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April 2019

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Abstract: This study investigates the effect of real exchange rate volatility on the distribution of income between labour and capital in South Africa. Both symmetric and asymmetric effects are considered. Using quarterly data for 1985:1–2018:3 and local linear projection, we find that the immediate response of labour's income share to a one standard deviation shock in exchange rate volatility is negative. Moreover, high exchange rate volatility impacts negatively on labour's income share, while low exchange rate volatility impacts positively on labour income. As the magnitude of the effect of high exchange rate volatility is greater than that of low exchange rate volatility, the study documents evidence of an asymmetric effect. A shock increase in some control variables (real gross domestic product, investment, and openness) is followed immediately by a decline in labour income, while an increase follows a positive shock in the relative price of investment. The policy implications of these findings are discussed.

Keywords: functional distribution of income, inequality, real effective exchange rate volatility, South Africa, uncertainty

JEL classification: E25, F31, F41, J38

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1   Introduction

Globally, inequality has become an important topic in the policy and academic arena, and especially salient since the 2007–08 global financial crisis. Inequality has gone beyond being a purely normative issue that is interesting to policymakers only when social justice matters; it is now recognized as a factor influencing economic growth, macroeconomic conditions, and other policy-relevant economic variables (Dagdeviren 2007; Easterly 2007).

Even though poverty and inequality have been of overriding concern in South Africa's development policies and programmes since its democracy in 1994 (as reflected for instance in social wage interventions, the main redistributive tool of the government: free primary healthcare, non-fee-paying schools, old age and child support grants, housing, and free basic services such as water, electricity, and sanitation), measures of poverty, inequality, and related phenomena in the country do not show a clear improvement, and in important respects show significant worsening.
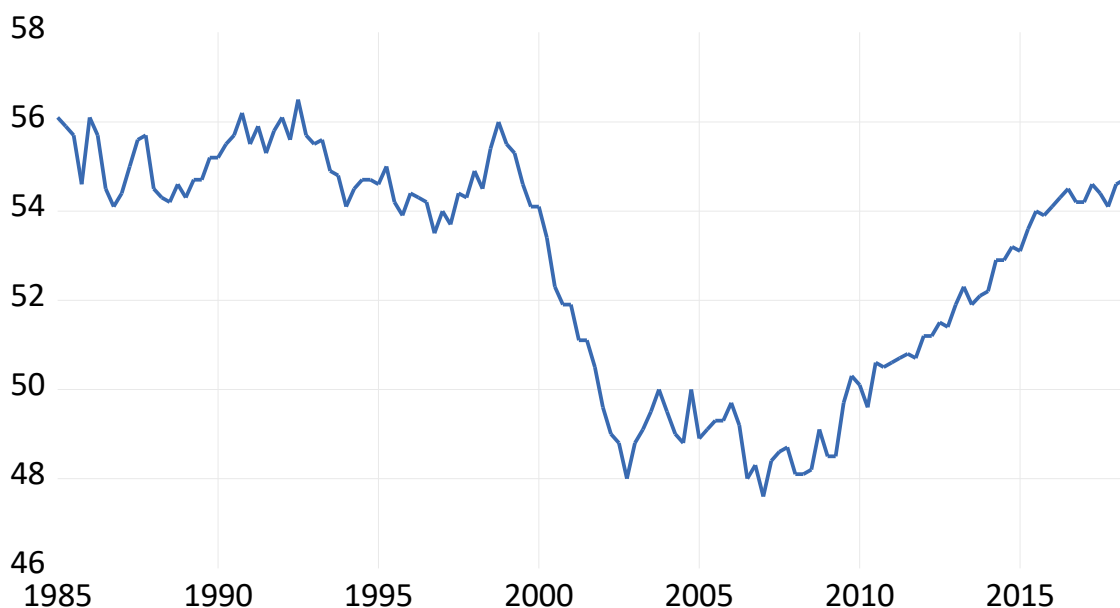
According to the World Bank (2018), in the third quarter of 2017, the aggregate unemployment rate in South Africa was 27.7 per cent, while that of youth stood at 38.6 per cent, principally comprising unskilled youth. Although some declines in poverty were witnessed, as poverty fell from 51 per cent to 40 per cent between 2006 and 2015 when measured by the national lower-bound poverty line (758 South African rands per person per month), based on 2015 income levels some 55 per cent of South Africa's population were poor when measured by the national upper-bound poverty line of 992 rands per person per month in 2015 prices.

One standard way of looking at income inequality is the Gini coefficient, which is based on household surveys and hence is calculated at the micro level. A World Bank (2018) report shows that South Africa's consumption-per-capita Gini coefficient was 0.63 in 2015, having increased since 1994, a trend that is also indicated in Atkinson et al. (2017). By this measure, South Africa is one of the most unequal countries in the world.

In this paper we adopt an alternative way of looking at income inequality: the functional distribution of income. From a macroeconomic perspective, we focus on the share of total income (measured as gross value added) accruing to labour relative to the share accruing to the owners of capital. The labour income share represents the functional distribution of income, while the Gini coefficient represents personal income distribution (Guerriero and Sen 2012). The two measures are related by the fact that income inequality is explained by the distribution across the population of the returns to labour and capital and the evolution of capital and labour shares (Rao et al. 2019). Given the high concentration of capital ownership, and hence capital income, in fewer individuals relative to salaries and wages, a declining labour income share and an increasing capital income share could contribute to increased income inequality (Burger 2015; Piketty 2014).

The labour income share in South Africa has exhibited short-term volatility (Figure 1), contrary to the stability of factor shares that economic theory might lead us to expect in the absence of short-term technology volatility. After the establishment of democracy in 1994, the share of national income going to those whose income depends on labour fell significantly from its stable range of 54–56 per cent to a nadir of approximately 48 per cent in 2008, while the share of those who own capital (mostly the top deciles of the wealth distribution) rose. Recovery in labour's income share followed, but the post-1994 fall and likely hysteresis effects led to high poverty, inequality, and unemployment being identified as the triple challenge in South Africa's National Development Plan 2030 (World Bank 2018).

