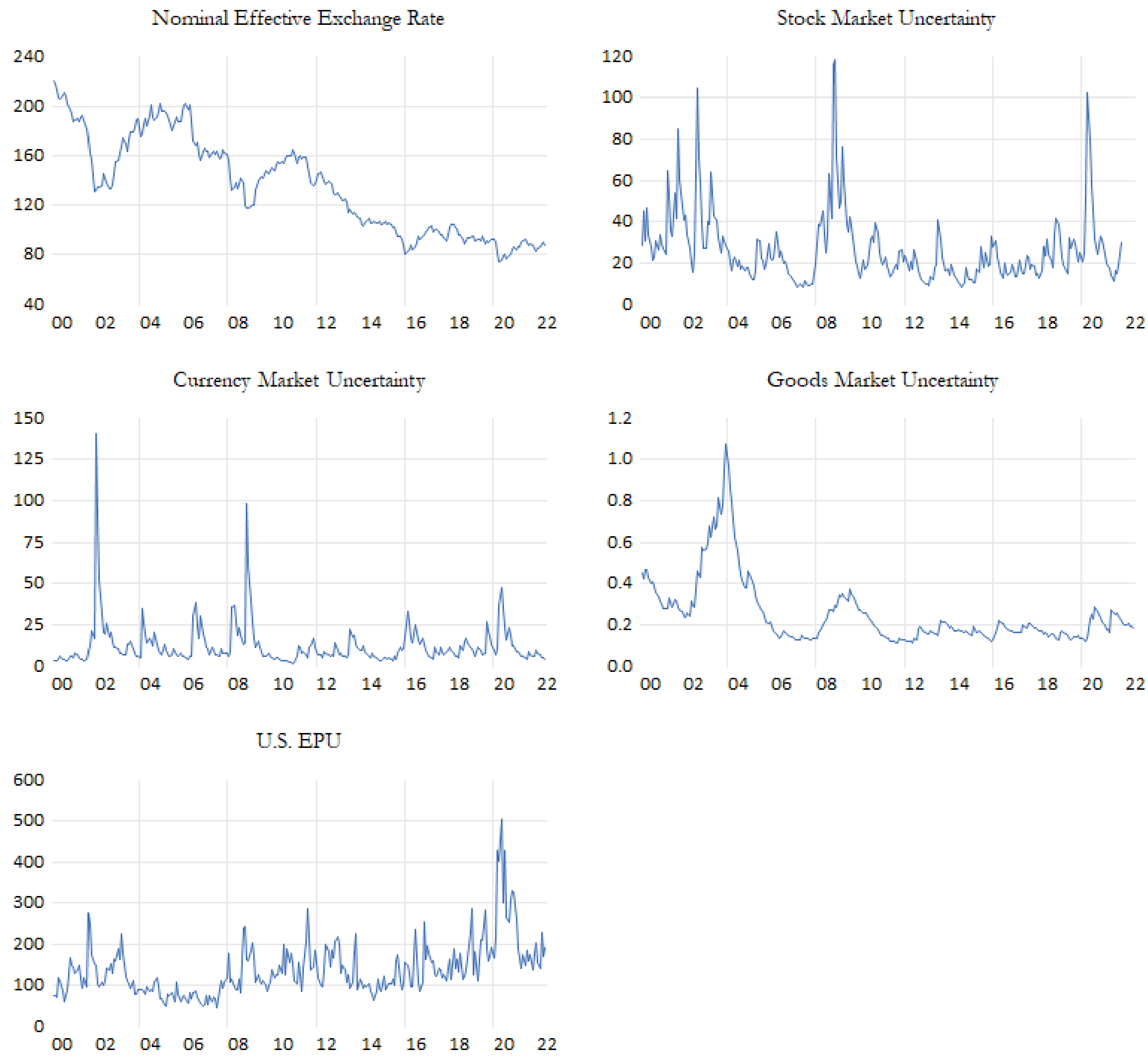
