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Manufacturing industry performance and stabilisation policies in South Africa

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Background: Manufacturing performance in South Africa is concerning, with the sector displaying signs of early deindustrialisation. South African authorities use a strategic blend of stabilisation policies in managing these unique macroeconomic conditions.

Aim: In light of that, the study examined the combined impact of fiscal and monetary policy on manufacturing sector performance.

Setting: The analysis was based on data obtained for aggregate and selected South African manufacturing industries.

Method: The study employed an autoregressive distributed lag (ARDL) technique between 1998 and 2020.

Results: Results revealed that raised tax revenue positively impacted aggregate manufacturing, food and wood production. Metal production, however, conformed to expectations, with increased tax revenue reducing output. Government spending expansion negatively impacted aggregate manufacturing and wood and metal industries, possibly signalling crowding out. Contrastingly, spending had a significant positive impact on chemical production. Aggregate manufacturing and wood and metal manufacturing had the expected negative relation with lending rates (LR). Food and chemical industries exhibited significant negative links with money supply (M3). This suggests that the type of credit extended towards these industries was not conducive to productivity.

Conclusion: The findings imply heterogeneity in industry responsiveness towards stabilisation policies in South Africa. Expansionary fiscal stimulus packages should target the industries that will most benefit. Reserve banking authorities consider output fluctuations in policy setting, but this is not legislated.

Contribution: The study contributes to the literature on policy coordination efforts in African countries at the disaggregated industry level.

Keywords: ARDL; fiscal policy; monetary policy; heterogeneity; manufacturing.

Introduction

Growth in South African manufacturing is required for the country to achieve convergence with developed nations and for a higher level of nonagricultural employment (Loewald 2020:1–11). It is difficult or even unlikely that a country will experience a significant rise in growth and development without a dynamic, fully functional manufacturing sector. Development of the sector is crucial in wealth creation and the evolution of secure, powerful manufacturing industries normally precedes industrialisation (Loewald 2020:1–11). Amidst the 2008/2009 global financial crisis, domestic manufacturing production declined, with industries most affected being those reliant upon foreign demand, such as iron and steel (Dednam 2022:11). In response, the Monetary Policy Committee (MPC) frequently adjusted the repurchase rate. There has since been a review of the financial regulatory framework, the implementation of Basel II and the adoption of a firmly expansionary fiscal approach, with public debt tripling and spending as a percentage of gross domestic product (GDP) rising (Shipalana 2021:4–9).

However, despite earlier interventions, domestic performance in manufacturing has been concerning, with production falling by 10.8% in 2020, trouncing declinations of the 2008/2009 financial crisis (Statistics South Africa 2020:2). The onset of COVID-19 has not exempt activities within the sector. The severity of lockdown measures introduced was observable by steep declines in manufacturing output. Production declined by 49.3% in April 2020 alone (Industrial Development Corporation [IDC] 2020a:9). Policy-wise, authorities have used a combination of macroeconomic stabilisation tools. There was a reduction in the repurchase rate in March 2020 to 3.5%, the lowest in South African history. However, monetary policy measures alone could not improve growth or reduce fiscal risks (Shipalana 2021:4). Not only is there concern regarding the precise effectiveness of domestic policy impacts on sectoral production, but the literature posits the possibility of heterogeneity concerning the responsiveness of various industries within the sector towards these stabilisation policies (Chavez 2023; Dobronravova 2022; Roy, Bashar & Bhatacharrya 2023).

In light of this, the study objective was to empirically examine the combined policy impact of fiscal and monetary variables on aggregate manufacturing and production within selected South African manufacturing industries. Manufacturing industries selected included: (1) metals, metal products, machinery and equipment; (2) food, beverage and tobacco; (3) petroleum products, chemicals, rubber and plastic and (4) wood and paper, publishing and printing. This selection was based on industry contributions towards aggregate manufacturing production and thus economic growth. The potential impact that policy impacts at the industry level would have on aggregate domestic growth was a significant factor underlying this selection. The dataset ranged between 1998 and 2020. Variables underwent stationarity testing via augmented Dickey-Fuller (ADF) and Phillips Perron (PP). Autoregressive distributed lag (ARDL) models and error correction models (ECMs) were regressed for aggregate manufacturing and the selected industries. In examining coordinated stabilisation policy efforts, the findings imply heterogeneity within South African manufacturing industries.