Figure 1: South Africa's labour income share (%)

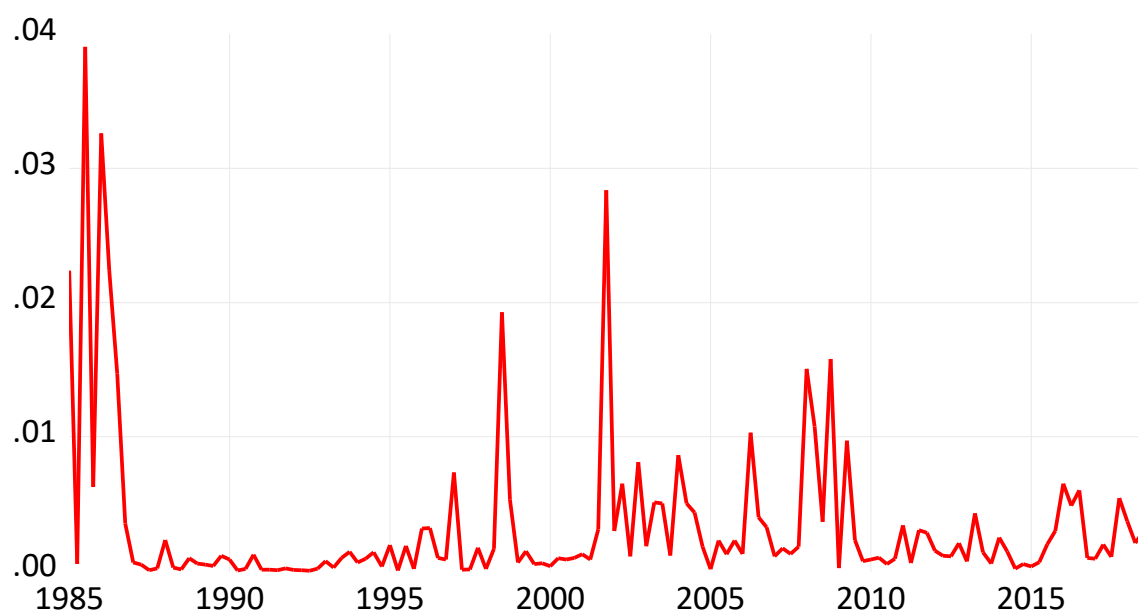
Source: authors' calculation based on data from SARB.

The persistence of inequality in South Africa requires a thorough examination of its drivers in order to contribute to the policy debate on its reduction. According to the National Development Plan 2030, raising living standards to the required minimum level will involve various mechanisms such as increasing employment, incomes, productivity, social protection, and quality public services. The World Bank (2018) report also identifies the role of education or skills creation and the labour market (90 per cent of the overall Gini coefficient during 2006–15 is attributed to the labour market) in reducing poverty and inequality in South Africa, while the role of social protection as a fiscal redistributive instrument is seen as limited. The need for more job creation and human capital development is also identified by Keeton (2014).

However, increasing financial and trade openness globally in recent decades has brought the role of exchange rates in inequality to the fore. Alexander (1952) was the first study that argued that a devaluation or depreciation will result in inflation, and that if wages do not fully adjust to inflation, there will be a transfer of income from workers to producers. Therefore, it is expected that a depreciation will increase inequality (Bahmani-Oskooee and Motavallizadeh-Ardakani 2017). A report by the United Nations Development Programme (UNDP 2013) also argues that the exchange rate policies initiated under the Washington Consensus have had adverse impacts on inequality, especially in developing economies; hence, these economies are encouraged to adopt either a peg or a freely floating exchange rate regime. However, Tinner (2015) notes that adopting either of these puts developing economies at risk of currency crisis and large currency devaluations, as the resulting inflationary shocks lead to declining real wages, which has greater impact on lower-wage earners, thereby worsening income inequality. Prasad (2014) also argues that while the distributional consequences of fiscal policy have received more attention, a broad range of other macroeconomic policies have received less attention, even though they could also have significant distributional consequences. This is particularly the case with monetary policy and financial sector policies. He adds that these consequences deserve more attention, especially in emerging economies, where the financial markets are often incomplete and imperfect: economic agents' limited access constrains their ability to insure against the effects of monetary and financial policies, thereby amplifying the distributional impacts of aggregate macroeconomic fluctuations and related policy responses.

The renewed interest in the relationship between exchange rates, other macroeconomic variables, and inequality is the context for this study of the influence on the functional distribution of income (as a proxy for income inequality) in South Africa. South Africa is a small open economy that was reintegrated into the world economy in 1995 after economic sanctions due to apartheid. The exchange rate policy in South Africa has undergone different changes over the past 30 years: the exchange rate was pegged to sterling before 1970 under the Bretton Woods system, followed by a managed float during 1970–2000, to the current fully floating regime under the South African Reserve Bank's (SARB) inflation-targeting framework since 2001 (Khomo 2018; Reinhart and Rogoff 2002; Rossi and Galbraith 2016). Under the freely floating exchange rate regime, the value of the rand is directly determined by market forces. Flexible exchange rates can lead to excessive short-term exchange rate volatility and currency misalignments (Lafrance and Tessier 2001). The South African rand is one of the most volatile currencies relative to other emerging economies, due to South Africa's close integration into the world economy and its liquid and well-developed foreign exchange market (Aye et al. 2015; Hassan 2015; Khomo 2018; Mpofu 2016). This exchange rate behaviour may have not only aggregated consequences for macroeconomic stability but also distributional consequences.

Policymakers and investors in general may prefer stable exchange rates, since stability reduces uncertainty, helps in accurate planning, and hence improves economic performance. This is particularly important given that the South African rand exhibits cyclical appreciation and depreciation trends. These trends coincide with high levels of volatility (Figure 2). They hence pose challenges for policymakers, investors, and consumers, among others, and may have both social and economic consequences. Therefore, besides the level of the real exchange rate, exchange rate volatility may engender uncertainty, with potential impacts on trade, investment, employment, inflation, and economic growth (Ames et al. 2001; Fu and Li 2014; Khomo 2018; Vieira et al. 2013). Such consequences for macroeconomic variables can have effects on the functional distribution of income. As Guzman et al. (2018) argue, under the assumption that firms are risk-averse, and in the presence of non-convexities such as those associated with bankruptcy costs, firms will care about not only the average exchange rate level but also its volatility. Therefore, the current study focuses on the volatility of the exchange rate and how this affects the functional distribution of income in South Africa.

Figure 2: Real effective exchange rate volatility

Source: authors' calculation based on data from SARB.