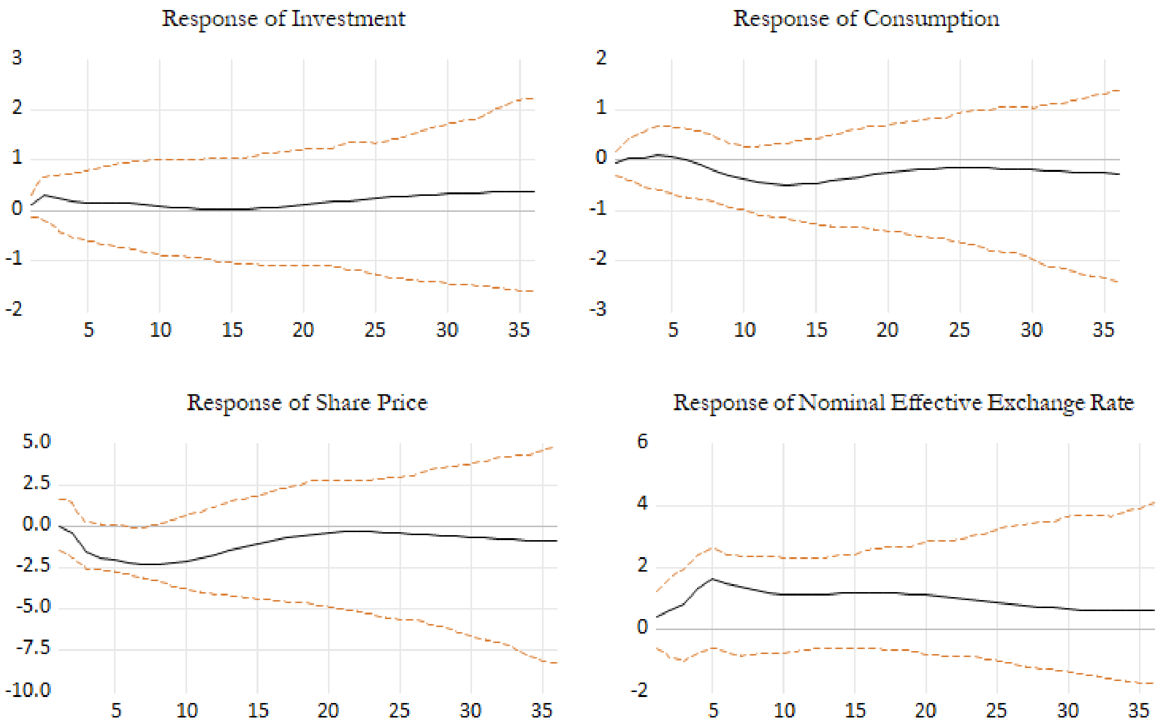


