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Wage inequality under inflation-targeting in South Africa

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Abstract: This paper aims at providing new evidence over the effect of conventional monetary policy shocks on wage inequality through the earnings heterogeneity channel under the inflation-targeting regime implemented in South Africa since 2000. The empirical contribution follows previous studies by implementing a multivariate time-series analysis and identifying the structural shocks in a vector error correction model. Impulse response functions show that the overall wage distribution worsens immediately after a positive shock to the prime rate. The effect is found to be symmetric such that expansionary shocks have similar, although opposite, consequences on wage allocation. Redistribution appears to be driven by the weakest sectors of the economy, given that the most sizeable industries experience no significant or clear-cut variation in the aftermath of a monetary shock. Interestingly, the top half of the distribution always narrow relative to the bottom indicating that better-paid jobs, which are concentrated among the white population, remain secure in bad times and benefit the most in good ones. By the same token, the black–white wage gap consistently widens after any kind of monetary shock.

Key words: distribution, earnings heterogeneity, inequality, monetary policy, vector error correction

JEL classification: C32, D13, D31, E52

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1 Introduction

In contemporary economics, labour income is thought of as a function of the worker's capability (Mincer 1958). However, if access to schooling, health care, and other determinants of labour productivity is unequally distributed among workers, then the market will fail in allocating income fairly and inequality may arise. Yet, high and rising income gaps within both advanced and emerging economies suggest that there is some other mechanism beyond the standard Mincerian theory through which preferential access to the top end of the distribution is attained; that is, weak unions (Machin 1997), skill-biased technological progress (Hassler et al. 2007), greater return on capital (Piketty 2014), and globalization (Jaumotte et al. 2013).

Normally, distributive issues are not considered to warrant the attention of monetary authorities, whose mandate is strictly concerned with aggregates. With a few exceptions, such as the Federal Reserve of the United States and the Bank of Israel that follow a dual mandate, price stability, intended as maintaining inflation around a low target level or target range, is the primary objective of modern central banks around the world. While countercyclical monetary policy may be an effective output stabilization tool, containing inflation is crucial to financial stability, sustainable debt servicing, and thus long-run growth.¹ Nonetheless, central banks' established monetary policy frameworks were strained and modified in response to new challenges brought about by the 2007–08 global financial crisis. Among those, not only has inequality become recognized as a contributory factor for financial instability and asset market inflation (Debelle 2004; Skott 2013), but also experimental policies like quantitative easing are now cited for making inequality worse (Mumtaz and Theophilopoulou 2017; Saiki and Frost 2014). Most recently, central banks' centrality in countries' responses to the COVID-19 pandemic raises additional issues about connections with both inequality and fiscal financing. Thus, the interaction between monetary policy and inequality now inescapably requires analysis and discussion in academic and policy circles. South Africa's high degree of inequality, which has worsened since the achievement of democratic government in 1994 and coexists with well-defined central banking practices, makes this study of potential inequality and monetary policy relationships particularly timely.

The responses of the South African Reserve Bank (SARB) to the 2007–08 global financial crisis were similar to those of other central banks. Although it has been following a flexible 3–6 per cent inflation-targeting rule since February 2000, SARB also implemented accommodative actions in the face of the global recession in 2008. Still, SARB's monetary policy rate—the repo rate that stands at 6.25 per cent in February 2020—has been consistently higher than that of comparable countries, at least until the pandemic-induced recession that triggered a cut of 100 basis points in the following months.

Policy debates over South Africa's interest rate policy under inflation-targeting include reference to its distributional effects: while the International Monetary Fund (IMF) has suggested moving from an inflation-target range to a point target, citing benefits for poorer households (see IMF 2018: 35), significant public pressure exists to fight unemployment. The policy importance for South Africa of assessing connections between monetary policy and distribution has not been matched by research into the subject. To the best of my knowledge, although several dimensions

¹ This central banking dogma results from the classical assumption that money is neutral in the long run and that markets are complete with agents fully insured against shocks. Consistently with these principles, the workhorse model in monetary policy analysis summarizes the demand-side of the economy by means of a representative agent, whose welfare is the normative criterion of optimal resource allocation.

of agent heterogeneity characterize emerging markets, the possible association between central banking and inequality has spurred little research between analysts in South Africa. The redistributive effects of the Monetary Policy Committee's decisions have been explored by the UNU-WIDER research programme on inclusive economic development in Southern Africa. Aye and Harris (2019), for instance, investigate how exchange rate volatility affects the functional distribution of income. A few other unrelated works focus on the impact of inflation on the poor (see Kahn 1984; Oosthuizen 2007). Thus, additional evidence has to be collected before one can produce robust stylized facts. This paper contributes to the debate on the premise that a better understanding of how monetary policy affects South Africa's economic inequality is essential for developing innovative and sustainable economic policy in the country.

This paper reports new evidence on the consequences for inequality and related variables of conventional monetary policy shocks under the inflation-targeting regime in South Africa. This study particularly focuses on the effects that unexpected changes in the prime rate indirectly have on the distribution of wages across employees, through their differential impact on economic activity and so on employment opportunities for various sub-groups of the population. A relevant analysis in this field should answer the following questions:

- (i) Does the SARB's monetary policy have any significant role on wage inequality through the earnings heterogeneity channel? If present, are these effects long term or transitory? And does the response of the labour share of income reflect inequality dynamics?
- (ii) Does monetary policy affect inequality differently across sectors?
- (iii) Are shocks asymmetric such that contractionary shocks affect earnings heterogeneity and, through that channel, wage inequality more or less than expansionary actions?
- (iv) Is inflation-targeting an exclusive or inclusive tool of labour market participation by ethnic groups in South Africa?

The paper is organized as follows. Section 2 reviews how monetary policy actions can redistribute wealth and income, including labour income. Section 3 describes the data cleaning process that was crucial to develop time-consistent inequality measures and the method followed to identify the monetary policy shocks. Section 4 presents the core model, extensions, and results over the impact of monetary policy shocks on wage inequality in South Africa since the start of the inflation-targeting regime in 2000, and Section 5 concludes.

2 Redistributive channels of monetary policy

When the SARB varies the repo rate at which commercial banks fund their reserve requirements, the decision has a direct effect on the prime rate at which the latter lend to firms and households and an indirect impact on employment and output due to the general equilibrium echo of prices and wages (Ampudia et al. 2018). However, empirical evidence suggests that agents have differential access to certain key markets (labour, goods, and asset markets) such that individual responses to interest rate variations differ depending on the size and composition of agents' income or wealth.² As a result, central banks' actions may have some redistributive effect across households. On the other hand, if markets are incomplete, agent heterogeneity can have

² Income sources include labour income (wages and salaries), capital or financial income, business income (from proprietorships), and transfer income (such as unemployment benefits). Household net wealth results from subtracting households' liabilities (mortgages, car loans, credit card debt, etc.) from assets (not only financial assets, but also business assets, and, crucially, housing).

implications for the overall transmission of monetary policy.³ Even under the neoclassical assumption that the effects of monetary policy on real variables cancel out over the course of the business cycle, these can still cumulate and persist over time if cycles are not perfectly symmetric. Likewise, if monetary policy shocks affect income and wealth of individuals differently, the dimensions of heterogeneity must be changing accordingly and so too the impact of central bank actions.

The next section outlines the channels through which monetary policy shocks can alter resource allocation across heterogeneous agents and produce inequality in income or wealth. The theoretical argument is illustrated in terms of an expansionary policy shock, a surprise reduction in the repo rate that initially raises the inflation rate. In contrast to the SARB's inflation-averse and conservative stance, politicians and other commentators have often advocated accommodative monetary policy as a quick fix for South Africa's most fundamental issues of economic growth, job creation, and economic inequality. In what follows, the transmission instrument of expansionary monetary policy shocks as well as the dimension of household heterogeneity associated with each channel are stressed.

2.1 Savings redistribution channel

As the real value of assets and liabilities decreases, surprise inflation redistributes wealth from creditors to debtors, thereby lowering inequality if the poor have a relatively higher balance sheet exposure. Laidler and Parkin (1975: 789) find evidence 'overwhelmingly based on United States data' that loose monetary policy reduces indebtedness of middle-class households that tend to own relatively more debt than upper-income households. Voinea et al. (2018) achieved a similar result in post-crisis Romania and also stressed how poor households with limited access to financial markets did not respond to policy changes. For the euro area, Adam and Zhu (2016) conclude that younger households are generally indebted and tend to benefit from an unexpected hike in the inflation rate. However, these effects are quantitatively very small for single-digit hikes in the inflation rate and differ across countries. The distributional effects of inflation not only depend on the size but also on the maturity structure of households' nominal position (Auclert 2019). Doepke and Schneider (2006) map US households into age and wealth categories and find that unexpected inflation hurts rich households the most, as they tend to hold long-term assets (e.g. bonds) and short-term debt whereas low and middle classes exhibit the opposite tendency because of the weight of long-term fixed-rate debt (e.g. mortgages) on their balance sheets. Furthermore, households with little or negative net wealth tend to adjust to interest rate changes significantly more than the wealthy (Cloyne et al. 2020).

