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The Movement of Exchange Rate and Expected Income: Case of South Africa

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Abstract

Many studies have investigated the impact of expectations on the exchange rates. However, it remains a challenge linking the exchange rates to its fundamentals. This study seeks to determine the impact of expectations of future income on the exchange rates behaviour. In this study, we employ the Bayesian VAR method. The study finds that the expectations of income have effects on the exchange rate behaviour. Furthermore, the exchange rates behaviour is asymmetric.

Keywords: *Expectations; Income; Output; Growth; Exchange Rates; FDI.*

JEL Classification: *E51.*

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1. Introduction

One of the main drivers of exchange rates is expectations, which are determined differently in the developing and emerging economies (Kaltenbrunner, 2015). Barbosa et al (2018) observed that in developing countries, exchange rates are not driven by expectations that are linked to macroeconomic fundamentals only; and that the exchange rates also depend on institutional characteristics linked to international liquidity, which in turn are driven by expectations. In the short-run, expectations about capital flows assume an autonomous function of determining exchange rates (Harvey, 1991). Accordingly, exchange rates largely depend on lenders and foreign investors' portfolio decisions, which are driven by expectations (Andrade and Prates, 2013).

Akiba (2004) maintains that exchange rate behaviour depends on the combination of expectations formed in the short-run and the medium term. However, expectations cannot be observed, which means that knowledge about expectations is incomplete (Juselius, 2017). It has been extensively demonstrated in the literature that economic agents form expectations rationally (De Grauwe and Grimaldi 2005). This is consistent with the rational expectations hypothesis, which assumes that economic agents use available information efficiently to construct expectations. This is in accordance with Muth (1961), who argues that expectations depend on the current state of the economy.

In South Africa (SA) the authorities have undertaken reforms to promote economic growth. Among these reforms are economic and political changes that constitute implications for the expected level of future income. The reforms allowed the economy to be free to engage in international trade with various markets. The economic reform offered an opportunity to international investors to do business in SA. These reforms meant the economy could potentially experience higher levels of productivity and, hence, income. Reforming the economy also meant that the government could give investors mining rights and mineral resource exploration rights. The reform aimed to reduce uncertainty about investing in SA. The reforms involved trade agreements with other countries and trading blocs.

Hayat et al. (2013) demonstrated that signing production agreements, economic cooperation deals, and being a member of economic blocs, fuels expectations of future income. In addition, it leads to a significant appreciation of the real exchange rate. Fluckiger and Ludwig (2018) argue that economies who are members of the trade bloc tend to seek economic prosperity from exporting, which can be expected to lead to the domestic exchange rate appreciation.

Moreover, economies can expect to have higher levels of income in future because of signed export agreement.

Since 1994, the South African government has taken part in numerous trade agreements to promote SA's economic interest, which include: the European Union-South Africa Trade and Development Cooperation Agreement (EUSATDCA), Europe Free Trade Association (EFTD), Southern African Customs Union (SACU) and Southern African Development Community (SADC). In some trade agreements, SA enters automatically because of its regional bloc membership. By virtue of being a member of SADC, it affords SA an opportunity to participate in regional trade.

In addition, SA has bilateral trade agreements with these countries and others. Some of the raw material found in SA are considered rare by EU, China, and USA, as indicated, hence, are required for survival of some of their manufacturing industries (Andersson, 2020, Jin et al., 2020, Moore et al., 2023). These economies have big manufacturing sectors that require supply of raw materials from the rest of the world. In their respective economies, domestic supply of raw material is not able to meet manufacturing demand, which drives them to secure supply elsewhere (Andersson, 2020). This places SA at an advantageous position in terms of supplying raw materials to their manufacturing industries. SA has, for a protracted period, remained the largest economy in Africa with an advanced infrastructure. This advantageous position afforded attracting business from rapidly growing countries that require raw materials.

India and China have been among the fastest growing economies in the world, who are SA's trade partners, with growth rates above 6% a year (Dixit and Ghosh, 2013; Wang et al., 2019; Hubacek et al., 2007). A substantial amount of their growth is derived from manufacturing, which means more raw materials are required to sustain their economic growth (Andersson, 2020). However, domestic supply cannot meet the demand requirements to maintain the high level of economic growth. Therefore, to maintain production, they require additional supply.

These developments created expectations for future higher income, which Hayat et al. (2013) argue that it should lead to exchange rate appreciation. However, the exchange rate (SA Rand. ZAR and the United States of America, USD) has a long continuous depreciation swing. This is concerning because it suggests that the relationship between the exchange rates and expected higher income is different for ZAR/USD or is not understood. The challenge facing the literature and policy making is that it has not yet been established if the relationship is different in South Africa. If the characteristics of the relationship

are not understood, it could lead to implementation of wrong policies, and hence unintended consequences. In addition, the exchange rates depreciation is concerning because I make one wonder what amount of it can still be considered a deviation from the long run equilibrium.