There are several studies that have examined the relationship between exchange rate volatility and macroeconomic variables such as trade, investment, economic growth, employment, and inflation, among others. There are also studies that have linked exchange rate level and inequality. However, the findings are inconclusive (Khomo 2018; Takaendesa et al. 2006). As noted by Pavcnik (2017), the effects of trade on poverty and inequality are context-specific and may depend on several factors, such as the nature of trade policy changes, trade patterns, and the mechanisms involved, among others. Moreover, while these studies focus on the level of exchange rate, to the best of our knowledge no previous empirical study has explicitly investigated the nexus between exchange rate volatility and income inequality. The present study on South Africa contributes to filling that gap.

This research intends to answer two research questions. First, what is the effect of exchange rate volatility on the functional distribution of income in South Africa? Second, is the effect of exchange rate volatility on the functional distribution of income in South Africa asymmetric? To answer these questions, we employ the local linear projection (LP) method of Jordà (2005), which has some appealing features compared with commonly used methods, including standard vector autoregression (VAR). For instance, the LP method is more robust to misspecification when the true data-generating process is not known; it does not suffer from the curse of dimensionality inherent to VAR; and it can more easily accommodate non-linearities. This study uses labour income share as a proxy for income inequality. As uncertainty is latent and hence not observable, the realized exchange rate volatility will be calculated from real effective exchange rate data, and may be interpreted as a measure of exchange rate uncertainty. Although the selected model is amenable to misspecification, we attempt to control for other economic indicators that may provide potential channels through which exchange rate volatility affects labour income share, such as investment, economic growth, and trade integration.

The paper is organized as follows. The literature review is presented in section 2. The data are presented in section 3. Section 4 discusses the econometric method. Results are presented and discussed in section 5. In section 6, conclusions and policy relevance are presented.

2   Literature review

2.1   Theoretical framework

Exchange rate volatility, interpreted as a measure of uncertainty, can affect inequality through its impact on various economic variables which in turn influence inequality. Using labour income share as a proxy for inequality, our study focuses on the channel through investment and employment.

Theoretically, uncertainty can affect investment either positively or negatively. The sign may depend on the assumptions about adjustment costs and irreversibility of investment (Bernanke 1983; Bleaney and Greenaway 2001; Dixit and Pindyck 1994; Pindyck 1991), the degree of competition in the industry (Caballero 1991), and risk aversion (Saltari and Ticchi 2007; Zeira 1990). The first two are associated with the real options and growth options theories. The real option theory argues that uncertainty should lower irreversible investment temporarily if markets are not perfectly competitive, due to firms adopting a wait-and-see approach; growth option effects imply an increase in investment in uncertain times (Binding and Dibiasi 2017). Rowthorn (1999) argues that if investment falls due to uncertainty, unemployment may rise, because investment is an important component of demand; also, technological complementarities between labour and capital imply that a capital slowdown will lead to a fall in employment, since capital is required for

employment creation, and constraints to capital accumulation may also be constraints to employment creation (Belke and Kaas 2004; Kreuser and Rankin 2017; Rowthorn 1999). Since the export sector employs a large proportion of unskilled workers, who are likelier to be poor (Fu and Li 2014), this may widen the inequality gap. Following this line of argument, higher exchange rate volatility is expected to increase inequality through the effect that increased uncertainty has in reducing aggregate investment.

However, a different effect of risk aversion might hold an alternative explanation of the link between uncertainty and inequality via investment. Risk aversion might affect firms' investment decisions in the presence of uncertainty. As noted by Senadza and Diaba (2017), one school of thought holds that risk-averse traders will substitute away from high-risk trading towards less risky trading, and hence will lower their volume of international trade and investment (McKenzie 1999; Saltari and Ticchi 2007). Another school of thought, which is based on the principles of mean-variance portfolio analysis, views higher risk as associated with higher returns, causing higher exchange rate volatility to be associated with a higher volume of trade and hence investment (De Grauwe 1996). This is consistent with Hartman (1972, 1976) and Abel (1983), who also argue that greater price uncertainty can lead competitive risk-neutral firms to increase investment. Focusing on such a portfolio composition effect, Kasa and Lei (2018) show that, in a continuous-time Blanchard-Yaari theoretical model, as investment returns are idiosyncratic and subject to Knightian uncertainty, agents will formulate robust portfolio policies which are non-homothetic in response to uncertainty. This implies that a high proportion of wealthy agents' wealth will be invested in uncertain assets with higher mean returns, a feedback mechanism that heightens inequality.

As this study uses labour income share as a proxy for inequality, it is important to highlight the role of elasticity of substitution (σ) in analysing the factor income shares. Using the Hicksian partial elasticity of substitution, Elsby et al. (2013) demonstrate the existence of a relationship between labour income share and elasticity of substitution. As shown by Alvarez-Cuadrado et al. (2018) and Paul and Oishi (2018), even if capital and labour are gross complements, a decline in effective capital per unit of effective labour can lead to a more than proportionate increase in the rental rate on capital compared with wages, a mechanism that could lower the labour income share. Therefore, either $\sigma > 1$ (capital and labour as gross substitutes) or $\sigma < 1$ (capital and labour as gross complements) can account for changes in the labour income share.

2.2   Empirical review

A large body of literature has examined empirical relationships between exchange rate volatility and macroeconomic variables, between macroeconomic variables (such as investment, unemployment, inflation, output volatility, trade, etc.) and inequality, and between the level (but not volatility) of the exchange rate and inequality. Focusing first on the relationship between exchange rate volatility and macroeconomic variables, we provide a review of current studies on this. For instance, Duarte (2003) examined the effects of the exchange rate regime in a dynamic general equilibrium model. The findings showed that the volatility of the real exchange rate increased sharply when moving from pegged to floating rates, while this pattern was not observed for other variables. Also, a higher co-movement of variables across countries was found under fixed instead of flexible rates. This finding implies that exchange rate volatility does not necessarily have a significant influence on macroeconomic variables. Lafrance and Tessier (2001) used quarterly data for 1970:1–2000:1 and a VAR model to examine the causal effect of real exchange rate variability on investment in Canada. Their study measured volatility as the monthly standard deviation of the nominal effective exchange rate, averaged over the previous 24 months. They found that exchange rates and their volatility had little effect on Canadian investment. However,

Belke and Gros (2002) showed that transatlantic exchange rate variability had a significant negative impact on labour markets in the European Union and United States. Also, Belke and Setzer (2003) found that exchange rate volatility reduced employment growth in a panel of 10 Central and Eastern European countries, using data for 1992–2001 and a fixed effects model.