2.2 Interest rate exposure channel

A fall in real interest rates also redistributes financial income between creditors and debtors. It decreases creditors' returns on interest-paying loan assets and lowers the real value of debtors' servicing costs. O'Farrell et al. (2016) analyse this interaction in selected OECD economies and find that lower returns on net wealth had a positive impact on income redistribution in Canada, the Netherlands, and the United States only, but negative elsewhere. The effect is found to be always small, indicating that direct interest payments account for a tiny part of household income. Bunn et al. (2018) also conclude that loose monetary policy narrowed the income gap between age groups in the United Kingdom, where young households tend to have outstanding debts. In the

³ A growing body of theoretical works explores how balance sheet differences across households determine their marginal propensity to consume out of temporary income shocks, and so may amplify the transmission of monetary policy (e.g. Iacoviello 2005; Krueger et al. 2016; Bilbiie and Ragot 2017).

best scenario, if highly indebted households adjust their consumption to changes in disposable income while expenditure choices of the top percentile do not depend on credit conditions, expansionary policy would reduce the consumption gap. Floden et al. (2016) observe Swedish households who have loans with adjustable rates and find that this group is very responsive to interest rate changes. In particular, monetary policy will affect consumption if households do not vary the level of indebtedness in response to rate variations. Otherwise, if the household is forward-looking and has good access to financial markets, such variations in cash flows will not necessarily result in consumption responses.

2.3 Portfolio composition channel

Meanwhile, a drop in the short-term rate curtails demand for financial assets and, consequently, inflates their price. This will, in principle, redistribute wealth and capital income from households whose net asset values increase slowly if ever, such as cash- and bond-holders, to those with faster asset price inflation, such as equity investors. In the context of a new Keynesian dynamic stochastic general equilibrium (DSGE) model with asset market incompleteness and labour market frictions, Gornemann et al. (2016) find that accommodative monetary shocks, by reducing labour income risk and precautionary savings, adversely affect the price of shares at the expense of the wealthy.

The unintended distributive consequences of monetary policy actions through their effect on asset prices have also been examined in the context of the recent unconventional large-scale asset purchases by central banks. Estimates of the impact of quantitative easing on wealth inequality through the portfolio composition channel are trivial (Montecino and Epstein 2015; Bivens 2015; Adam and Tzamourani 2016; O'Farrell et al. 2016; Bunn et al. 2018), or cancelled out by the monetary shock's savings redistribution (Casiraghi et al. 2018, in Italy; Inui et al. 2017, in Japan). However, the rising value of real estates could potentially reduce wealth inequality if homeowners represented a large proportion of the population (Adam and Tzamourani 2016; Domanski et al. 2016; O'Farrell et al. 2016). In South Africa, Orthofer (2016) estimates that 10 per cent of the population own approximately 95 per cent of national wealth while 80 per cent of the population own no wealth at all.

2.4 Earnings heterogeneity channel

Through its positive impact on economic activity and employment, an accommodative monetary policy shock that has a positive effect on real gross domestic product (GDP) may indirectly reduce inequality if labour earnings at the bottom of the distribution are relatively more responsive to demand conditions. Empirical evidence is ambiguous. Coibion et al. (2012) show that contractionary shocks have positive and statistically significant effects on inequality in the United States. They further show that the effects on wage income are larger than for total income. By contrast, under the inflation-targeting regime in Mexico, Villarreal (2014) finds that unanticipated increases in the nominal interest rate (contractionary shocks) decrease labour income inequality over a two-year horizon. The study also notes that his result may be explained by the presence of stronger financial frictions in Mexico, which increase the weight on inflation in the central bank's loss function, 'such that inflation stabilization is welfare enhancing, whereas the opposite occurs in the United States' (Villarreal 2014: 14). Another stream of literature explores how countercyclical monetary policy actions affect the job creation process across different income decile groups. For example, Gregg and Machin (2012) and Bivens (2015) estimate decile-specific hourly Phillips wage regressions, and both studies find a negative relationship between wage growth and unemployment across all deciles: the lower down the income distribution, the more sensitive an individual is to unemployment. Bivens (2015: 30) also observes that 'the most important distributional effect of expansionary monetary policy is by far the impact that lower unemployment rates have on wages at the bottom and middle of the wage distribution'. On this basis, the post-2008 US Federal

Reserve's accommodative stance has supposedly reduced in inequality compared with the counterfactual of no or less intervention.

Reallocation effects may arise through the earnings heterogeneity channel due to different reasons. For example, when labour markets are segmented and mobility across firms is limited, or when unionization is stronger in manufacturing than in services, the heterogeneous impact of monetary policy on firms and sectors easily translates into large distributional effects across workers. Using a two-sector dynamic general equilibrium model, Inui et al. (2017) estimate these dynamics in Japan in the period before 2008 and demonstrate that labour market flexibility (rather than financial heterogeneity) is the crucial structural feature that prevents monetary policy shocks to have large distributional effect. However, the authors also note that sustained flexibility in the labour market, by weakening the profile of workers at the bottom of the income distribution, can become a source of structural inequality in the long run. Looking at asymmetric elasticities across the skill distribution, Carpenter and Rodgers (2004) find that the US Federal Reserve's monetary tightening increases unemployment rates of low-skilled workers and racial minorities, particularly teenagers, due to their higher substitutability. Dolado et al. (2018) develop a new Keynesian model with capital–skill complementarity in the production function and asymmetric search-and-matching frictions in the labour market. They find that expansionary monetary policy shocks increase earnings inequality by raising the wage premium and employment opportunities for high-skilled workers, and therefore they rule in favour of a strict inflation-targeting regime. Dolado et al. (2018) also note that their model is not consistent to conclude that, by opposite reasoning, contractionary shocks reduce income inequality given high-skilled workers would have the opportunity to search for low-skill jobs. By contrast, Gornemann et al. (2016) consider labour market heterogeneity in the form of asymmetric search-and-matching frictions in a DSGE model and show that a less conservative monetary policy rule that provides partial insurance against unemployment risk is relatively more beneficial for poorer households.

Furthermore, Heathcote et al. (2009) show that while top earnings are mainly affected by changes in hourly wages, earnings changes in the bottom deciles are directly related to the number of working hours and the unemployment rate, that is, with business cycle fluctuations. Asymmetric effects of monetary policy may also derive from sectoral heterogeneity. Galbraith and Hale (2014) finds that between-sector gaps drive wage inequality in the United States. Bivens (2015) points out the heterogeneity of sectors and particularly at how interest-sensitive industries—such as construction, durable goods manufacturing, and tradable goods—could benefit relatively more from lower interest rates. These sectors also tend to pay higher wages than other economic sectors.

2.5 Inflation tax channel

Using time-series evidence for the United States, Romer and Romer (1999) find that expansionary monetary policy decreases inequality in the short run through the channels mentioned so far. However, they notice, monetary policy has a differential impact across economic agents in the long run too, through the new equilibrium rate of inflation. In fact, Romer and Romer (1999) show that in the long run low inflation and stable aggregate demand growth are associated with the enhanced well-being of the poor. Persistently high inflation discourages investment and consumption, and so job creation and long-run growth. Besides, inflationary pressures disproportionately erode the purchasing power of low-income households that tend to use relatively more cash as a percentage of their total expenditures (Easterly and Fischer 2001). Furthermore, individuals at the low end of the distribution usually spend a higher proportion of their income and have less choice over consumption baskets that consist of a few basic items, such as staple food and housing. Inflation, therefore, encourages precautionary savings (Erosa and Ventura 2002). As poor households spend more time shopping to protect from higher inflation productivity can also drop (Cysne et al. 2005). Albanesi (2007) models a bargaining game in which richer households hold greater power in the

political process, such that the government finds incentives in financing public spending through seigniorage rather than taxation. This then leads to inflation and to income inequality. Finn et al. (2014) adjust income by the inflation rate experienced by the poor in South Africa and find that the poverty rate soars by 4.5 percentage points over the period 2005–10. In a panel of 15 OECD countries, Galli and von der Hoeven (2001) find a U-shaped relationship: income inequality declines as inflation rises from low to moderate rates but inequality increases when inflation is above 12 per cent. De Mendonca and Esteves (2018) observe that, in developing countries, enhancing the transparency of central bank operations can significantly decrease the adverse effect of inflation on the poor.