This study is different because it examines the effects of expectations of future income on the exchange rate behaviour. It assumes the exchange rate is impacted asymmetrically by its fundamentals. Furthermore, the study uses a non-linear model to estimate the exchange rate behaviour. The data used in this study is detailed enough to provide unbiased results. The findings of this study are useful because they can be applied to other emerging economics with similar market characteristics as SA.

In addition, this study will fill the gap in the literature regarding an emerging economy's exchange rates response to expectations of future higher income. The South African Reserve Bank (SARB), which is the authority of monetary policy in SA and other stakeholders, are interested in knowing what the key factors that drive the SA exchange rate are. Furthermore, how exchange rates drivers can be managed effectively to achieve sustainable economic growth for SA. This study provides direction to these concerns. Finally, the remainder of the paper is organised as follows exchange rates fundamentals, methodology, data and variables, result and conclusion.

2. Literature on Exchange Rates

White (2015) explains that prior to the collapse of the Bretton Woods System, many economists thought that exchange rates would be stable if countries adopted flexible exchange rates (Dunn,1970; Lanyi,1969; Stoll, 1968). However, empirical evidence demonstrated volatile and unpredictable behavior of floating exchange rates. Meese and Rogoff (1983) showed that there is no link between the exchange rates and its fundamentals. Further to that, Pfahler (2021) proved that random walk models performed better than any other model in predicting the behavior of exchange rates. While Chang and Matsuki (2022) using recent data challenges this proposition, they state that the Taylor rule model of monetary policy outperformed random walk models.

Xie and Chen (2019) do not believe that monetary models of exchange rate determination are able to provide useful insight. Earlier Tawadros (2017) had found that the exchange rate behaviour is explained better by using monetary models. The accuracy of determining the behaviour of exchange rates has varied overtime when using the random walk (Ribeiro, 2017). The link between the

exchange rate and its fundamentals remains challenging, hence, the debate is yet to be settled. Moosa and Burns (2014) confirm that the random walk performs better compared to any other model, but the success has only been determining the direction of exchange rates. The point noted by Cheung et al. (2005), and Rossi (2013), is that there is no consensus among economists about the exchange rate behaviour in response to its fundamentals.

Voss and Willard (2009) attributed reasons for the dismal results to overlooking asymmetric effects on monetary models. There are many other reasons provided in the literature for poor performance of various models (Meese, 1990; Bacchetta and Wincoop, 2006; Evens and Lyons, 2005; Eichenbaum et al., 2018; Kohlscheen et al., 2017). However, the literature indicates that there is a link between monetary variables and exchange rates (Baharumshah et al., 2017). Engel and West (2005) were not able to find evidence that the exchange rate and its fundamentals are correlated. Rossi (2013) mentions that the literature indicates that out-off-sample estimations perform better compared to traditional fundamentals. However, Beckmann et al. (2011) confirm that some macro fundamentals show exchange rates predictability in the short run. The dismal performance for macro fundamentals in predicting exchange rates has been discussed by many researchers (such as Engel and West, 2005; Molodtsova and Papell, 2009; Taylor and Peel, 2000; Ghosh at al. 2016; Ahmed et al 2021; and Amat, at al. 2018).

Beckmann et al. (2011) declare that fundamentals are central in determining exchange rates, although their effects are significantly different in each period. However, the literature indicates that studies are not able to link floating exchange rates to their theoretical determinants (Itskhoki and Mukhin, 2021). This forms the basis of fundamental uncertainty, according to the Post Keynesian framework. While modelling the behaviour of exchange rates differs, Harvey (2009) argues that expectations of exchange rates are central in determining the exchange rates both in the short-run and the long-run. The expectations of the exchange rates are formed differently in various countries. This point is supported by Lavioe and Daiggle (2011), who argue that while there might be capital mobility, there are domestic conditions which impact on the free flow of capital. Furthermore, domestic limitations of free flow of capital are associated with each home country's regulations of the capital market.

It is common in the literature to use uncovered interest parity hypothesis to formulate expectations of exchange rates (Ismailov and Rossi, 2018; Engel, 2016), but it is contended that uncovered interest parity depends on arbitrary assumptions (Kilian and Taylor, 2003). The failure to model the behavior of

exchange rates implies that models used in the area of macroeconomic research are invalid or are largely incomplete. Furthermore, this erodes the policy suitability of these models and creates uncertainty about the impact of the fundamentals.