Literature review

Theories promoting fiscal or monetary policy intervention in growth generally indicate policy impacts as positive. Classicalists first identified the relevance of manufacturing in growth and paved the way for the present study, given the identification of the link between monetary policy and economic variables. However, they failed to identify the relevance of combined policy impacts (Twinoburyo & Odhiambo 2018:124). Keynes (1936) advocated policymakers enhance deficits by increasing government spending or decreasing taxes (Calitz, Steenekamp & Siebrits 2020: 403–411). Keynes's contributions are still relevant, given the recognition of the role of combined policy impacts in stabilising output (Calitz et al. 403–411; Sahoo, Mohanty & Sahu 2024).

The formulation of the IS-LM framework later led to the Keynesian interest rate channel. Monetary policy transmission is a 'macro policy stimulus-microeconomic response-macro output' process (Xu 2020:740). In the course of monetary policies controlling macroeconomic output, micro-economies (industries, businesses, households, individuals) occupy a decisive role in responding to monetary policy changes (Xu 2020:740). Monetary policy can also be heterogeneous. Researchers Garrison and Chang (1979) first noted industrial heterogeneity arising from different industrial capital density distributions in varying regions. This has led to additional research on monetary transmission mechanisms at the industrial level (Roy et al. 2023; Sahoo et al. 2024; Yesigat, Rao & Nagaraja 2019).

The managerial theory of the firm as developed by Baumol (1959) posited that for growth to be observed via industrialisation, public spending must be increased in facilitating economic developmental processes. Emphasis was placed on how a firm's decision to grow is not solely reliant on sales revenue maximisation at the firm level, it also depends on fiscal policy. Government spending triggers industrial productivity (Effiong, Ukere & Ekpe 2024:2517). Similarly, New Keynesians provided ample rationale for government interventionist mechanisms via countercyclical policy. New Keynesians advocated recessions as caused by economy-wide market failures. These non-neutrality fiscal policy implications adhere to the current research objectives (Mankiw 2019:5). The Savers-Spenders theory as developed by Mankiw (2000) has also been used in analysing the impact of fiscal policy on aggregate growth in economies (Queku et al. 2024; Tiony 2023) and manufacturing (Arikpo, Ojong & Ogar 2017; Effiong et al. 2024).

Empirically, limited studies have related fiscal variables to the manufacturing sector in the aggregate (Hong, Ke & Nguyen 2024; Ogu & Kem 2020). However, of particular relevance to the present research is the study by Osinowo (2015), whose analyses of fiscal policy occurred at disaggregated levels. The non-neutrality of fiscal operations aligns with the theoretical positions put forward by the managerial theory of the firm and New Keynesians. Global studies on monetary policy and manufacturing have also been conducted at the aggregate (Agbonrofo & Olusegun 2023) and disaggregate (Ahmad & Rangaraju 2020; Roy et al. 2023; Sahoo et al. 2024; Yesigat et al. 2019). The relationship between bank rates and manufacturing is negative for most, with interest rate tightening discouraging production (Agbonrofo & Olusegun; Kutu & Ngalawa 2016a). Money supplies have generally positively impacted manufacturing output (Matola 2023; Omolade & Ngalawa 2016; Roy et al. 2023).

Empirical studies examining combined stabilisation policy effects at the disaggregated industry level are even less in supply. Research by Tkalec and Vizek (2010) examined combined policy impacts at disaggregated industry levels in Croatia, finding monetary rather than fiscal policy to be more impactful on manufacturing production. However, more recently, research by Ahumada and Villarreal (2023) on government stabilisation efforts also emphasised the role of expansionary monetary policy, finding that interest rate deductions significantly boosted manufacturing production in Mexico during the COVID-19 pandemic.