2.6 Income composition channel

In general, different segments of the income distribution depend on distinct sources of income. In South Africa, government transfers and remittances are a fundamental source of income for poor households and they become less important in upper deciles of the distribution, where middle-income households depend mostly on labour income, while households at the top of the distribution can also rely on capital income (Leibbrandt et al. 2012). If, given government transfers, monetary policy actions boost one type of income disproportionately, then they may have redistributive consequences depending on the composition of income by decile.

Based on analysis of past recessions in the United States, Heathcote et al. (2009) consider that the Great Recession would mitigate rising pre-tax income inequality by causing larger declines in income from business activities and dividends than from wages and rising transfers. They also conclude that taxes and social transfers improved income inequality at the bottom of the distribution, with only tiny effects on the whole distribution. Coibion et al. (2012) report that a contractionary shock leads to a significantly negative response of total incomes in the 10th percentile, especially at longer horizons, whereas incomes of those at the 90th percentile rise persistently relative to the median household. The DSGE model by Gornemann et al. (2016) provides results similar to, but less persistent than, Coibion et al.'s (2012): in their exercise, the income of high-wealth households rises due to a spike in dividends whereas the income of lower-wealth households declines on the back of lower earnings.

Using data on the wage share and income distribution in 32 advanced and emerging countries, Furceri et al. (2018) show that a positive monetary policy shock significantly increases income inequality by 1.25 and 2.25 per cent in the short and medium term, respectively. The effect is found to be asymmetric as policy tightening raises inequality more than easing lowers it. By contrast, investigating monetary policy in the United States from 1983 to 2012, Davtyan (2017) finds that a surprise increase in the interest rate reduces income inequality up to 0.4 percentage points in the Gini index.

In contrast to the effects of conventional monetary policy easing, quantitative easing worsens income inequality: while employment changes and mortgage refinancing tend to narrow income inequality, these impacts are often outweighed by the increase in inequality from realized returns on various financial assets (Mumtaz and Theophilopoulou 2017; Montecino and Epstein 2015; Bunn et al. 2018). Saiki and Frost (2014) estimate these effects based on Japanese household survey data and find that the Bank of Japan's Abenomics programme significantly widened income inequality. Feldkircher and Kakamu (2018) find an opposite result for Japan but their measure of unconventional monetary policy is the shadow interest rate, which is likely to understate the portfolio rebalancing effect of central banks' asset purchases.

3 Data

3.1 Wage inequality⁴

Despite there being a rich body of literature examining cross-sectional inequality in South Africa, no consensus has been reached on the quality of long-run time series that measure the distribution of income in the post-apartheid period. In effect, multiple generations of household surveys have been produced since 1994 by local statistical and research agencies, which provide nationally representative micro-level information on the labour market.⁵ Although these resources constitute today an abundant pool of information, they were not originally designed for dynamic analysis and, indeed, do not allow for straightforward comparability and immediate use in longitudinal studies. In other words, the nature of the data collected differs more or less substantially in each survey wave because of differences in the sample design instrument and definitions, for example.

As a response to rising concerns over the validity of using distributional data to undertake time-comparative exercises, the University of Cape Town's DataFirst initiated a study of 58 successive labour market cross-sections and integrated them into a single stacked dataset: the so-called Post-Apartheid Labour Market Series (PALMS) (Kerr et al. 2019). The major advantage related to the latest release, PALMS v3.3, is that it exhibits a labour income variable at individual level that is consistent over the entire period from 1993 to 2017.⁶ Although PALMS yields significant improvements in the treatment of labour data in South Africa, it still preserves a number of incongruities inherited from primary sources. To date, the South African literature that assesses the sensitivity of distributional trends to economic policy shocks is almost non-existent precisely because dynamic analyses would suffer from the presence of methodological shortcomings: spurious shifts among repeated cross-sections are inevitably related to real changes in the variables of interest.

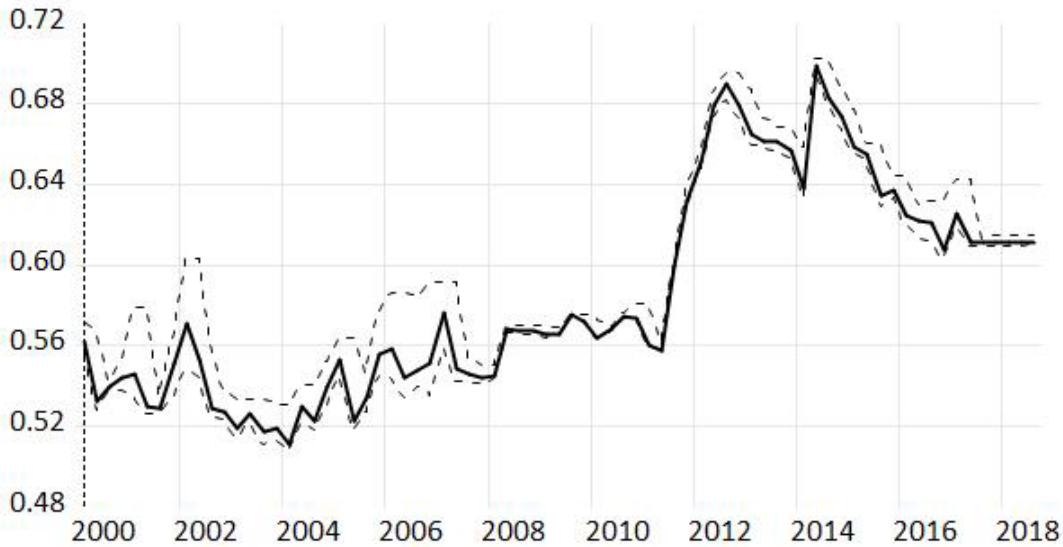
For the purpose of this paper, it is therefore necessary to derive unbiased estimates and accurate standard errors of inequality coefficients that can be better compared over time. While it is not feasible to fully address all problems pertaining to primary data collection, corrections implemented on PALMS v3.3 deal with outliers and implausible data records, missing observations at random, bracket responses and sample weights, breaks in the series (or missing observations not at random), underreporting of high incomes, and extrapolation of quarterly frequency observations. Ultimately, inequality is measured here through the Gini index based on pre-tax wage income at constant prices and individual level, for employees in the working age, collected between the first quarter of 2000 and the second quarter of 2019. Figure 1 plots the Gini index series and 95 per cent confidence interval (dotted lines).

⁴ This section relies heavily on my previous work (Merrino 2020).

⁵ According to Devereux (1983), until the 1980s government censuses ignored the personal incomes of blacks that had to be calculated as a residual of national accounts. For this and other reasons, the present paper only refers to the post-apartheid period.

⁶ This is labelled '*realearnings*' and it reports monthly earnings *per capita* before taxes and at constant prices as for December 2015.

Figure 1: Evolution of the Gini index, individual basis (2000 Q1–2019 Q2)



Source: author's calculations based on PALMS v3.3 after adjustment.

Figure 1 reveals the presence of a positive trend in wage inequality that is confirmed by existing literature making use of alternative survey data. This figure also displays a 10 per cent rise in the Gini index over the course of one year, from 2012 Q1 to 2013 Q1. This sudden change may be mostly due to methodological issues, given that ‘in 2012 South African officials changed the way they measured key earnings variables’ (Leibbrandt et al. 2018: 12), and partly to the decline in real GDP growth that corresponds to this period, although this is just a suspicion that cannot be tested here.