Figure A1: The plot of all variables.

Source: SARB database, IMF IFS database, Bloomberg, Baker et al. (2016). Note: Industrial production is the volume of production with index: 2015=100. Investment and consumption are measured in real 2015 prices in R millions.

High Uncertainty



Low Uncertainty

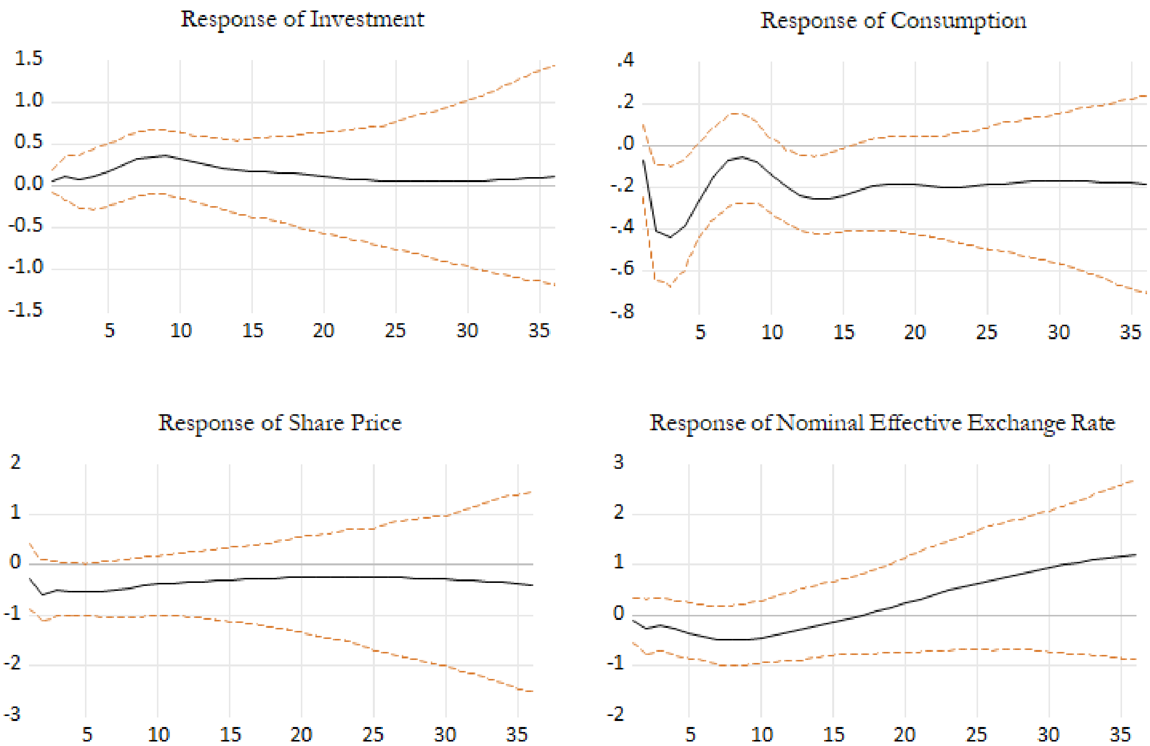
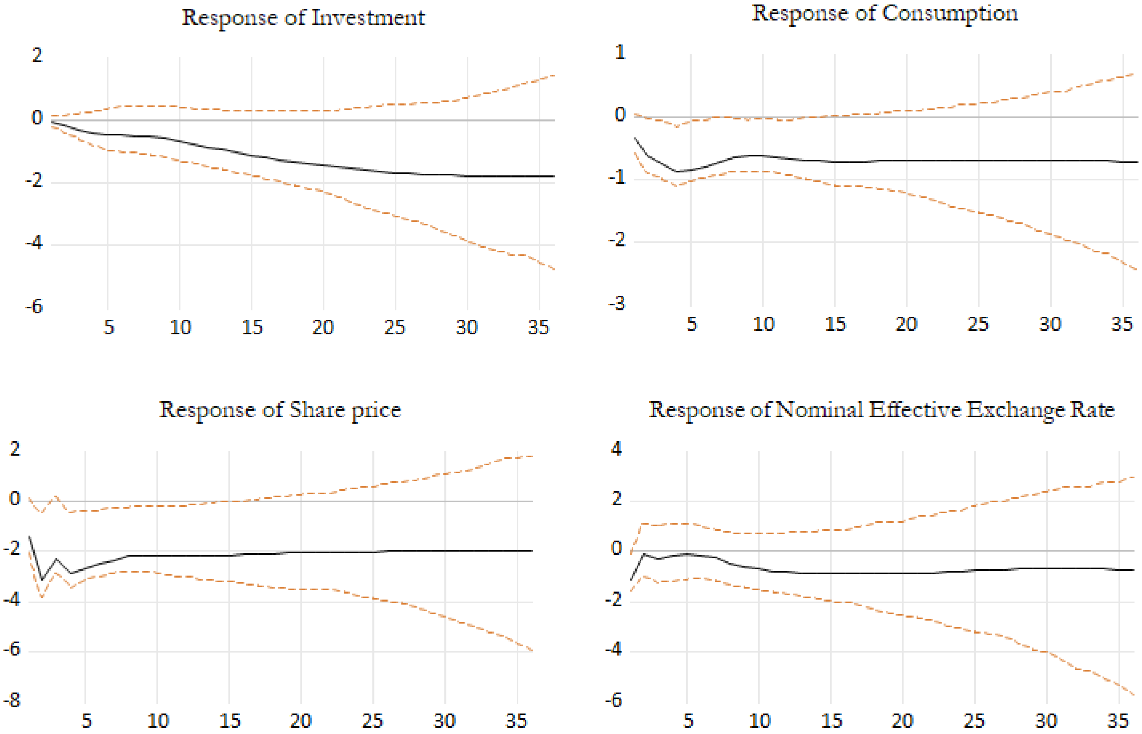