The literature recognizes the importance of examining the components related to higher future income, however, giving a considerable attention to the relationship between exchange rate behavior and stock of prices of oil. Mensi et al. (2017) evaluated asset prices and established that available fundamental information is a driver for a prevailing price of assets. Ngoma (2022) states that real exchange rates respond asymmetrically to an oil shock. Moreover, the shock triggering an increase in the oil price tends to be followed by a rapid exchange rate appreciation. The literature points out that the export of manufactured goods and natural resources affect the exchange rate behavior (McLeod and Mileva, 2011). These observations are confirmed by Bekun et al. (2019), who found that the Rand exchange rate depends on natural resources.

Deveruex and Yu (2019) reveal that the exchange rate has a time changing relationship with its fundamentals. While Engel et al. (2007) argue that current economic information about exchange rate fundamentals has little weight in determining exchange rates, the expectation about the fundamentals weighs more. This is supported by Beckmann and Czudaj (2017), who emphasize that the exchange rate responds to its expectations. Furthermore, the exchange rate behavior reflects available information. This is different from what the random walk predicts, which is that the exchange rate should not be affected by expectations of future income (Chakrabarti and Scholnick, 2002). Expectations of lower future output increase expectations of a lower interest rate in the future. So, if the exchange rate appreciates today, the likelihood of it depreciating in the future increases (Taylor et al., 2001).

3. Methodology

Following Van der Ploeg (2011), assume households consume tradable goods that are non-minerals, $\boldsymbol{C_t^T}$, imported from the rest of the world, and tradable good $\boldsymbol{C_t^N}$. Households' supply of labour is inelastic to domestic firms producing non-tradable goods. Assume the tradable good is dominated in the domestic currency. The price of the tradable good is exogenous, and it is determined by international demand $\boldsymbol{C_{wt}}$, which is

$$P_T = g(C_{wt},) \tag{1}$$

while domestic demand for the non-tradable good determines the price P_N, which is defined by

$$P_N = f(C_t) \tag{2}$$

Households maximize their utility by consuming both tradable and non-tradable goods. Following Cashin et al. (2004), each household's optimal level of consumption is given by

$$C_t = C_t^N + C_t^T \tag{3}$$

C_t, is equal to the sum of income from minerals, W_t and labour income H_t.

$$C_t = k_t(W_t + H_t) \tag{4}$$

here k_t captures preferences, other factors, and income, where as W_t and H_t includes current and expected present values of future income.

$$W_t + H_t = E_t\left[\sum_{i=t}^{\bar{T}} \frac{Y_i^W + Y_i^H}{(1+R)^{i-t}}\right] \tag{5}$$

here $\bar{T}$ is the life expectancy and R denotes the interest rate, while Y_i^H and Y_i^W both denote current income. We can define Y_i^H and Y_i^W as,

$$Y_{i+1}^H = \beta_H\left(Z_{i+1}^H, Y_i^H, \mu_i^H\right) \tag{6}$$

and

$$Y_{i+1}^W = \beta_W\left(Z_{i+1}^W, Y_i^W, \mu_i^W\right) \tag{7}$$

where Z_{i+1}^W denotes foreign firms' productivity, Z_{i+1}^H is Foreign Direct Investment (FDI) and $\mu_i^W(\mu_i^H)$ represents the shocks to income such as a mineral resource boom or a strengthening of economic ties between two trading countries.

The real exchange rate (e_t) is the ratio of prices of non-tradable good P_N, to tradable good P_T. Therefore, real exchange rate can be expressed as a function of the expected future income and international demand,

$$e_t = \frac{P_N}{P_T} \tag{8}$$

$$e_t = R\left(E_t\left[\sum_{i=t}^{\bar{T}} \frac{Y_i^W + Y_i^H}{(1+R)^{i-t}}\right], C_{wt}\right) \tag{9}$$

This equation shows that the exchange rate depends on current and expected future mineral and labour income, $E_t(.)$, and demand of imported tradable goods. It is important to note that $E_t(.)$ depends on FDI, government expenditure, productivity, or trade agreements.

3.1. BVAR Model

A Bayesian Vector Autoregressive (BVAR) estimating technique is applied on this theoretical framework. The BVAR is chosen because its results are produced by sampling from the posterior distribution of variables. The Bayesian estimation framework allows for the reduction of the variance of unrestricted least squares estimators. Furthermore, it allows inclusions of various information about VAR model parameters which are impossible at times to facilitate when using the frequentist analysis.

The frequentist analysis techniques rely on the existence of a parameter vector describing the data collected, which is obtained from the sample. Then inferences are made on the basis of the value of the parameter. These common methods of analyzing data assume parameters are non-stochastic, irrespective of them being stochastic in nature. This is where the Bayesian analysis differs from the common frequentist estimation technics.