3.2 Monetary policy shocks

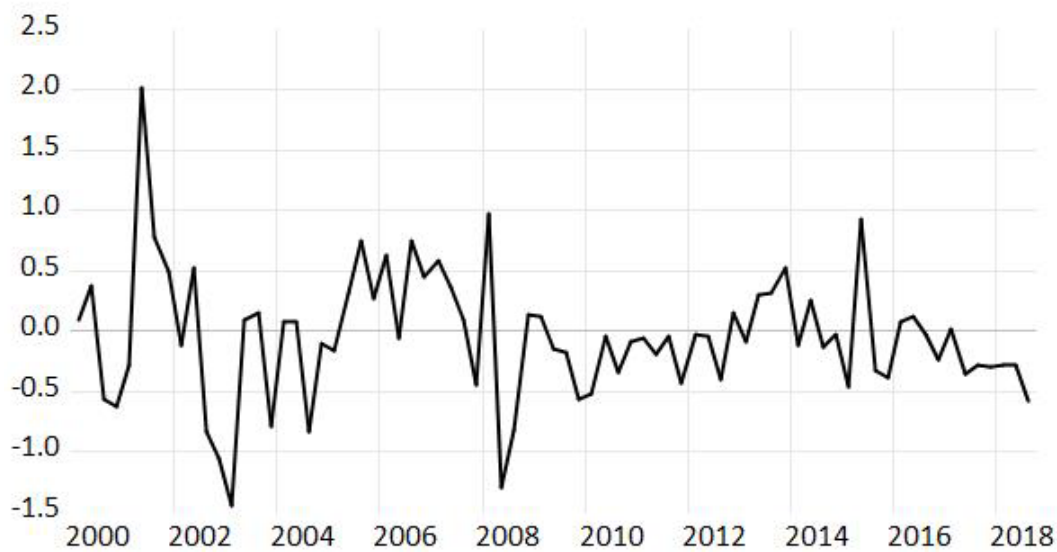
To date, the most conventional approach used in the South African literature to identify conventional monetary policy innovations simply relies on contemporaneous restrictions and a Choleski decomposition of the variance–covariance matrix of the residuals from a vector autoregressive (VAR) model in which the policy rate is ordered last, or alternatively on long-run restrictions in the tradition of Blanchard and Quah (1989). One issue that is not addressed by these methods is to distinguish between the stochastic component of the monetary policy measure and its systematic response to economic conditions. This is particularly problematic in times when the central bank targets inflation and interest rates move endogenously with economic activity. In light of these concerns, in order to identify the unexpected component of the US Federal Reserve funds rate, Romer and Romer (2004) regressed the change in the target rate around the policy decision on a proxy for the information set available to the policy maker just prior to that decision. This information set includes a range of real-time indicators and forecasts to reflect the forward-looking nature of monetary policy.

A simplified version of the Romer and Romer (2004) shock series is used here to identify monetary policy innovations purged of anticipatory effects between the third quarter of 2000, corresponding to the outset of the inflation-targeting regime, and the second of 2019.

$$\Delta i_t = \alpha + \tilde{i}_t + \sum_{t=0}^{t+2} \beta_t \Delta \tilde{y}_t + \sum_{t=0}^{t+2} \gamma_t \tilde{\pi}_t + \varepsilon_t \quad (1)$$

In Equation (1), Δi_t indicates the change in the prime rate at which commercial banks lend to their customers over each quarter. On the right side of the equation, \tilde{i} , $\Delta \tilde{y}$, and $\tilde{\pi}$ represent forecasts of the prime rate,⁷ the annualized real output growth and consumer price index (CPI) inflation rate, respectively, as sourced from the Reuters Econometer (2000–19).⁸ Time horizons, indicated by t , account for the present and the two quarters ahead. Finally, ε_t is the residual that represents the monetary policy innovation in quarter t . The unexpected change in the South African prime rate derived from Equation (1) is plotted in Figure 2 and shows that major shocks occurred at the end of 2001 and 2003, then in the aftermath of the 2007–08 global financial crisis, and finally in 2015.

Figure 2: Evolution of the monetary policy shock (2000 Q4–2019 Q2)



Source: author's calculations based on SARB (2019).

4 Structural vector error correction model

Once wage inequality and monetary policy shocks have been quantified, it is possible to empirically investigate the distributional effect of monetary policy on South African households' wage income through multivariate time-series analysis. To do so in the presence of multiple continuous variables that are potentially mutually dependent, the natural solution is to estimate a VAR model; that is, a system of dynamic linear equations where each variable is regressed on p lagged values of its own as well as of the other variables.

$$B_0 Y_t = c + B_1 Y_{t-1} + \dots + B_p Y_{t-p} + u_t \quad (2)$$

⁷ The Reuters Econometer provides forecasts of the prime rate until 2008 and of the repo rate afterwards. Since variations in the prime rate reflect changes in the repo rate, especially since 2009, missing prime rate forecasts are derived by applying the repo rate forecast's growth rate to the prime rate's forecast in the last quarter available (2008 Q4).

⁸ The Reuters Econometer (2000–19) data are supplied by the South African Reserve Bank (SARB) and have been used in this study with permission from the SARB Research Department.

In the benchmark model, Y_t is a $(k \times 1)$ vector of four endogenous variables: real GDP growth rate (g) and CPI inflation (π) sourced from the SARB's database, the Gini index or another measure of individual real wage inequality in first difference ($ineq_t$), and the monetary policy shock (ε) as identified in Section 3.

To determine whether the data are generated by stationary stochastic processes, the augmented Dickey–Fuller test and the non-parametric Phillips–Perron unit root test are employed. Both tests classify all endogenous variables as stationary except for the Gini index that is integrated of order one. Thus, the Johansen trace and maximum-eigenvalue tests are used to check for cointegration: the null hypothesis that there is a single cointegrating relationship, denoted by r , cannot be rejected at the 1 per cent significance level.

When the variables of a VAR model are cointegrated, a structural vector error correction (SVEC) model in first differences must be estimated instead, to account for the long-run relationship to which the levels of the variables tend to return. The reduced form of an SVEC is presented in Equation (3). The right-hand side includes (i) the deterministic term c , but no linear trend since data is differenced, (ii) the cointegrating relationship, (iii) the VAR terms, and (iv) the dummy variable $break_t$ that accounts for the 2012 dramatic change in the Gini index referred to in Section 3.1.⁹ The residual vector e_t is assumed to be a K -dimensional unobservable zero-mean white noise process with positive definite covariance matrix $E(e_t e_t') = \Sigma_e$.

$$\Delta Y_t = c + \Pi Y_{t-1} + C_1^* \Delta Y_{t-1} + \dots + C_p^* \Delta Y_{t-p} + break_t + e_t \quad (3)$$

In Equation (3), let the SVEC be of order p and Π be equal to $\alpha\beta'$, where α and β are $(k \times r)$ matrices with full column rank, r . The columns of β contain the k long-run parameters and the columns of α contain the r adjustment vector to long-run equilibrium values. The error term is $e_t = Bu_t$.

4.1 Identification scheme

The structure imposed on this vector of endogenous variables must exactly define the exogenous component of each variable in the model. In a k variable model, k^2 parameters are required for identification with $k(k-1)/2$ linearly independent restrictions that uniquely identify the structural shocks. For the long-run impact matrix Π of the four-variable SVEC, the number of shocks with permanent effects is $k-r=3$, whereas at most $r=1$ shock has transitory effects. The full specification of the parameters is based on theoretical assumptions and depicted in the matrix-form Equation (4). Given nominal variables should not influence economic activity in the long term, shocks to the prime rate are assumed to have no permanent effects by setting the last column of Π equal to zero. Since the zero column stands for $k-r=3$ independent restrictions, three more are needed. Therefore, assume the existence of a vertical long-run aggregate supply curve that requires Π 's first row of zeros, in conjunction with inflation being independent from inequality and interest rate shocks in the long run. As such, the cointegrating vector is fully identified and only one restriction to the short-run parameters in matrix B is needed.

⁹ The dummy variable is included only when inequality is proxied by the Gini index in first difference.

$$\Pi = \alpha\beta' = \begin{bmatrix} * & 0 & 0 & 0 \\ * & * & * & 0 \\ * & * & * & 0 \\ * & * & * & 0 \end{bmatrix} B = \begin{bmatrix} * & * & * & * \\ * & * & * & * \\ * & * & * & * \\ * & 0 & * & * \end{bmatrix} \quad (4)$$

The number of autoregressive lags according to the Akaike information criteria is one. The SVEC(1) system is estimated by maximum likelihood.

4.2 Robustness

The output of the benchmark model, in which inequality is measured by the Gini index, is shown in Appendix Table A1. The third row of the t -values matrices refers to the estimates of the inequality function, which are all statistically significant.

For robustness checks, the SVEC model is enriched by real GDP growth and inflation rate that identify some of the fundamental transmission channels of monetary policy. Appendix Figure A1 shows that the response of real output growth to a contractionary prime rate shock is negative and persists over the course of two years. The lower quadrant of Appendix Figure A1 exhibits a negative reaction of CPI inflation, too, therefore solving the price puzzle. In a second specification of the SVEC(1), real output growth is replaced by investment and employment in log difference.¹⁰ As shown by Appendix Figure A2, both the number of employed individuals and the amount of private investment decrease as a result of a contractionary shock in the prime rate. It is also worth noting that empirical findings are also robust to the particular measure of inequality used in Equation (3), as shown in Figure 3 and discussed in Section 4.3. Additionally, the effects of monetary policy shocks on inequality are consistent with different lags specification if greater than three-quarters.

The diagnostic tests for serial correlation, non-normality, autoregressive conditional heteroskedasticity in the residuals, and break points in the regression line are performed and shown in Appendix Table A2.