Further, Belke and Kaas (2004) examined the effects of exchange rate volatility on the labour market in the eurozone and the United States, using a simple Dixit/Pindyck-style model. Their results showed that exchange rate volatility had a significant negative effect on unemployment in both the eurozone and the United States, with the effect being larger in the former. The effect on employment was negative and only significant for the eurozone. Using a general methods of moments model and panel data on 29 Chinese provinces for 1987–2008, Hua (2011) found that real exchange rate appreciation had a negative effect on both economic growth and employment. Alegwu et al. (2017) examined the asymmetric effects of real exchange rate volatility on agricultural products export in Nigeria, using the VAR model and annual time series data for 1970–2013. Analysis using the real exchange rate volatility, measured as generalized autoregressive conditional heteroscedasticity (GARCH) (1, 1), showed that the effects of the real exchange rate volatility shock during appreciation and depreciation on most of the products were significantly different.

There are also some specific South African studies that have linked exchange rate volatility and macroeconomic variables. Aye et al. (2015), for example, investigated the effect of real effective exchange rate uncertainty on exports in South Africa, using quarterly data for 1986:4–2013:2. Results based on a bivariate GARCH-in-mean structural VAR model showed that exchange rate uncertainty had a significant and negative effect on exports, and the effects of a positive and negative uncertainty were asymmetric. Sikhosana and Aye (2018) analysed asymmetric volatility spillovers between the real exchange rate and stock returns in South Africa, using different GARCH-type models and monthly data for 1996–2016. They found that there was a bidirectional and asymmetric volatility spillover effect between the two markets in the short run. Khomo (2018) examined the effect of exchange rate misalignment and volatility on economic activity in South Africa, using monthly data for 1980–2016 and non-linear autoregressive distributed lag (NARDL). The results showed that exchange rate volatility, which was obtained from a Glosten-Jagannathan-Runkle GARCH (1,1) model, did not have a significant effect on real gross domestic product (GDP).

As far as the effect of the exchange rate level on inequality is concerned, there are also some notable studies. For instance, Bahmani-Oskooee (1997) used a cross-sectional model and data from 28 countries, and showed that devaluations had an adverse effect on income inequality. Minot (1998) investigated the distributional and nutritional impact of devaluation in Rwanda. The results showed that the negative impact of price changes associated with devaluation was larger on the real income of urban than of rural households. Also, the negative impact was larger on high-income than on low-income households. Minot noted that the difference was not due to the propensities of poor and rich households to buy tradable goods, but was due to the fact that rural and low-income households had a low level of participation in the cash economy, which insulated them from price changes relative to urban and high-income households. Tille (2006) found that the impact of the exchange rate was highly heterogenous across sectors, since a depreciation led to a substantial competitiveness and welfare gain for agents with a high exposure to foreign competition, while it adversely affected agents facing mostly domestic competition.

Using annual time series data over the 1952–2002 period and an error correction model, Bahmani-Oskooee and Gelan (2008) showed that dollar depreciation had unequalizing effects on a measure of Gini in the United States in the short run, while the impact on the long run was negligible. However, Shahbaz et al. (2013) found that exchange rate devaluation worsened inequality in the long run in Pakistan. Fu and Li (2014) analysed the impact on household welfare of renminbi

appreciation that arose through exchange rate-induced changes in consumer prices. The results showed that exchange rate-induced consumer price changes arising from the appreciation of the renminbi reduced the consumption expenditure of all households, thus improving their welfare, although the gains were lower for poorer households, who spent more on commodities that were less responsive to exchange rate movements. This finding is in contrast with Kraay (2008), who found that in Egypt a large appreciation of the currency led to a welfare loss of 7.4 per cent of initial expenditure.

Artuça and McLarenb (2015) examined the role of occupational mobility in the effects of trade shocks on wage inequality, using the March 1976–2010 Current Population Surveys of the United States Census. Using a novel model of offshoring based on task-by-task comparative advantage, they found that occupation played an important role in determining who was harmed by an offshoring shock. Rossi and Galbraith (2016) investigated the relationship between the exchange rate and intersectoral wage inequality in selected open economies, including South Africa. With the exception of the Russian Federation and South Africa, there was a high correlation between exchange rate and industrial pay inequality. For South Africa they found a correlation coefficient of 0.0917, using 1999–2011 data. Analysis using a log-log model also showed that a devaluation of the national currency of 10 per cent increased industrial pay inequality by two to three per cent.

Cerdeiro and Komaromi (2017) investigated the effect of trade on income and inequality, using a cross-sectional approach. Results based on annual data for 1990–2015, and a gravity model estimated with the Poisson pseudo-maximum likelihood estimator, showed a consistently positive and significant effect of trade on inequality over time. Cravino and Levchenko (2017) examined the impact of large exchange rate devaluations on the cost of living at different points on the income distribution. They found that the cost of living rose for the bottom income decile, increasing 1.48–1.62 times more than for the top income decile, with changes in the relative prices of tradables and lower-priced varieties, since the bottom decile consumed more of such products. In Bahmani-Oskooee and Motavallizadeh-Ardakani (2017), analysis based on a NARDL model and data for 51 states in the United States showed that exchange rate depreciation had significant short-run and long-run asymmetric effects on income inequality. A similar analysis was conducted by Bahmani-Oskooee and Motavallizadeh-Ardakani (2018) for 41 countries including South Africa, using NARDL and Gini income inequality from the University of Texas Inequality Project. Their results showed that exchange rate had short-run asymmetric effects in 34 countries and long-run asymmetric effects in 22 countries.

From the foregoing empirical review, two things can be deduced. First, the results pertaining to the relationship between exchange rate level and inequality, and between macroeconomic variables and inequality, are inconclusive. Second, and more importantly for the current study, there is a dearth of knowledge on the explicit relationship between exchange rate volatility and income inequality. This study examines the effect of real exchange rate volatility on income inequality in South Africa, thereby contributing to filling that gap.

3   Data

We use quarterly time series data covering the period 1985:1–2018:3, which spans important events in the history of South Africa. The data are drawn from a period when the South African economy became highly liberalized following the De Kock Commission in 1985, the formal ending of the fixed exchange rate regime, and the post-democratization period, which is associated with South Africa's increased integration into the global economy after economic sanctions were lifted. It should be noted, however, that the length of the period is determined purely by data availability.