In the Bayesian framework, the vector parameter is assumed to take a stochastic nature. The Bayesian analysis allows modeling perceptions about the parameter. The perceptions are weighed in probabilities distributions. There is no repeated sampling required, and the nature of data is not important for drawing inferences on the parameter. The observed data determines the inference in the Bayesian framework. The data is taken as given, while the parameter of interest is treated as unknown. This holds because the prior information on the variable of interest given is in a density form. Let's consider a VAR model.

$$y_t = \sum_{s=1}^{k} y_{t-s}\beta_s + z_t\vartheta + \varepsilon_t \qquad (10)$$

here β_s and ϑ are vector parameters of $n \times n$ and $j \times n$ dimensions respectively. The posterior probability distribution function (pdf) is the quadratic loss functiony_{t+b}, conditional on the observed data y_t, y_{t-1} and the independent variables z_{t+b}. Equation (10) is a partial system such that $\boldsymbol{z_t}$ may contain a deterministic time trend. The first difference of (22) $\boldsymbol{y_t^* = y_{t-1}^*\beta + z_tQ + \varepsilon_t^*}$, where $y_t^* = \{y_t, \dots, y_{t-k+1}\}$, $Q = \{\vartheta, 0, \dots, \}$, $\varepsilon_t^* = \varepsilon_t, 0, \dots, \}$ and

$$\beta = \begin{pmatrix} \beta_1 & I & 0 \dots 0 \\ \beta_2 & 0 & I \ddots \vdots \\ \vdots & \vdots & \ddots I \\ \beta_k & & \cdots 0 \end{pmatrix} \tag{11}$$

To examine how the results are generated, consider the following .

$$y_t(h) = \int F(\beta, \boldsymbol{Q}, \boldsymbol{y_t^*}, \boldsymbol{Z}, \boldsymbol{h}) v(\emptyset|y) \partial \tag{12}$$

where $v(\emptyset|y)\partial$ is the marginal posterior which is established from estimated parameters $\boldsymbol{\beta}$ and $\boldsymbol{Q}$, and where F(.) denotes the function of the forecast. We take the VAR system and express the posterior distribution with a Bayesian framework as show in the following equation.

$$F(\beta, \boldsymbol{Q}, \boldsymbol{y_t^*}, \boldsymbol{Z}, \boldsymbol{h}) = \boldsymbol{y_t^* \beta^h} + \sum_{\boldsymbol{s=1}}^{\boldsymbol{h-1}} \boldsymbol{z_{t+h-s}}\, \boldsymbol{Q} \beta^s \tag{13}$$

The stochastic variables in the future are assumed to be independent of ε_t, $E(\varepsilon_{t+s}|\boldsymbol{z_{t+s}}) = 0, s, w > 0$. This allows the posterior to be conditional to the observed situation. Equation (13) is a VAR linear function of parameters. However, the model becomes none-linear when the density distributions are estimated for a longer period.

We use the Minnesota Prior, which is characterized by a variance covariance matrix that is diagonal and fixed. Let us consider the prior for an ith period.

$$\delta_i = N\left(\bar{\delta}_i, \bar{\sum}_i\right) \tag{14}$$

Applying Bayesian framework, the posterior pdf is described by

$$\delta_i/y = N\left(\bar{\delta}_i, \bar{\sum}_i\right) \tag{15}$$

where

$$\bar{\sum}_i = \left(\sum_i^{-1} + \tau_{ii}\, U'U\right)^{-1} \tag{16}$$

Through rearranging:

$$\bar{\delta}_i = \bar{\sum}_i \left(\sum_i^{-1} \tilde{\delta}_i + \tau_{ii}^{-1} U' y_i\right) \tag{17}$$

The fixed diagonal components τ_{ii} are found in the Data Generation Process (DGP), since the covariance matrix of the residual is assumed to be diagonal. This is similar to stating the belief that the single element follows random walk behavior. The Menesota prior assumes that the information contained in the most recent lags consists of more relevant and reliable information. When the number of lags keeps increasing the coefficient matrix of β_s in equation (13), the posterior distribution converges and approach zero. The covariance matrix works to reduce the number of parameters to be estimated. A belief about each coefficient decay over its own lags is given by β_s/k. The parameter k denotes the number of lags, and it uses another variable $\emptyset$ to determine lags containing coefficients with relevant information (relative importance of its own lags).

$$Var[\beta_s] = \frac{\beta^2}{k}\begin{pmatrix} 1 & \emptyset\sigma_2^2/\sigma_1^2 & \dots & \emptyset\sigma_1^2/\sigma_n^2 \\ \emptyset\sigma_2^2/\sigma_1^2 & 1 & \dots & \emptyset\sigma_2^2/\sigma_n^2 \\ \vdots & \vdots & \ddots & \vdots \\ \emptyset\sigma_n^2/\sigma_1^2 & \emptyset\sigma_n^2/\sigma_1^2 & \cdots & 1 \end{pmatrix} \tag{18}$$

In this study, we also test the long-run relationship between expectations of income and the exchange rate behavior.