4.3 Impulse response functions

As a first step of the empirical analysis, the distributional effects of monetary policy shocks are evaluated through the graphical representation of impulse response functions (IRFs) of the short- and long-run reaction of wage inequality to unanticipated increases in the prime rate. Figure 3 shows the response over 24 quarters of different measures of inequality. Each quadrant is the result of the SVEC(1) presented in Equation (3), with *ineq* _{t} measured by the Gini index (Figure 3a), the generalized entropy index with factor 2 (Figure 3b), the percentile dispersion ratio P90/P10 (Figure 3c), and the percentile dispersion ratio P90/P50 (Figure 3d). A bootstrap procedure is used to construct the 95 per cent confidence interval for the impulse responses that is plotted through the dashed line.

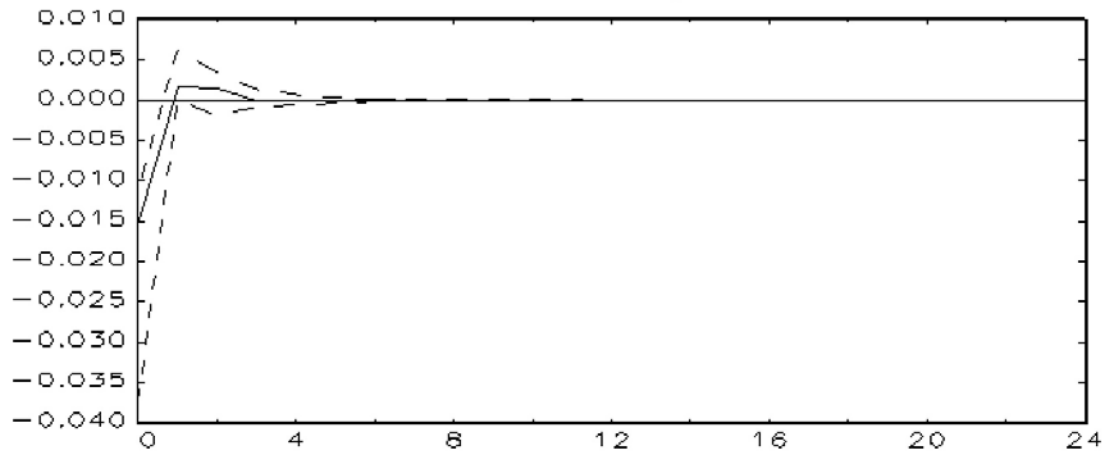
Figure 3 plots demonstrate that interest rate shocks have some immediate effect on the allocation of wage income across South African households. In particular, plots of IRFs suggest that inequality increases in the first two quarters that follow an unexpected tightening in the prime rate. A similar response, although more accentuated, is exhibited by the generalized entropy index with factor 2 (i.e. particularly sensitive to the presence of relatively high incomes) and the P90/P10 dispersion ratio. These plots suggest that the redistributive effect of monetary shocks is due to the

¹⁰ Sourced from SARB (2019).

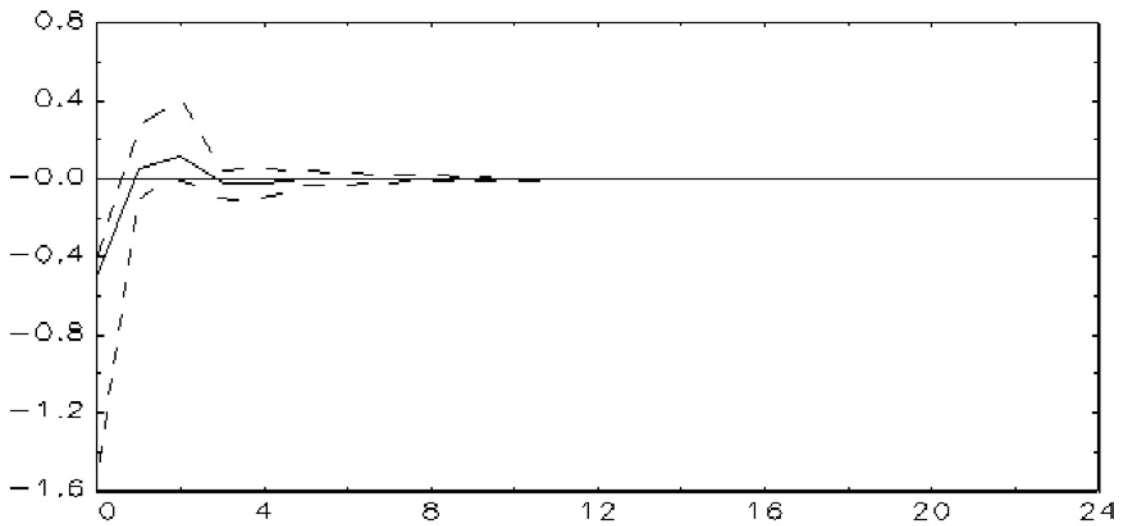
widening gap between the top wage-earning 10 per cent of workers and the bottom decile of the wage distribution. It is also evident that all variables stabilize just about a year after the monetary policy shock.

Figure 3: Impulse response functions (IRFs) of wage inequality to positive monetary shocks