The dependent variable in our estimated model is labour income share, defined as the ratio of compensation of employees to gross value added at factor cost.[1] Exchange rate volatility is the main independent variable of interest. Labour income share, the measure of functional distribution of income that we use as a proxy for inequality, is potentially limited by not incorporating the (lack of) income of the unemployed or economically inactive. However, a declining labour income share constitutes a major factor in understanding rising inequality (Burger 2015), since labour income is more unequally distributed than capital income (Piketty 2014). Moreover, there is some evidence that declines in the labour income share have a significant relationship with income inequality, as the decline in labour shares is concentrated at the lower end of the labour income distribution (ILO and KIEP 2015). Also, labour income represents a higher share of total income for lower- and middle-income groups (World Bank 2006, 2013).

The monthly real effective exchange rate is used to calculate the volatility series. As the labour income share data are quarterly, exchange rate volatility is defined as the quarterly realized real effective exchange rate:

$$RVOL_t = \sum_{i=1}^{T} r_{t,i}^2 \qquad\qquad [1]$$

where r_t is the monthly return (natural logarithm of the first difference) for month i within quarter t, and $i = 1 \dots T$ where T is the total number of monthly observations within a quarter. RVOL is the quarterly realized volatility of the real effective exchange rate. The major advantage of the realized volatility is that it is model-free, and hence void of measurement or specification errors. By inference, it does not suffer the generated regressor problem associated with two-step estimation procedures (Pagan 1984).

Other control variables included are gross fixed capital formation as a percentage of GDP; real GDP; openness (trade as a percentage of GDP); and relative price of investment, calculated as the ratio of investment deflator to GDP deflator. These have been selected based on the findings of existing studies (Dao et al. 2017; Elsby et al. 2013; Guerriero and Sen 2012; IMF 2017; Karabarbounis and Neiman 2014; Piketty 2014). Table 1 presents the a priori expectations and economic explanations for these variables.[2] All variables are sourced from SARB. All variables except real exchange rate volatility were found to be non-stationary variables, and hence have been transformed into their growth rates to avoid spurious regression. The plots of these variables are presented in Figure 3.

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[1] The labour income share is unadjusted for self-employment, due to the unavailability of higher-frequency employment and mixed income, which would be needed to perform the adjustment.
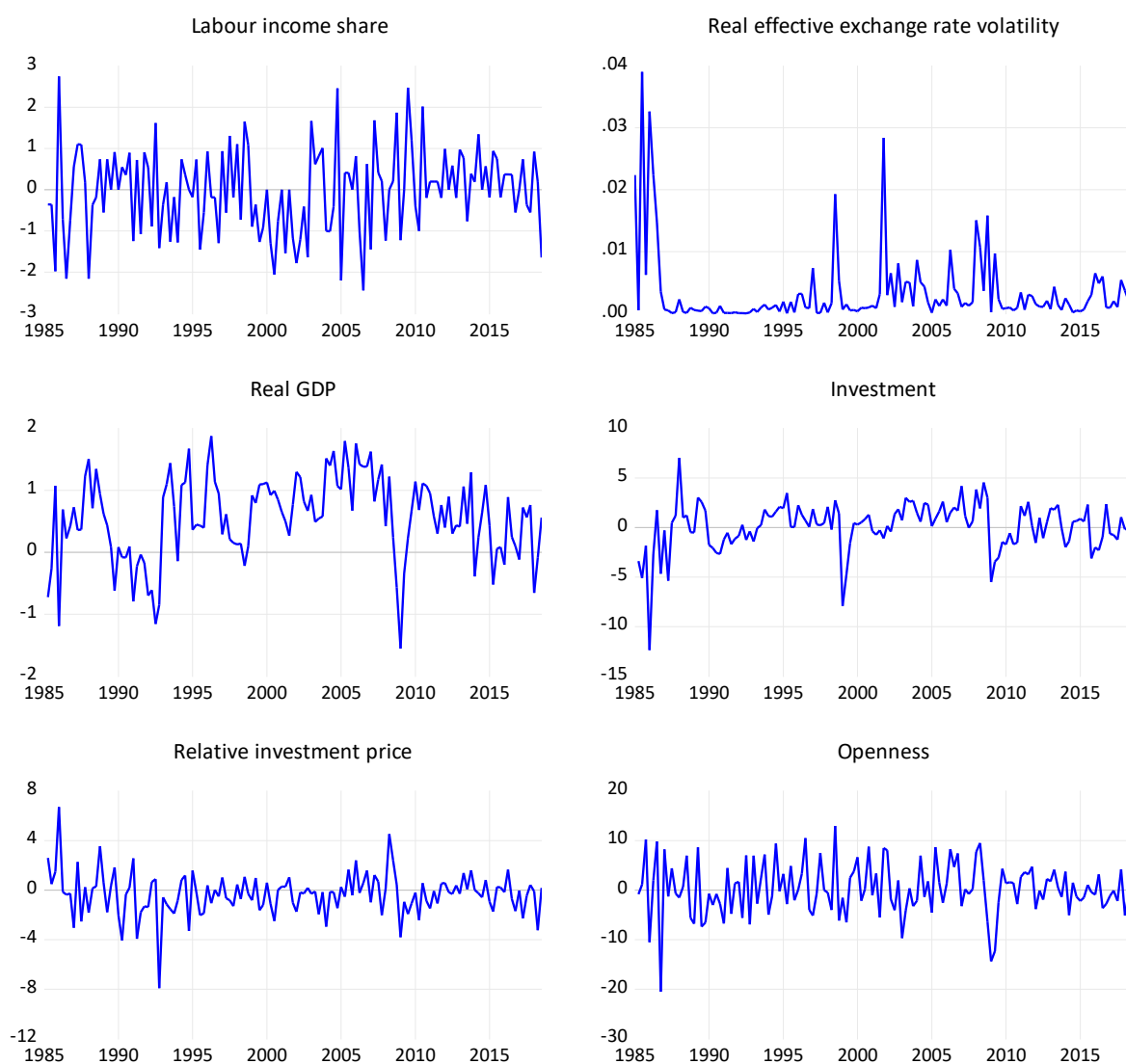
[2] While the immediate response of the labour income share is expected to conform to these a priori expectations, these may not be constant across all horizons, especially if the relationship between labour income share and the variables is time-varying.