3.2. Variables and Data

The data is sourced from the SARB and the Federal Reserve Bank of St Louis. The sample stretches from 1994q1-2017q4. This study borrows from Hayat et al. (2013), who investigated expectations of higher future income resulting from the sale of oil. In this study we examine the expectations of income as a direct consequence of mineral resources. The behaviour of the exchange rate is a function of the terms of trade tot_t, which relate positively to the real exchange rates, the foreign direct investment FDI_t, which is capital coming from the rest of the world. Furthermore, the higher the FDI, the more the exchange rate is expected to appreciate. The study also includes investment I_t, excluding FDI, as the exchange rates depend positively on the Investment. Then the interest rate i_t is included, which relates to the exchange rates through the flow of capital. When the interest rate increases relative to the rest of the world, the exchange rate is expected to appreciate. The degree of openness $open_t$, is positively related to the exchange rates. The expected income Y_{t+1}^e, is measured using mineral resources reserves. The model is the relationship being analysed in this study;

$$e_t = \beta_1 + \beta_2 Y_{t+1}^e + \beta_3 tot_t + \beta_4 I_t + \beta_5 FDI_t + \beta_6 i_t + \beta_7 Open_t + \beta_8 MP_t + \varepsilon_t$$

3.2.1. Real Exchange Rate

Firstly, an explanation of the causes of the exchange rates shift is provided. Edward (1989) defines real exchange rates as the ratio of non-tradable prices to tradable prices of goods, which ensures simultaneous internal and external equilibrium. When the non-tradable goods market clears in the current period, the internal equilibrium occurs and the same is expected to repeat in future. While external equilibrium occurs when the current account balance is zero inter-temporally, the real exchange rates are expected to be at equilibrium. Therefore, real exchange rate behaviour should reflect dynamics exhibited by fundamentals in the economy.

The exchange rate of the South African Rand against the United States Dollar (USD) has a sustained long depreciation swing (see Figure 1). From 1994 to the end of 1996 the domestic exchange rate was stable. Thereafter, the Rand began depreciating rapidly against the USD. Then the rate of depreciation slowed down at the beginning of 1998 until 1999. The depreciation rate picked up in 1999, before slowing down just before the year 2000 to the end of 2001. In the year 2002, the Rand reached the highest-level of depreciation against the USD since 1994. The depreciation seen in 2002 caused the government to institute the Mayberg Commission 2002, which investigated the cause of the Rand exchange rate depreciation. However, soon after, the Rand gained strength against the USD until 2007. Then the exchange rate depreciation lasted until the last quarter of 2009. Thereafter, the Rand gained strength against the USD until 2012. In the years after 2012, the Rand experienced a sharp depreciation against the USD until 2016. In 2016, there was a pick, which characterised the highest depreciation seen in the history of the Rand. Then in the following years the Rand became stable against the USD. In the subsequent years, the exchange rate experienced slight appreciations. However, the Rand exchange rate has not appreciated enough to go back to 1994 and 1995 levels. The exchange rate does gain strength in some instances, but not enough to reverse the losses.

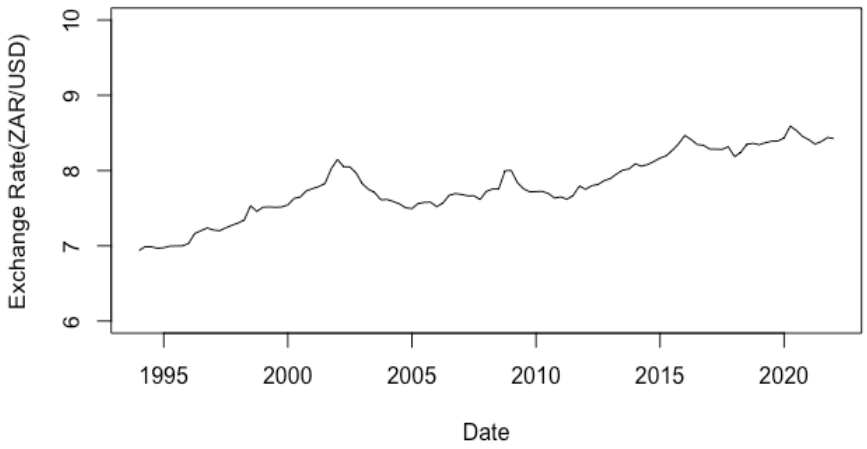

Figure 1. Exchange Rage (ZAR/USD) 1994-2021

3.2.2. Expectations of Income

Following Masedua et al. (2018), we use mining reserves to measure expectations of future income. The quantity of the reserves depends on new discoveries or revision of previous estimates. The invention of new technology also enhances the available quantity in terms of how it is used. The exploration can also provide new knowledge about the deposits that are still underground, which might have been overestimated or underestimated. If new mineral reserve deposits are discovered, the expectations of future income will be higher. Conversely, when new information shows that the mineral reserve deposits are lower than previously estimated; this lowers the expected income in the future.