Domestically, Kutu and Ngalawa (2016b) examined the sensitivity of industry production to monetary shocks in BRICS (Brazil, Russia, India, China and South Africa) from 1994 to 2013. Analysis was at the industry level; however, fiscal policy coordination was excluded. A study by Akinyemi, Ogbuji and Adedokun (2018) examined monetary policy instruments and manufacturing sector performance for 20 African nations between 1970 and 2016. Focus was on overall manufacturing activities, rather than industry impacts. Research by Habanabakize and Muzindutsi (2017) was at a sectoral rather than aggregate level in South Africa. However, the study was on the linkage between government expenditure and job creation, rather than output growth. Limited South African literature further strengthens the need to examine combined fiscal and monetary policy impacts on domestic manufacturing production at a disaggregated industry level. Undertaking the present study will assist in determining whether heterogeneous policy approaches are required at the industry level.

Research methodology

Data sources

The data are from secondary sources, including Statistics South Africa, the Organization for Economic Cooperation and Development (OECD) and the South African Reserve Bank (SARB). Data extraction is quarterly, from 1998 to 2020. The selected period and sources are based on data availability.

Conceptual framework

The study employs the fiscal policy theoretical framework of Musgrave (1959). The framework advances how policymakers are conscious that macroeconomic indicators (y_i) like employment, economic growth, inflation and poverty can be impacted by variations in policy instruments (x_j) (Gachari & Korir 2020; Tendengu, Tsegaye & Kapingura 2022). The general functional form is (Equation 1):

$$y_i = f(x_1, x_2, x_3 \ldots x_j) \quad \text{[Eqn 1]}$$

Additionally, Gachari and Korir (2020:24) stipulate that should a minimal or realistic change in a policy instrument result in significant alterations to a macroeconomic indicator that instrumental variable is efficient concerning that indicator. Fiscal variables in the form of deficits are indirect, while taxes and spending signify direct forms of control. Analysis can also expand, to include nonfiscal instruments, such as interest rates, exchange rates and capital formation (Tendengu et al. 2022:4). This allows for the Musgrave (1959) theoretical foundation to incorporate nonfiscal policy impacts, such as monetary policy, on macroeconomic indicators (Gachari & Korir 2020).

Model specification

The executive and legislature are responsible for conveying fiscal policy, which is affected by the political scene, while central banking authorities conduct monetary policy independently. Both policies are essential and strategic elements that can influence production levels. This mandates proper coordination between fiscal and monetary policy authorities to achieve desired economic outcomes. Given theoretical and empirical considerations, the study modifies the functional models of Idris (2019). Research by Idris examined the relative effectiveness of stabilisation policy impacts on Nigerian production efforts. The study by Idris underpinned the modelling of policy impacts in other developing nations, such as Ethiopia (Woldsemayat 2020) and the ASEAN-5 (Indonesia, Malaysia, Philippines, Thailand and Vietnam) (Samsuddin & Selvia 2021), thus highlighting its relevance to the present research.

The linear model depicting the combined, collaborative impact of fiscal and monetary policy on manufacturing industry performance in South Africa, as premised in the work of Idris (2019) is specified as (Equation 2):

$$(MANO_i)_t = \beta_0 + \beta_1 TTR_t + \beta_2 TGE_t + \beta_3 DF_t + \beta_4 LR_t + \beta_5 NEER_t + \beta_6 M3_t + v_{it} \quad \text{[Eqn 2]}$$

where aggregate manufacturing production, or production within industry i of the manufacturing sector, ($MANO_i$), is dependent on total tax revenue *(TTR)*, total government expenditure *(TGE)*, deficit financing *(DF)*, lending rates *(LR)*, the nominal effective exchange rate *(NEER)* and money supply *(M3)*. β_0, β_1 … β_n indicate the parameters to be estimated and v_{it} the error term at time t.

Research relating to the effect of oil prices on manufacturing activities is also well-documented (Gummi, Hassan & Mu'azu 2018; Karadag 2021). Oil serves as a primary input in industrial production. The inclusion of Brent crude oil prices *(OIL)* and log terms for significantly sized variables modifies Equation 2 (see Equation 3):

$$Log\,(MANO_i)_t = \beta_0 + \beta_1 Log\,(TTR)_t + \beta_2 TGE_t + \beta_3 DF_t + \beta_4 LR_t + \beta_5 Log\,(NEER)_t + \beta_6 M3_t + \beta_7 Log(OIL)_t + v_{it} \quad \text{[Eqn 3]}$$

Economic variable definitions and a priori expectations

No universal criterion is sufficient to define manufacturing ($MANO_i$). Broadly, it is the process through which products are altered, renovated or reconstructed. Manufacturing indices (2015 = 100) of physical production volumes are used. Total manufacturing production is used as a baseline against which selected industries within the sector can be compared. Selected industries within the sector are those considered to hold a significant share of aggregate manufacturing production in South Africa. These industries, and their contributions to total manufacturing (IDC 2020b), are: (1) metals, metal products, machinery and equipment (22.5%); (2) food, beverage and tobacco (21.4%); (3) petroleum products, chemicals, rubber and plastic (14%) and (4) wood and paper, publishing and printing (10.4%).