Table 1: A priori expectations and economic explanations

Variable	A priori expectation	Explanation
Exchange rate volatility	-	A heightened uncertainty could lead risk-neutral and wealthy agents to increase their investment in expectation of higher returns. Since capital income is concentrated more at the top end of the distribution, and is more unequally distributed than labour income, this could widen inequality, i.e. reduce the labour income share.
GDP	+ -	Economic growth could spur more job creation and financial development. Depending on who benefits more from this in terms of higher wages or higher profits, the impact could be positive or negative.
Investment	-	An increase in investment may cause redistribution from wages to profits, which could reduce the labour income share.
Relative price of investment	+	Declines in the relative price of investment would lead to a substitution of capital for labour, which would reduce the overall labour income share.
Openness	-	Increased offshoring, outsourcing, and import competition could lead to a decrease in domestic demand for labour, or worker displacement.
Labour income share	Not applicable	Not applicable.

Source: authors' compilation.

Figure 3: Labour income share and its drivers

Source: authors' calculations based on data from SARB.

4   Empirical model

To achieve the objective of this study, which is to examine the effect of real exchange rate volatility on income inequality in South Africa, the LP method developed by Jordà (2005) is proposed. The LP method entails running a sequence of predictive regressions of a variable of interest on a structural shock for different prediction horizons. The impulse response is then obtained from the sequence of regression coefficients of the structural shock. Therefore, the method can produce the response of inequality to exchange rate volatility at different horizons. This method has advantages in general and compared with the standard VAR model (Jordà 2005; Ocakverdi 2016; Teulings and Zubanov 2014). The estimation relies on robust standard errors and is simple to implement. With the LP method, the impulse response functions can be computed without the specification and estimation of the unknown true data-generating process; it is hence non-parametric in nature. The LP method is therefore more robust to misspecification of the data-generating process relative to the conventional VAR. Moreover, the method captures potential non-linearities better than the standard VAR. The impulse responses from the LP are consistent and asymptotically normal.

The time profile of the effect of shocks on the expected or future value of variables in a dynamic system is measured by an impulse response function, which is defined as the difference between two forecasts (Hamilton 1994; Koop et al. 1996). According to Koop et al. (1996), the generalized impulse response function of yt at horizon h is defined as follows:

$$IR(t, h, \delta, \Omega_{t-1}) = E(y_{t+h}|v_t = \delta, \Omega_{t-1}) - E(y_{t+h}|v_t = 0, \Omega_{t-1}), \ h = 0,1 \dots . H \quad [2]$$

where δ is an n x 1 vector indicating the shocks, 0 is an n x 1 vector of zeroes, v_t is an n x 1 vector of additive random shocks, Ω_{t-1} denotes the information set including values of variables up to t-1, and $E(. |.)$ denotes the best mean predictor. Jordà (2005) proposed to recover the multiplier from the set of regression coefficients β_j^h associated with the following set of h-step-ahead predictive regressions:

$$y_{t+h} - y_{t-1} = \alpha^h + \sum_{i=1}^{I} \gamma_i^h y_{t-i} + \sum_{j=1}^{J} \beta_j^h x_{t-j} + \sum_{m=1}^{M} \vartheta_k^h z_{t-m} + v_{t+h|t-1} \ h = 0, 1 \dots . H \quad [3]$$

where y_t is the endogenous variable of interest, i.e. income inequality; x_t is the white-noise shocks from exchange rate volatility, with mean zero and variance δ_x^2; z_t is the vector of control variables, which may include shocks other than xt; and v_{t+h} is a prediction error term with variance δ_h^2. The coefficient β_j^h provides us with the impulse response function of inequality to exchange rate volatility shock at horizon h =0....H, keeping all other variables constant. Thus, we generate the accumulated impulses to exchange rate volatility shocks from the estimated $\{\hat{\beta}_1^{(h)}\}_{h=0}^H$. The order of I, J, and M is determined by the Akaike information criterion. We set H = 10 quarters. To test the null hypothesis that the impulse response is equal to zero for all horizons using one and 1.65 standard deviation confidence intervals and *p*-values, the system of equations across horizons is jointly estimated.

In addition to estimating equation 3, which assumes symmetric effects, the study estimates an asymmetric effect model to answer the second research question. This can be specified as:

$$y_{t+h} - y_{t-1} = \alpha^h + \sum_{i=1}^{I} \gamma_i^h y_{t-i} + \sum_{j=1}^{J} \beta_j^h x_{t-j}^{High} + \sum_{j=1}^{J} \beta_j^h x_{t-j}^{Low} + \sum_{m=1}^{M} \vartheta_k^h z_{t-m} + v_{t+h|t-1} \ h = 0, 1 \dots . H \quad [4]$$

x_t is defined to be either high or low. The indicator for high exchange rate volatility (x_{t-j}^{High}) is one if volatility is above the sample mean, and zero otherwise. Similarly, the indicator for low exchange rate volatility (x_{t-j}^{Low}) is one if volatility is below the sample mean, and zero otherwise.

In other words, we define high exchange rate volatility if the value is above the mean, and low exchange rate volatility for values below the mean, by multiplying aggregate exchange rate volatility with two dummy variables which take the value of one if above the mean and zero otherwise, and another dummy variable when the opposite holds, to give us high and low levels of exchange rate volatility.

4   Results and discussion

The generalized impulse response function over 10 horizons for the symmetric effect of exchange rate volatility on labour income share is given in Figure 4. Focusing first on the main variable of interest, we see that the labour income share declines by about 20 per cent up to the fourth quarter in response to a standard deviation shock in exchange rate volatility. Subsequently it increases between the fifth and seventh quarters, before declining persistently. Although the joint and cumulative responses are not statistically significant, the responses in the first, fifth, and sixth quarters are significant. This implies that exchange rate volatility leads to a falling labour income share relative to capital income. This could be explained by the fact that higher uncertainty is associated with higher mean returns. Therefore, increasing exchange rate volatility may lead risk-neutral and wealthy agents to increase their investment in uncertain assets. As capital income is more unequally distributed than labour income (Piketty 2014), inequality will rise. Also, due to wealth concentration, the richest households earn a large part of their income as capital income. In other words, capital owners are over-represented at the top of the distribution (Roine et al. 2009). Hence, an increased rate of capital return would imply increased inequality. In the same manner, a decreased labour income share would imply rising income inequality, since labour income accrues more to low-income households, who are the majority in the population (Kreuser and Rankin 2017; Seekings 2014).

In response to openness, the labour income share declines to about 10 per cent up to the fourth quarter before exhibiting rising and falling trends, with the trend remaining positive in the last quarter.