The mining reserves (MR) changed from 1994 to 2021 (see Figure 2). The quantity of MR increased from 1994 to 1996, thereafter, declined until the end of 1998. The late 1990s can be seen with higher reserves, and it is a period characterized by a sharp increase in the quantity of deposits. This could be due to foreign firms coming to SA to do business, hence, more exploration leading to new discoveries of mineral resources. The period from 2003 to 2011 saw the quantity of mineral resources increase sharply. Then from 2011 to 2014, the quantity of mineral deposits was relatively stable. In the beginning of 2015 first

quarter, there was a decline in the number of deposits. The end of the second quarter of 2015 marked the beginning of a period where the MR was stable until 2017. In the end of the second quarter of 2017 the MR increased, and from there, it increased slightly until 2019 first quarter. Since then, the quantity of reserves fluctuates with a slight upward swing.

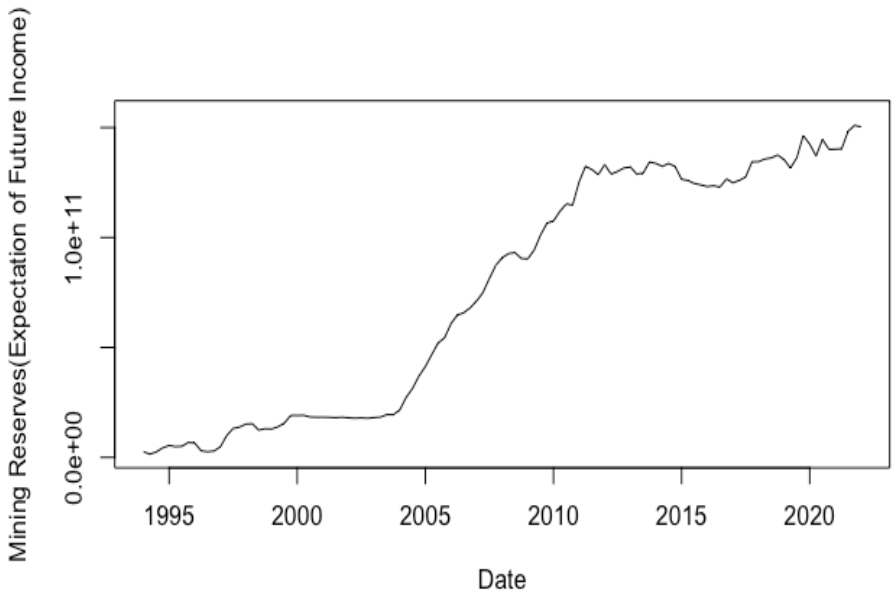

Figure 2. Exchange Rage

The mining reserves are used as the measure of expectations of future income. In this study, the level of income is allowed to vary in the entire period of the sample, starting from 1994 to 2021. Following Beek (2021), we assume the impact of natural resources on the exchange rate is asymmetric. Therefore, following Kassi (2019), we assume fundamentals have asymmetric impact on the exchange rates. We use the Schorderet (2003) method to decompose the expectation of income to allow for asymmetric impact on the exchange rates. The variable is decomposed into two components, which are: expected higher future income (positive) and expected lower future income (negative). The equation below shows a decomposed series into positive and negative components.

$$\emptyset_t = \emptyset_0 + \emptyset_t^+ + \emptyset_t^- \quad (19)$$

where $\emptyset_t$ is a scalar I (1) variable, $\emptyset_0$ represents the values occurring in the beginning and $\emptyset_t^+$ and $\emptyset_t^-$ are decomposed variables. For more on the decomposition of the variable (see Nzimande and Msomi, 2016).

Other control variables used in the analysis are terms of trade, mining production, foreign direct investment, Interest rates and investment. The impact of these variables on the exchange rate behaviour is extensively discussed in the literature (see among others Tawadros, 2017; Chueng et al., 2004: Engel et al., 2007; Beckmann et al., 2011; Lavioe and Daiggle, 2011; Engel and West, 2005).