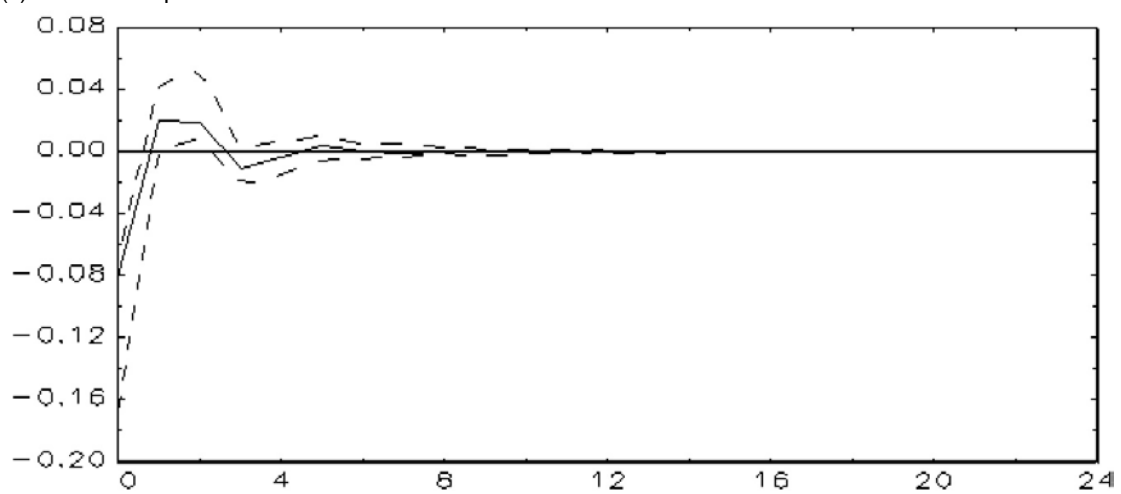
(a) Gini index



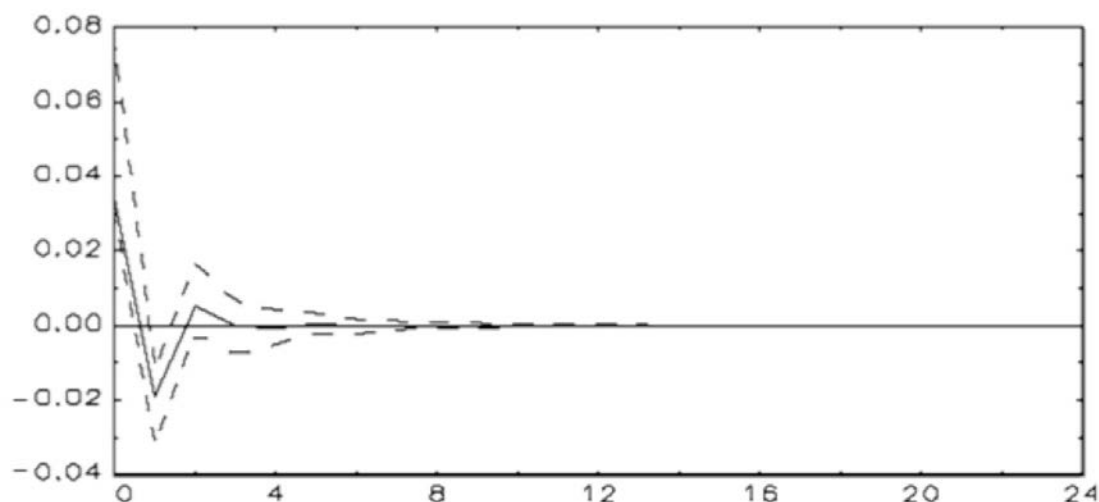
(b) Generalized entropy index



(c) P90/P10 dispersion ratio



(d) P90/P50 dispersion ratio



Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

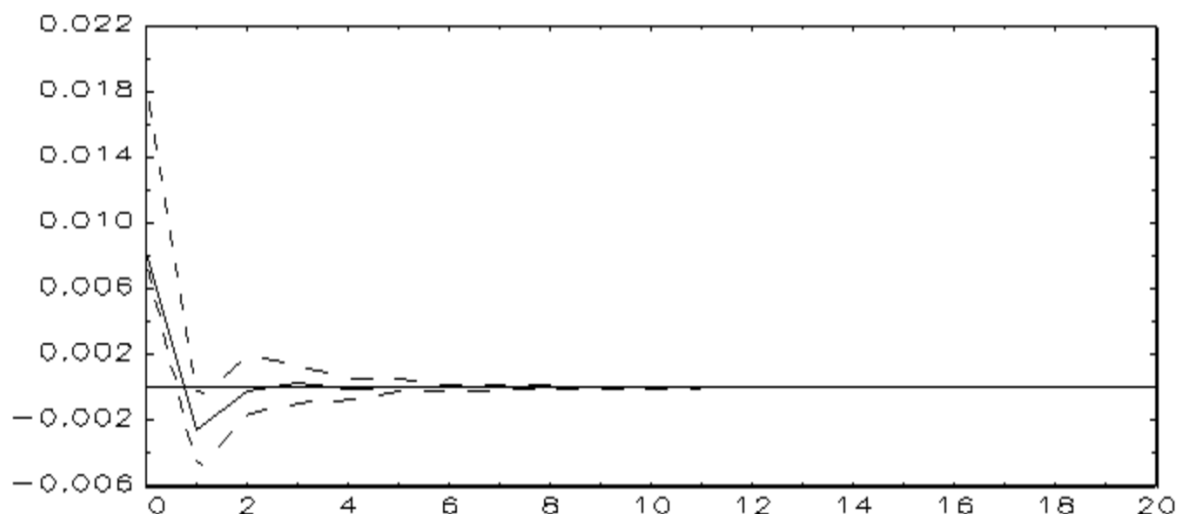
An opposite result is found when measuring inequality by the 90th/50th percentile dispersion ratio. Figure 3d displays that average wage earned by the richest 10 per cent of employees decreases with respect to the median in the first quarter that follows the surprise increase in the prime rate.

Besides widening the wage gap between the richest and the poorest 10 per cent (Figure 3c), the surprise increase in the prime rate slightly evens up the distribution of wages at the top half (Figure 3d). A possible explanation for this puzzle of figures, which takes account of the various moments of the distribution, is that the contractionary shock deteriorates the bottom of the wage distribution relatively more than the top. If the loss of employment depicted in Appendix Figure A1 allegedly prevails among low-paid workers (below the median wage), then the average wage earned by the 10th percentile decreases, so that the gap between the poorest and the richest increases and the whole distribution, as captured by the Gini index and the generalized entropy index, worsens.

Figure 4 shows that the labour share of national income also decreases on a small scale in the first quarter following an unexpected rise in the prime rate. The labour share, measured by total employee's compensations as a share of national income,¹¹ is often considered an alternative measure of inequality whereby the bigger the labour share as opposed to capital share, the higher income is channelled to the bottom deciles of the distribution, assuming that they rely on employment as the main source of earnings. The responses of the Gini index and the labour share are opposite, implying that a positive shock raises inequality (Figure 3a), while it lowers employment (Appendix Figure A1) and the labour share (Figure 4).

¹¹ Sourced from SARB (2019).

Figure 4: IRFs of the labour share to positive monetary shocks



Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

4.4 Sectoral analysis

After implementing a sectoral decomposition of the Gini index, the system of endogenous variables in Equation (3) is estimated with inequality measured for each sector of the South African economy separately. Interestingly, the sectoral analysis reveals that monetary policy has a contrasting effect on the distribution of earnings that varies across productive sectors. It is found that, as a consequence of a surprise increase in the prime rate, there is no significant impact on inequality for waged workers employed in the wholesale and retail trade, manufacturing, services such as tourism and communications, and—unsurprisingly—in the public sector. In conclusion, the transmission of monetary policy is redistributive due to sectoral heterogeneity too.

In the service and government sectors, contractionary shocks are found to actually improve the wage allocation, although not significantly. This result suggests the possibility that in these sectors the monetary tightening decreases wage rates more than employment and so it hurts top earnings relatively more (Heathcote et al. 2009).

Noticeably, the trade, manufacturing, and government sectors constitute the biggest market share of the South African economy, accounting for almost half of GDP, outperformed only by the financial and real estate sectors (Stats SA 2019), and they also tend to pay comparatively higher wages on average. This is in line with Galbraith and Hale's (2014) comments that the dispersion of earnings across industrial sectors in the United States is positively related to inter-industry distribution of profits, meaning that higher wage rates are paid in the strongest sectors despite their lower employment rates. Similarly, the wage distribution in these strongest sectors is less responsive to interest rate innovations of any sign. However, further empirical analysis finds no significant contribution of monetary policy shocks to inter-industry inequality; that is, inequality between workers employed in these sectors and the others.

4.5 Positive versus negative monetary policy shocks

The impact of unexpected monetary contractions or expansions on inequality can be asymmetric. Furceri et al. (2018) find that the tightening of policy raises inequality more than easing lowers it. In the presence of asymmetry, the multiplication of shocks can then cause persistent effects.

To distinguish between negative and positive unanticipated shocks, the series of negative monetary shocks is extracted from the monetary policy shock in terms of a minimum (shock, zero); the series of positive monetary shocks is extracted from the monetary policy shock in terms of a maximum (shock, zero). The benchmark SVEC(1) model expressed by Equation (3) is run on both series of shocks, negative and positive. The IRF of negative (expansionary) shocks must be interpreted as mirrored.

Contrarily to Furceri et al. (2018), the effect appears to be symmetric between contractionary and expansionary monetary policy shocks when observed in the IRF of the Gini index and the generalized entropy index. This finding implies that, while unexpected monetary tightening has a negative impact on inequality due to disproportionate destruction of low-waged jobs (as established in Section 4.3), a surprise monetary stimulus improves the distribution of wages to a similar extent. Analogously, the gap between the 90th and the 50th percentile shrinks as well as that between the 90th and the 10th percentile. Thus, while the distribution of real wages across South African workers responds more or less symmetrically to monetary policy shocks of opposite direction, the most striking feature relates to the top half of the distribution given that the P90/P50 ratio reacts positively to both types of shocks. This implies that (i) a contraction, by destroying low wage-paid jobs relatively more, increases the median wage; and that (ii) an expansion, by benefiting higher brackets relatively more than the 10th percentile, also increases the median wage. This is likely to be the consequence of the structural segmentation of the South African labour market, whereby better-paid jobs remain secure in bad times and benefit the most in good ones.

More interestingly, the labour share of income is found to respond negatively to the central bank stimulus. This apparently contradictory finding is not completely surprising in South Africa. By looking at the evolution of the labour share in the post-apartheid era, it emerges that it has been moving in the same direction as wage inequality (Merrino 2020). In particular, it started to increase when the growth rate of the South African economy began to decline around 2011. This counterintuitive dynamic can be explained by the fact that during the recession capital gains were being lost disproportionately such that labour income actually increased.

One plausible reason for this apparent contradiction could be given by the fact that the wage share compresses with respect to the capital share of national income because *ceteris paribus* financial gains are relatively more elastic to interest rate changes. In South Africa, this effect is confirmed by several empirical studies. For example, Gumata et al. (2013: 11) evidence that, as a result of an unexpected rise in the repo rate, the Johannesburg Stock Exchange all-share index ‘does not react upon impact, and eventually decreases gradually, attaining the lowest level of 0.32% after two quarters’. If this is the case, the functional distribution of income remains overall an inadequate proxy for labour income inequality in the South African case (Merrino 2020).