The effect of exchange rate volatility may be more severe on economies that are highly integrated into the global economy, such as South Africa. Although trade may be expected to boost economic growth, its distributional impact is not very clear. However, the results might be explained from the fact that increased trade integration, which is a form of globalization, may lead to increased capital intensity, especially due to increased offshoring and outsourcing. For instance, when firms reallocate capital to other countries for production, labour-intensive production is outsourced to countries with lower wages. This may lead to a decrease in domestic demand for labour, and consequently in the labour share (Jayadev 2007). Also, increased import competition may lead to worker displacement and an increase in capital intensity, with the consequence of a falling labour share, especially if the aggregate elasticity of substitution between capital and labour is above unity (Schwellnus et al. 2018). This is consistent with evidence in Elsby et al. (2013) for the United States, and in IMF (2017), where it was found that that increased participation in global value chains had a negative effect on labour share in low-income countries but no effect in high-income countries. Moreover, in line with Rodrik (1997) and Slaughter (1999), reduced barriers to trade weaken the bargaining power of the majority of workers (poor and low-skilled workers), who cannot cross

international borders, relative to capital owners and highly skilled workers, who can easily cross international borders. This is because the former's services can easily be substituted with workers from other nations, thereby reducing bargaining power and wages.

The response of the labour income share to economic growth shows that in the first four quarters the labour income share declines, with the response significant up to the second quarter. From the fifth to the 10th quarters the response is mainly positive, with the exception of a decline between the eighth and ninth quarters. Economic growth may serve as a vehicle for providing more jobs through better financial and infrastructural development. Firms are more willing to invest when the economy is booming. If the larger share of the benefits accruing from economic growth goes to workers in the form of higher wages, then economic growth could lead to a higher labour income share. However, if much of the benefit goes to business owners in the form of profits paid as dividends to shareholders, instead of higher wages to workers, then economic growth could lead to a declining labour income share. If growth is to impact on inequality in the desired direction, it needs to be balanced and inclusive.
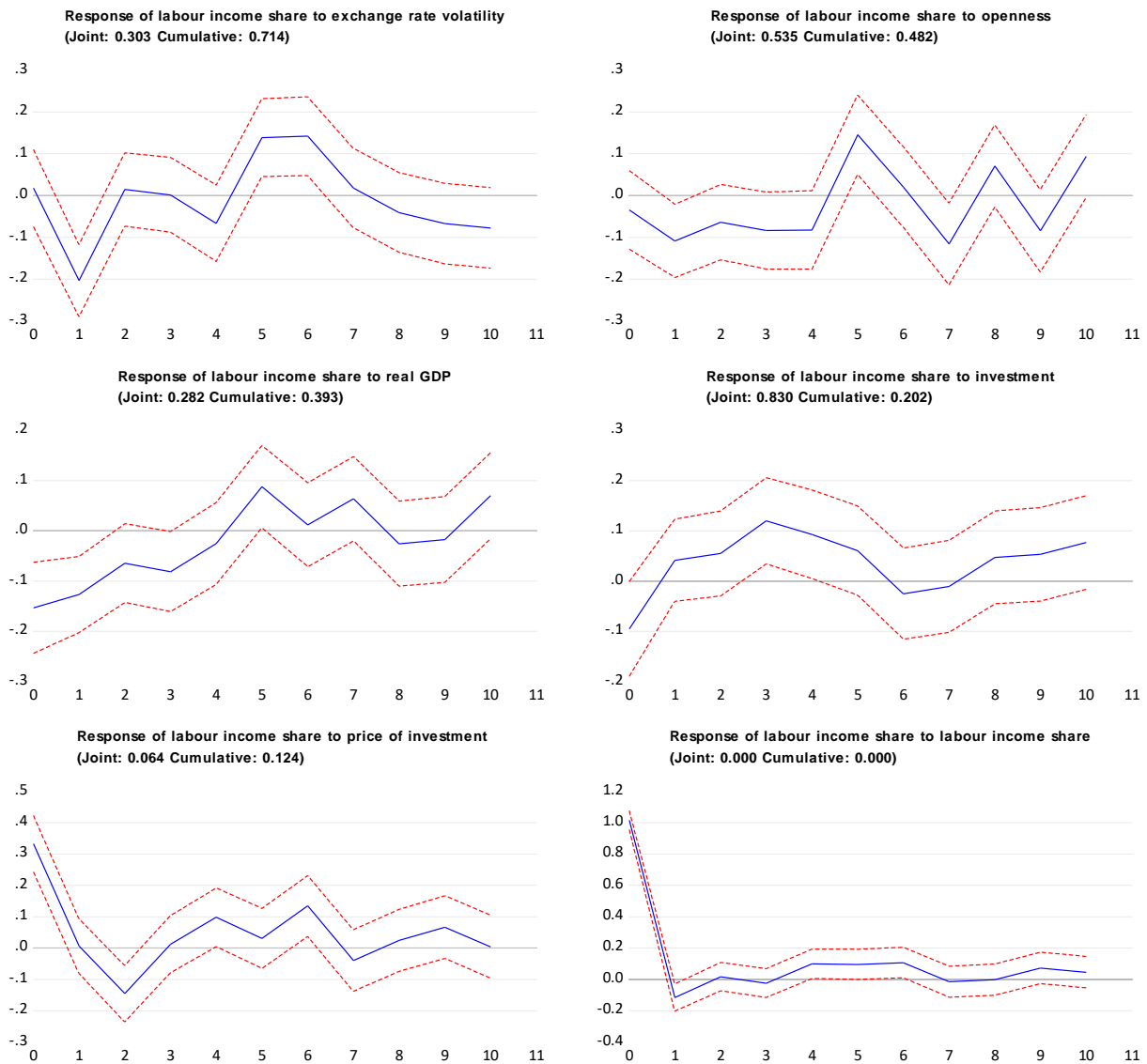
Regarding the response of labour income share to investment, we also observe a decline in the first, sixth, and seventh quarters, and an increase in the remaining periods. An intensive investment process connotes the use of more capital in the production process. According to Kaldorian theory, factor returns adjust in order to finance investment. As saving occurs from both profits and wages, the theory proposes that since the marginal propensity to save out of profits by owners of firms is more than the marginal propensity to save out of wages by workers, the share of labour increases when saving from profit increases relative to saving from wages, and is reduced by a higher rate of investment. In other words, an increase in investment may cause redistribution from wages to profits, thereby generating an increase in the rate of profit and a fall in the real wage; as a result, the functional income distribution will shift to favour owners of capital over owners of labour (Guerriero and Sen 2012). This trend could widen inequality, given the relationship between labour income and income inequality.