4. Results

We run a BVAR to test the impact of expectations of income on the exchange rate. The result of the BVAR is shown in the subsequent table which considers the positive component of expectations associated with higher income. The negative value on the coefficient means the domestic exchange rates is appreciating. While the positive sign of the coefficient means a depreciation of the domestic exchange rates. The following table shows the results when the income is expected to be higher.

Table 1. Bayesian VAR estimation results with higher expectations of income

	EX
Exchange Rates (-1)	0.652493
Exchange Rates (-2)	0.084701
Expectations of Income (-1)	-0.029899
Expectations of Income (-2)	0.008680
Interest Rates (-1)	0.000921
Interest Rates (-2)	-0.002944
Foreign Direct Investment (-1)	0.093743
Foreign Direct Investment (-2)	0.033457
Investment (-1)	0.163656
Investment (-2)	-0.026206
Degree of Openness (-1)	0.022363
Degree of Openness (-2)	-0.016792
Mining Production (-1)	-0.224776
Mining Production (-2)	0.067339
Terms of Trade (-1)	-0.358636
Terms of Trade (-2)	-0.139438
intercept	0.379430

In period t-1, given that the economic agents expect future income to be higher than in the previous period, the exchange rate is likely to appreciate (see Table 1). This is consistent with what is demonstrated in the theory. In period t-2, given that income is expected to increase in the future, the exchange rate is more likely to depreciate. This is not expected, but it might mean previous expectations about mineral recourses have unexpected effects on the exchange rate behavior. This is similar to what Singhal et al. (2019) observed for the Mexican peso.

Investment produces unexpected results in time t-1. Given the investment increased, the exchange rate is likely to depreciate. These results are contra to predictions of theory. However, time t-2 produces results that are consistent with theory, given that investment increases, the exchange rate is more likely to appreciate. These results are expected and comparing the probability to period t-1, it is larger.

Given that the economy is open to international trade in time t-1, the exchange rate is likely to depreciate. These results are not expected. The theory assumes the more open the economy becomes the higher is the number of skilled labour. The economy will be efficient in production, hence, export more, resulting to an increase in demand for domestic money. High demand for domestic money leads to an appreciation of the home currency.

Given that mining production increased in period t- 1, the exchange rate is likely to appreciate in the current period, which is consistent with the theory. However, given that mining production increased in period t-2, the exchange rate is likely to depreciate in the current period. These results are consistent with what is expected. This is expected because having increased output in the previous periods means a fall of the level of output can be expected in the future. This means that some economic agents may expect the exchange rate to fall as a result of a low production, hence, low exports.

The following table display the result of the BVAR. The test is run to determine what is the impact of the expectations of income on the behaviour of the exchange rates. The difference of the result shown in the table below is that we use the component of expectations that capture the expected fall of income.

Table 2. Bayesian VAR estimation of lower expectations of income

	EX
Exchange Rates (-1)	0.637800
Exchange Rates (-2)	0.088941
Expectations of Income (-1)	-0.028334
Expectations of Income (-2)	-0.001733
Interest Rates (-1)	0.000670
Interest Rates (-2)	-0.002700
Investment (-1)	0.147780
Investment (-2)	-0.015046
Foreign Direct Investment (-1)	0.094562
Foreign Direct Investment (-2)	0.035148
Degree of Openness (-1)	0.021653
Degree of Openness (-2)	-0.013712
Mining Production (-1)	-0.205413
Mining Production (-2)	0.051909
Terms of Trade (-1)	-0.360941
Terms of Trade (-2)	-0.138045
intercept	0.391813

Given that in period t-1 future income is expected to fall in time t, the exchange rate is likely to appreciate (see Table 2). The results are inconsistent with economic theory. When there are less deposits available, the supply falls, which leads to higher prices of minerals. The increase in prices of commodities leads to higher demand for domestic currency, which is used in exchange for minerals. Considering that the anticipated future income in period t–2 indicates an expected decline in period t, the exchange rate exhibits depreciation (refer to Table 2).

Suppose investment in t-1 increases, the exchange rate is likely to depreciate. This effect of investment on the exchange rate is not expected. While it is given that investment increased in t–2, the exchange rate appreciates in the current period (see Table 2). This is consistent with the theoretical prediction. With the observed increase in the interest rate in t–1, the probability that the exchange rate will depreciate in period t, increases. The increase of the interest rate in t–1 leads economic agents to expect a decline in period t or t+1, hence, the exchange rate to depreciate, which might be putting pressure on exchange rate behaviour(see Table 2). Given that interest rates rose in t–2, the probability that

the exchange rate will appreciate increases. These results are consistent with the predictions of the theory.