4.6 Monetary policy and the black–white wage gap

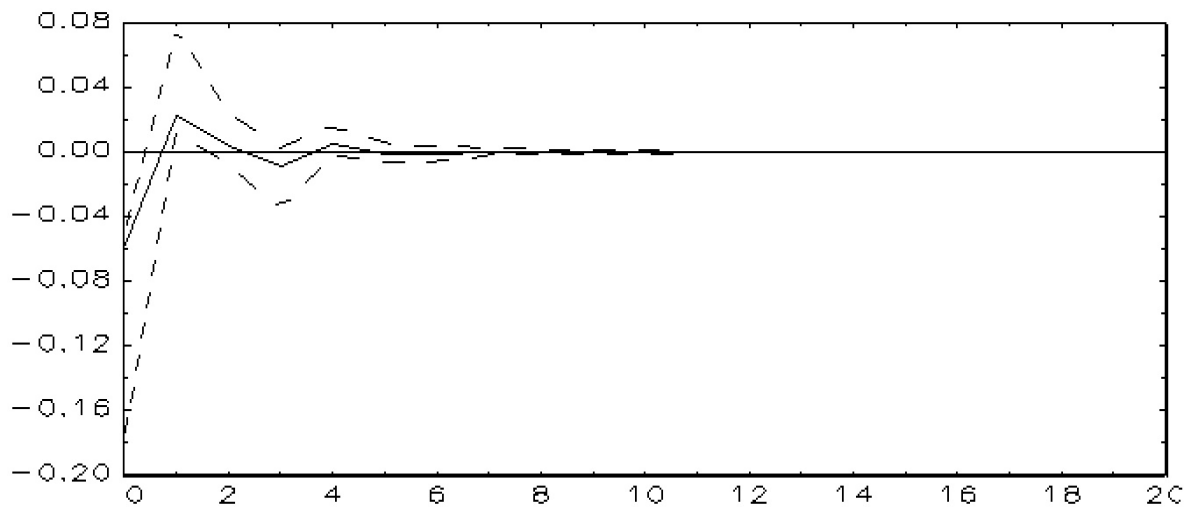
The fact that the distributional effect of monetary shocks is small persuades that more fundamental forces—such as education, globalization, demographics, skill-biased technology, and managerial compensation—may substantially drive inequality dynamics in South Africa. In this sense, it would be useful to understand how the distributional effects of monetary policy relate to the structure of the South African economy given that, if jobs are destroyed, they will likely be cut among the most vulnerable socio-economic groups.

For this reason, the same dataset used to compute wage inequality in Section 3.1 is used to compute the wage gap between black African and white workers in South Africa in each quarter from 2000 to 2019. The black–white wage differential is calculated as the ratio between the average wage of white and black workers. The resulting series is always and substantially positive and it shows that

white wage-paid employees earn three or four times more than black employees on average, with particularly high peaks in 2008 and 2015 (see Appendix Figure A3). The series is therefore transformed in log-differences before being included in the SVEC of Equation (3).

The IRFs plotted in Figure 5 indicate that the wage gap between the two ethnic groups significantly increases after a contractionary shock to the prime rate. This effect unsurprisingly resembles dynamics on inequality expressed by the Gini index, the generalized entropy index, and the 90th/10th percentile ratio. In fact, economic inequality in South Africa is inextricably linked to the tragic legacy from the apartheid regime, which has left the majority of the black population at the bottom of the socio-economic ladder. If a contractionary shock increases inequality by reducing low-waged employment relatively more, and if the bottom of the wage distribution is mostly populated by a black labour force, then the shock will also worsen the ethnicity-pay gap.

Figure 5: IRFs of the wage gap to positive monetary shocks



Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

However, after an accommodative shock, the wage gap follows the same trajectory. If this result can appear counterintuitive in general, it is less so in the particular case of the highly segmented South African labour market. Section 4.5 clarified the distributional dynamics that follow a negative shock to the prime rate. Thus, if employment for workers at the bottom of the wage distribution increases relatively less than for top-wage earning workers, also the average wage of the richer white workers will increase relative to the average wage earned by black workers.

5 Conclusions

This paper made use of forecasted and observed data of macroeconomic time series to identify monetary policy shocks that are orthogonal to the business cycle, and of disaggregated data on labour to quantify the evolution of wage inequality market in South Africa since 2000. The econometric analysis attempted to investigate the indirect distributional effects of monetary policy shocks through their influence on real economic activity, and thus on the allocation of labour income across workers. Results must also be interpreted in light of the measure of inequality considered, which is based on full-time wage-paid workers only, including employed individuals who earn zero monetary compensation but overlooking self-employed and unemployed

individuals.¹² If wages are already concentrated in specific sub-groups of the population, then we have good reasons to think that the broader picture of inequality is more dramatic but that the effect of monetary policy shocks depicted in this paper is less effective overall. Results must be dealt with carefully due to underlying data quality and, particularly, to changes in the methodology used in processing the data.

IRFs from an SVEC (1) show that unexpected monetary policy actions have tiny but immediate and significant effects on wage inequality in South Africa. Adopting different measures of inequality allows us to explore the effect of monetary surprises on the various moments of the wage distribution. An unexpected increase in the prime rate deteriorates low wage-paid employment disproportionately. As a result, the gap between the richest and the poorest 10 per cent of wage-paid workers widens and overall inequality worsens.

Furthermore, the model reveals that, while accommodative monetary policy shocks improve wage inequality to a similar extent that contractionary shocks worsen it, the top half of the distribution will shrink in any event. It seems, therefore, that better-paid jobs remain secure after monetary contractions and benefit the most after monetary stimuli. Besides, the fact that the top half of the distribution narrows in response to both types of shocks and so that this effect does not cancel out over the course of the business cycle can lead to permanent effects on overall inequality. At the same time, given white workers are concentrated in the top deciles as a repercussion of the apartheid regime that formally fell down in 1994, there is reason to suspect that this group may be favoured over black African workers who, instead, receive lower compensations on average. In effect, it is found that the black–white wage gap significantly widens under both positive and negative shock. Another outcome of the paper is that four of the biggest employment sectors of South Africa—namely, trade, manufacturing, services, and the public sector—do not significantly respond to monetary policy shocks in distributional terms. These dynamics, therefore, imply that monetary policy can contribute to inter-sectoral inequality, too.

Overall, the redistributive effects of monetary policy in South Africa are visibly driven by the peculiar structure of the economy and, particularly, its deeply segmented labour market. Skilled workers receive relatively high compensations due to a large demand for their services, while low-skilled workers suffer extreme levels of unemployment. As a result, while the strongest sectors and socio-economic groups remain under protection, in the rest of the economy surprise contractions cut investment and employment and increase wage inequality. Thus, it can be said that improving SARB’s transparency and accountability as to limit policy actions that are not expected by the markets shall be the right step towards inclusion.

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¹² See Merrino (2020) for the detailed derivation of the inequality measure used here.

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Appendix A: Output and robustness check of vector error correction models

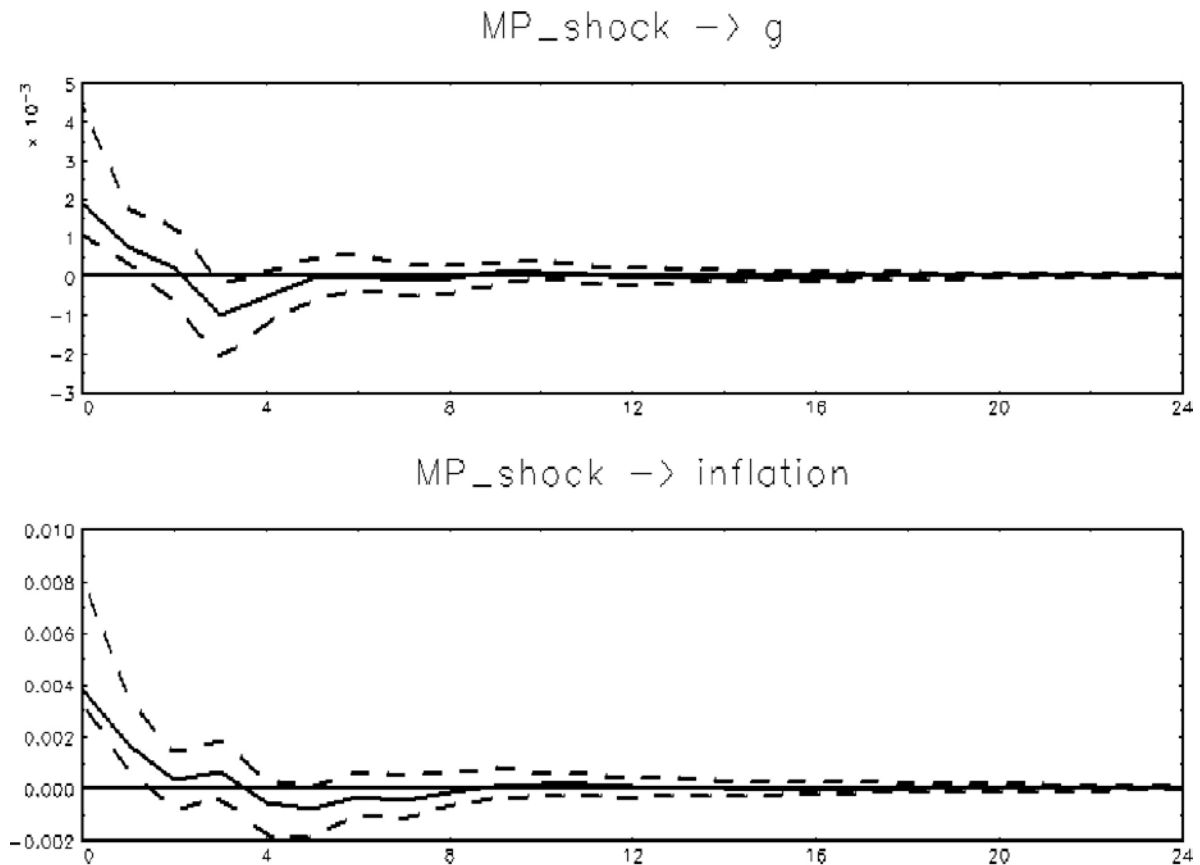
Table A1: Estimation output of SVEC(1) with $ineq_t$ measured by the Gini index