Fiscal policy instruments incorporate tax revenue, government expenditure and deficit financing. The TTR dataset (in Rmilllion's) includes revenue from all three South African sources, personal income, company and value-added tax (VAT). Consumers are becoming increasingly price sensitive; the Nielsen State of the Retail Nation Report for the first quarter of 2024 revealed South Africa to be one of the most price-sensitive countries in the world (NielsenIQ 2024). Literature dictates that increased *TTR* reduces output (Ahumada & Villarreal 2023). Total government expenditure (measured as a percentage of GDP) is synonymous with public consumption and investment spending (Fourie & Burger 2015:397), with a positive relation to production expected. Production should be increased via raised government spending by boosting private investment (Osinowo 2015). Deficit financing (measured as a percentage of GDP) relates to generating funds and financing deficits resulting from excessive expenditures over given revenues. Surveys in the sector noted that more than 50% of respondents have increased debt levels, in both short- and long-term finance. Given domestic economic conditions, this is likely the result of strained cash flows (Manufacturing Circle 2016). According to Tkalec and Vizek (2010), DF may crowd out production.

Monetary variables in this context include interest rates, exchange rates and M3. Nominal interest (in percentage terms) signifies the rand value borrowers are obligated to pay, or lenders are entitled to receive for monies lent (Parkin 2020). Nominal interest in the form of the repurchase rate is relevant for the present study, given that all other variables in the model are expressed in nominal form. Literature dictates that the impact of LR on output is negative (Agbonrofo & Olusegun 2023; Kutu & Ngalawa 2016a). Interest rate tightening discourages production. Modifications in rates cause variations in investment and consumption, influencing output and prices (Kutu & Ngalawa 2016a). The NEER is an unadjusted trade-weighted index calculated using nominal rates; it is the rate at which one country's currency exchanges for a basket of currencies (Appleyard, Field & Cobb 2017).

Research by Loweald (2020) identified a strong link between exchange rate depreciations and manufactured imports in South Africa, solidifying the need for incorporation of the exchange rate into the present analysis. The impact of *NEER* on manufacturing may vary (Sahoo et al. 2024). The sign of the relation depends on industrial technological intensity; depreciations in low-tech industries invigorate production efforts (Tkalec & Vizek 2010). The NEER dataset used is in indexed form (2015=100). For M3 (measured as a percentage change), the preferred monetary aggregate of SARB is *M3*. This is the single most comprehensive measure of money in South Africa (Mahadea et al. 2017). The impact of *M3* on output is generally positive in the literature (Omolade & Ngalawa 2016; Matola 2023). There has also been extensive research on the impact Brent crude oil prices *(OIL)* have on manufacturing (Gummi et al. 2018; Karadag 2021). South Africa is an oil-importing nation; hence, growth tends to be vulnerable to oil prices. Brent crude oil is measured in Rands per barrel.

Stationarity testing

Should there be any doubt concerning the presence of a trend, formal stationarity techniques by the likes of ADF and PP can be employed (Stock & Watson 2015:603). Null hypotheses for ADF testing relate to a time series containing unit roots ($\delta = 0$), which implies nonstationarity and leads to spurious regressions. Alternatively, ($\delta < 0$) implies that a series is in actuality stationary (Stock & Watson 2015:603). While ADF enables the correction of higher-order serial correlation via the addition of lagged differenced terms on the right-hand side of an equation, PP tests correct the t-statistic of the coefficient (γ) in accounting for serial correlation present in the error term (e_t) (Asteriou & Hall 2016:357). To confirm the order of integration, this study uses both ADF and PP.