With the increase in FDI observed in t-1, there is a likelihood that the exchange rate will depreciate. The exchange rate does not respond to FDI as expected. There might be unobserved factors working against FDI's impact on the exchange rates. The same results are obtained in t–2. On the other hand, when the degree of openness increased in t–1, the exchange rate is likely to depreciate. It is possible that there is an unobserved factor putting pressure on the exchange rate to depreciate. The degree of openness is not responding as expected. Whereas, the degree of openness increased in t–2, the probability that the exchange rate appreciates increases. On contrary, when mining production increased in t–1, the probability that the exchange rate will appreciate increases; while at time t–2 if mining production increased, the exchange rate is likely to depreciate (see Table 2). This is not consistent with the expected response of the exchange rates to variations of mining production. There might be some unobserved factors putting pressure on the exchange rate to depreciate. However, it might be that the effects of the increase in mining production took place long ago. So, in period t mining production might no longer have impact on the behaviour of the exchange rates. The terms of trade in both time periods t–1 and t–2, given they increased, the probability that the exchange rate will appreciate increases.

The following discussion is for the results of the BVAR with expectations of future income not decomposed into positive and negative components.

On the other hand, when we refrain from breaking down expectations of future income into two distinct parts and instead consider it as a singular entity,we observe following results.

First, when expected future income is increased in t-1, the exchange rate is likely to appreciate; whereas, in t-2 the exchange rate is likely to depricate. The anticipation of future income does not exert an influence on exchange rate behavior. The fluctuations in the exchange rate are likely attributed to latent factors that are believed to be exerting pressure, prompting a tendency for depreciation. The probabilities vary, and the outcomes are diverse, highlighting asymmetric effects on exchange rates.

Second, when the interest rate increased in t–1, there is a likelihood that the exchange rate will depreciate; contrary to the anticipated response in exchange rate behavior. The rise in interest rates during the previous period may be interpreted as an expectation for future increases, causing economic agents to

anticipate exchange rate depreciation in the current or upcoming periods. Consequently, economic agents' beliefs drive the exchange rate in the opposite direction.

Third, an increase in FDI will contribute to a probable depreciation of the exchange rate in both t–1 and t–2 periods. Unobserved factors counteract the influence of FDI, resulting in the depreciation of the exchange rate. The distinct probabilities highlight the asymmetric behavior of the exchange rate.

Fourth, with an increase in investment in t–1, the exchange rate is likely to depreciate, introducing suspicion about additional factors affecting the exchange rate. The unexpected response of the exchange rate contradicts prevailing theories. Conversely, when investments increased in t–2, the likelihood of the exchange rate appreciating rises, showcasing different behavior in response to the same variable across distinct periods and indicating an asymmetric behavior of the exchange rate.

Fifth, an increase in the degree of openness in t–1 is likely to lead to exchange rate depreciation, contrary to the expected behavior. The dominance of unobserved factors overrides the impact of increased openness. However, when the degree of openness rises in t–2, the probability of the exchange rate appreciating increases. Over time, the influence of openness on exchange rate behavior becomes more prominent, showcasing asymmetrical behavior that varies with the elapsed period.

Sixth, an increase in mining production at t–1 might cause the exchange rate to appreciate in period t. However, an increase in mining production at t–2, seemingly generates negative impact on the exchange rate, reflecting varied effects depending on the period. These differing probabilities underscore the asymmetric response of exchange rate behavior to mining production.

Lastly, when the terms of trade improve in both t–1 and t–2, there is a probability of the exchange rate appreciating in period t, but the distinct probabilities for each period indicate an asymmetric behavior of the exchange rate.

5. Conclusion

This study has shown theoretically and empirically that expectations of income affect the behaviour of the exchange rate. Firstly, the exchange rate movement is asymmetric to the shock of expectations of income. Secondly, the expectations of higher income have an impact on the exchange rate behaviour if

they are made in the recent past. Finally, the expectations of higher income formed in a distant past result in the exchange rate depreciation.

This study also discovered that the expectations of a fall in income lead to an appreciation of the exchange rate. However, there are signs that the exchange rates might be influenced by unobservable factors. But the investigation of the unobserved factors is beyond the scope of this study.

We recommend that the SARB or government should use expectations of higher income to manage or to influence the behaviour of the exchange rates. The timing of forming expectations must be considered because recent expectations of higher income lead to an exchange rate appreciation. The expectations of higher income formed in a distant past longer than t-1 cause the exchange rate to respond by depreciating. Accordingly, for expectations to have an impact on the exchange rate, the lag between forming expectations and period t must not the too long.

The expectations of lower income cannot be relied on since there are signs of that they are being influenced by unobserved factors. As has been noted, the impulse responses give results that have no significance. However, the results show that the exchange rates do not go back to equilibrium.

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