Technology-driven declines in investment prices will lead to greater demand for investment, and hence a decline in the labour share, if factor prices are determined completely and the elasticity of substitution between capital and labour is greater than one (Schwellnus et al. 2018). Analogously, an increasing relative investment price will lead to declining capital intensity (Katayama and Kim 2018), and hence rising labour share, if capital and labour are substitutes. The effect of the relative investment price on inequality, as shown in Figure 4, is mainly positive, the only exception being for the second and seventh quarters. This is consistent with Karabarbounis and Neiman (2014), who found that large declines in equipment prices across a broad range of high-income and emerging economies explained around 50 per cent of the global decline of the labour share, with estimated elasticity of substitution in the range of 1.2–1.5.

Figure 5 presents the responses of labour income share to low and high real effective exchange rate volatility. It is important to note that for brevity, the responses to the other control variables are omitted, since they are exact replications of those in Figure 4. Labour income share immediately rises in response to low exchange rate volatility. In other words, when exchange rate volatility falls, the labour income share rises by about 10 per cent before declining, and then rises again in the longer term. Its response to a high exchange rate volatility is an immediate fall to about 20 per cent. The response remains negative for most of the periods, except around the fifth and sixth quarters, when it turns to a positive. Although a Wald test performed jointly and cumulatively over the 10 horizons did not reject equality in responses, it can be seen that there is a significant difference between the responses of labour income share to low and high volatility in the first quarter, since the latter exhibits a bigger impact (20 per cent) relative to the former (10 per cent). This is consistent with the fact that bad news usually has a larger effect on economic variables than
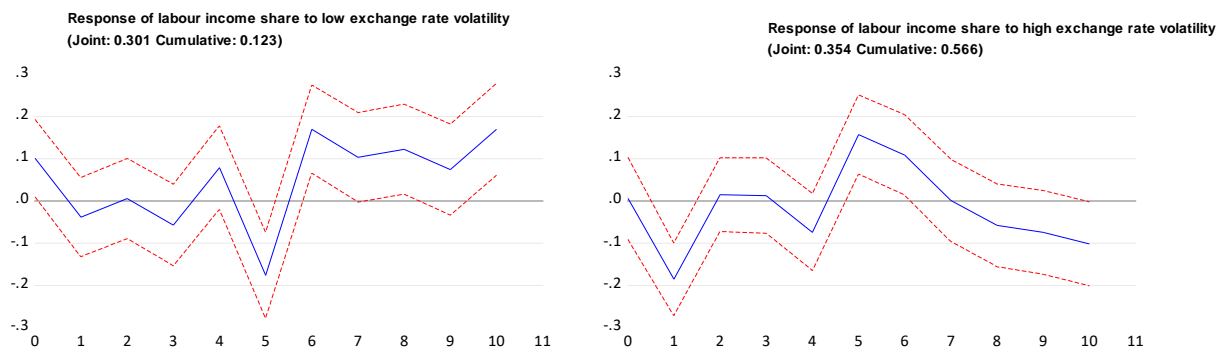
good news: in this case, low exchange rate volatility is good news, while high exchange rate volatility is bad news. This provides evidence of asymmetric effects of exchange rate volatility.

Figure 4: Symmetric response of labour income share to generalized one standard deviation shocks with 68 per cent conditional confidence bands

Response of labour income share to exchange rate volatility
(Joint: 0.303 Cumulative: 0.714)

Response of labour income share to openness
(Joint: 0.535 Cumulative: 0.482)

Response of labour income share to real GDP
(Joint: 0.282 Cumulative: 0.393)

Response of labour income share to investment
(Joint: 0.830 Cumulative: 0.202)

Response of labour income share to price of investment
(Joint: 0.064 Cumulative: 0.124)

Response of labour income share to labour income share
(Joint: 0.000 Cumulative: 0.000)

Source: authors' calculations based on data from SARB.

Figure 5: Asymmetric response of labour income share to generalized one standard deviation shocks with 68 per cent conditional confidence bands

Response of labour income share to low exchange rate volatility
(Joint: 0.301 Cumulative: 0.123)

Response of labour income share to high exchange rate volatility
(Joint: 0.354 Cumulative: 0.566)

Source: authors' calculations based on data from SARB.

13

5   Conclusion and policy implications

This study has examined the relationship between exchange rate volatility and labour income share, which serves as a proxy for income inequality. The findings show that labour income share declines immediately in response to a positive exchange rate volatility shock. Moreover, except for the relative price of investment, labour income share falls immediately in response to a one standard deviation positive shock in the other control variables (real GDP, investment, and openness). Further, our analysis of asymmetry shows that while high exchange rate volatility mainly exhibits a negative effect on labour income share, low exchange rate volatility mainly exhibits a significantly smaller positive effect.

These findings have important implications. With linear income share functions, a lower labour income share implies that a larger fraction of gains from increased productivity accrues to capital. As the ownership of and returns from capital tend to be more concentrated at the upper end of the income distribution, a declining labour share will likely increase income inequality. Optimal policies require a stable real exchange rate. Stable South African rands would contribute to a stable wage-price relation and consequently a stable income distribution. Therefore, volatility in the exchange rate should be of concern to all stakeholders in the economy, since it could have distributional consequences that may also further affect the real economy.

Nominal exchange rate volatility might be expected in a monetary policy regime where the exchange rate acts as a shock absorber. To the extent that short-term real exchange rate volatility results from nominal volatility, policy choices to mitigate it may be considered in view of the findings of links between real exchange rate volatility and labour's income share. But this study does not offer support for any one policy framework. Traditionally, countries have adopted a range of market interventions to manage foreign exchange instability, but for South Africa their costs and conditions for success have not been established by research. Any such policy consideration should take into account further research to assess the robustness of the links found here, and to examine factors beyond the scope of the present study. For example, the effect of exchange rate volatility on inequality should be compared with the effect of economic and socio-economic fundamentals upon inequality; greater knowledge of the effect of capital's share upon aggregate fixed investment is required; and the potential for microeconomic amelioration of exchange rate volatility by small firms through increased opportunities for diversification and hedging foreign exchange risks should be considered.

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