Estimated B matrix			
0.0053 (5.0033)	0.0006 (0.7685)	-0.0006 (-0.8513)	0.0012 (1.2147)
-0.0009 (-0.8478)	0.0050 (5.0783)	0.0021 (0.9472)	0.0025 (1.6737)
0.0018 (0.6161)	0.0085 (2.6983)	0.0022 (1.1397)	-0.0121 (-1.7674)
0.0838 (1.0818)	0.0000	0.4222 (1.1335)	0.0940 (1.7956)
Estimated long-run matrix			
0.0028 (5.8274)	0.0000	0.0000	0.0000
0.0002 (0.2050)	0.0038 (4.6713)	0.0021 (1.1204)	0.0000
0.0005 (0.8393)	0.0027 (5.0799)	0.0000 (-0.0931)	0.0000
0.0933 (1.7226)	0.0681 (1.8741)	0.1977 (1.1436)	0.0000

Notes: t -values in parenthesis. A structural vector autoregressive model is identified. Long-run restrictions provide five independent restrictions. The contemporaneous restriction provides one additional restriction. Estimation is carried out by maximum likelihood. Convergence is achieved after 19 iterations. Log likelihood: 955.31.

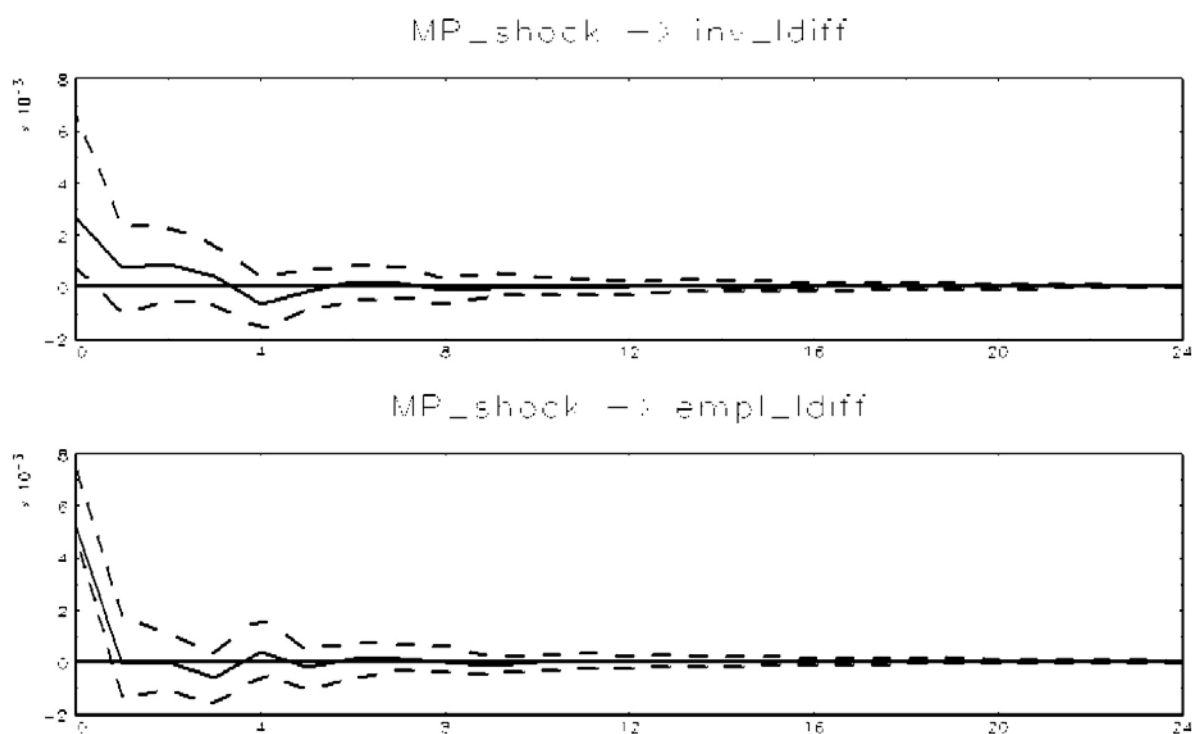
Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

Figure A1: IRFs of real GDP growth and CPI inflation to monetary policy shocks



Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

Figure A2: IRFs of employment and investment to monetary policy shocks



Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

Table A2: Residual and stability analysis

Test	H_0	Test stat	<i>P</i> -value
Portmanteau (16)	No serial correlation	180.55	0.88
Jarque-Bera	Non-normality	14.22	0.0008
ARCH-LM (16)	No heteroskedasticity	13.10	0.66
Multivariate ARCH-LM (5)	No multivariate heteroskedasticity	516.42	0.30
LM (5)	No autocorrelation	91.43	0.17
Chow test	No breakpoint	134.11	0.48

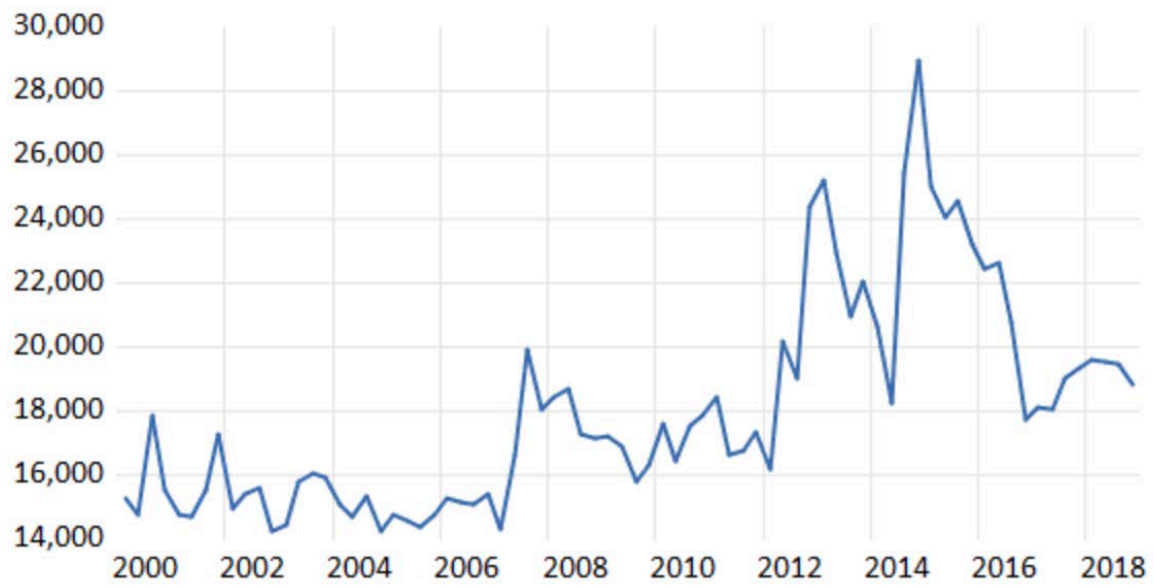
Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

Table A3: Proportions of forecast error variance decomposition of Gini index

Forecast horizon	<i>g</i>	Inflation	Gini	MP shock
1	0.00	0.90	0.01	0.08
2	0.01	0.86	0.04	0.09
3	0.03	0.84	0.03	0.10
4	0.03	0.83	0.03	0.10
5	0.03	0.85	0.03	0.09
6	0.03	0.86	0.03	0.08
7	0.03	0.86	0.03	0.08
8	0.03	0.87	0.03	0.07
9	0.03	0.88	0.03	0.07
10	0.03	0.88	0.03	0.06
11	0.03	0.89	0.02	0.06
12	0.03	0.89	0.02	0.06

Source: author's calculations using JMulTi version 4.24 (see Lütkepohl and Krätzig 2004).

Figure A3: Wage gap (in South African Rands) between white and black employees (2000 Q1–2019 Q4)



Source: author's calculations from PALMS v3.3 after adjustment.