Figure A2: Impact of a monetary policy shock - Stock market

High Uncertainty



Low Uncertainty

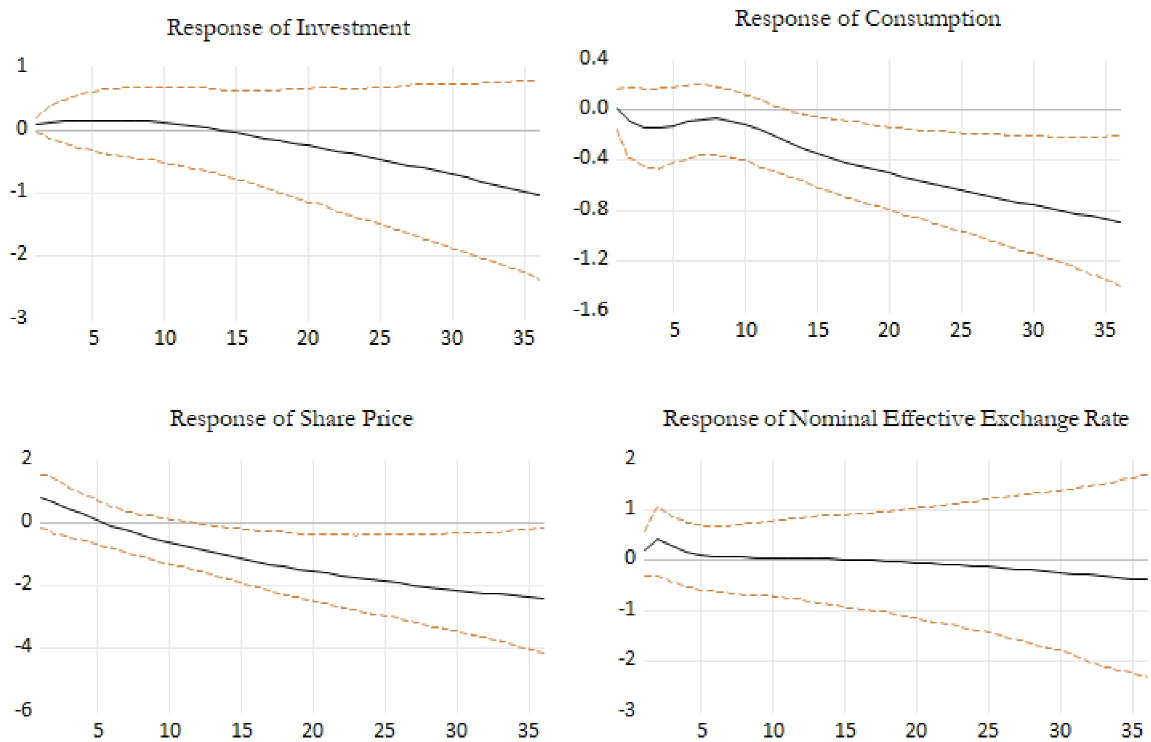
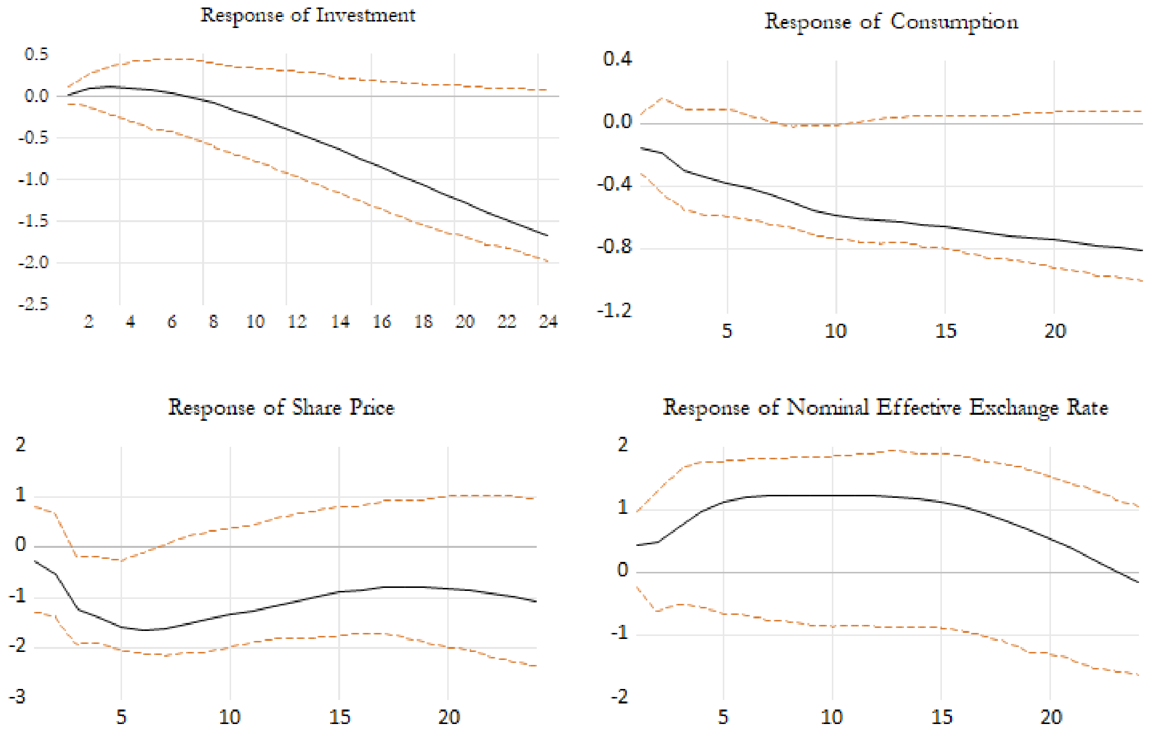


Figure A3: Impact of a monetary policy shock - Currency market

High Uncertainty



Low Uncertainty

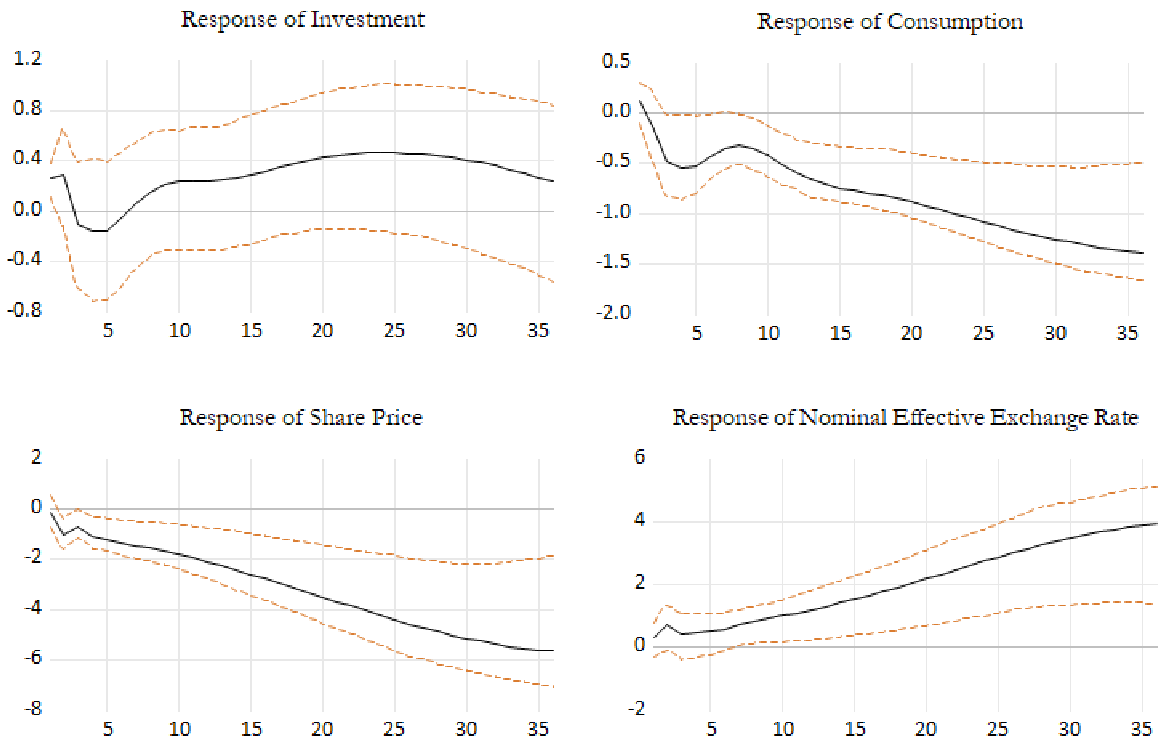


Figure A4: Impact of a monetary policy shock - Goods market

High Uncertainty

Low Uncertainty

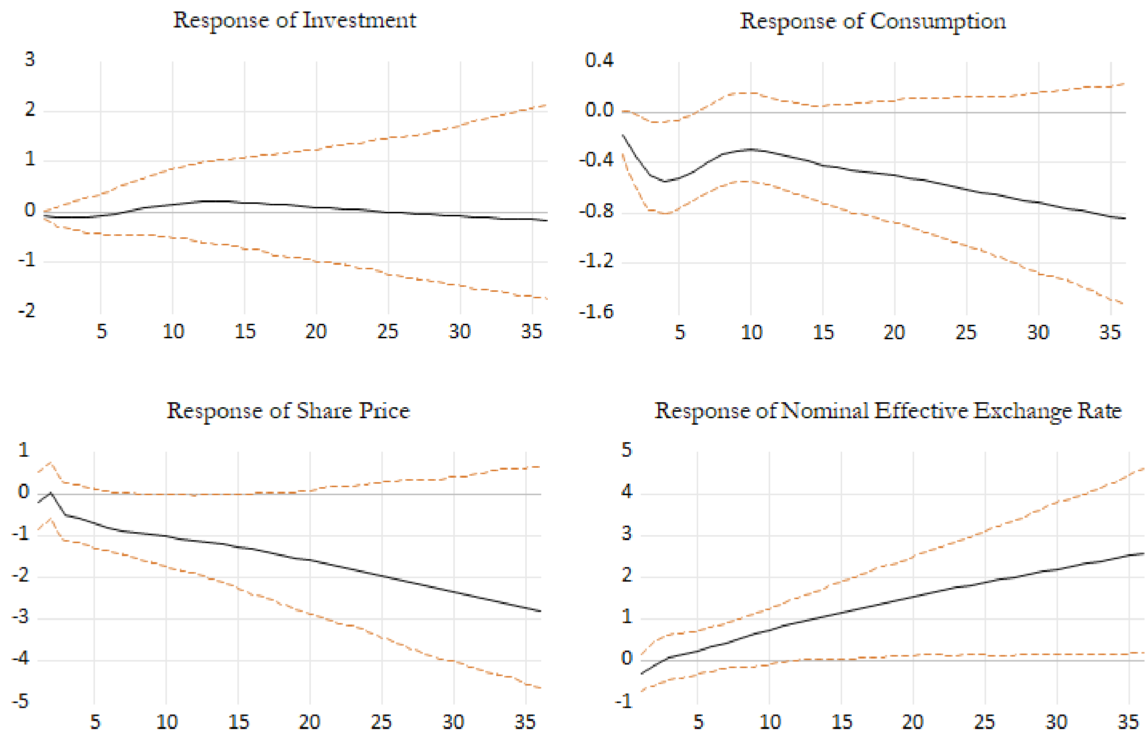


Figure A5: Impact of a monetary policy shock - Global market