Cointegration techniques

After stationarity is confirmed, various techniques can be used in cointegration testing. The ARDL procedure, however, has several advantages over Engle-Granger and Johansen (Kripfganz & Schneider 2023). ARDL does not require all variables included in a model to be of the same integration order; it is more efficient in handling small and finite sample data sizes, and unbiased estimates of long-run models are obtainable (Kripfganz & Schneider 2023:983–994). After determining the appropriate lags, long- and short-run estimates of the ARDL model are estimated. Based on Equation (3), the long-run ARDL model for examining the combined impact of fiscal and monetary policy on manufacturing sector production at the aggregate and industry levels in South Africa is given by (Equation 4):

$$\begin{aligned} Log(MANO_i)_t = \alpha_0 &+ \sum\nolimits_{k=1}^{m} \beta_k Log(MANO_i)_{t-k} \\ &+ \sum\nolimits_{k=0}^{n} \gamma_k Log(TTR)_{t-k} + \sum\nolimits_{k=0}^{q} \delta_k (TGE)_{t-k} \\ &+ \sum\nolimits_{k=0}^{t} \mu_k (DF)_{t-k} + \sum\nolimits_{k=0}^{v} \pi_k (LR)_{t-k} \\ &+ \sum\nolimits_{k=0}^{x} \rho_k Log(NEER)_{t-k} + \sum\nolimits_{k=0}^{\rho} \rho_k (M3)_{t-k} \\ &+ \sum\nolimits_{k=0}^{\rho} \rho_k Log(OIL)_{t-k} + \varepsilon_t \end{aligned}$$

[Eqn 4]

The ARDL bounds test is premised on the joint F-statistic. The bounds test has an asymptotic nonstandard distribution under the null hypothesis of no cointegration. Should there be evidence of a cointegrating vector, the ARDL model may be reparametrised into an ECM to acquire the short-run dynamics connected with long-run estimates (Kripfganz & Schneider 2023:984). The derivation of short-run elasticities, as they pertain to the combined model for fiscal and monetary policy impacts, results in the formulation of the ECM (see Equation 5):

$$\begin{aligned} \Delta Log(MANO_i)_t = \alpha_0 &+ \sum\nolimits_{k=1}^{n} \beta_k \Delta Log(MANO_i)_{t-k} \\ &+ \sum\nolimits_{k=0}^{n} \gamma_k \Delta Log(TTR)_{t-k} + \sum\nolimits_{k=0}^{n} \delta_k \Delta (TGE)_{t-k} \\ &+ \sum\nolimits_{k=0}^{n} \mu_k \Delta (DF)_{t-k} + \sum\nolimits_{k=0}^{n} \pi_k \Delta (LR)_{t-k} \\ &+ \sum\nolimits_{k=0}^{n} \rho_k \Delta Log(NEER)_{t-k} + \sum\nolimits_{k=0}^{\rho} \rho_k \Delta (M3)_{t-k} \\ &+ \sum\nolimits_{k=0}^{\rho} \rho_k \Delta Log(OIL)_{t-k} + \varphi ECT_{t-1} \end{aligned}$$

[Eqn 5]

Diagnostic checks and stability testing

Diagnostic testing based on residuals allows for checking the adequacy of functional form and signals the validity of model assumptions. These assumptions include no serial correlation, normality and homoscedasticity. Following the estimation of ECM, stability testing in the form of CUSUM and CUSUM of squares is conducted for parameter stability (Asteriou & Hall 2016).

Ethical considerations

This article does not contain any studies involving human participants performed by any of the authors. Ethical clearance was obtained from the University of Fort Hare's Inter-Faculty Research Ethics Committee (IFREC) on 26 March 2018.

Results

Stationarity results

Formal stationarity testing is completed at levels, using ADF and PP with intercept, trend and intercept and no intercept or trend (Table 1). LTOTAL is stationary at the 10% significance level for intercept only under the ADF testing procedure. Regarding the PP results, LTOTAL illustrates stationarity at the 1% level of significance for intercept and trend and intercept and nonstationarity for none. Noticeably, TGE is stationary at the 1% level under intercept for ADF and for varying levels for intercept, trend and intercept and none for PP. Deficit financing is nonstationary according to ADF but stationary under PP at the 1% level. Alternatively, LR is stationary under ADF at the 1% significance level but is nonstationary under PP, except for none, where it is stationary at 10%.

Following differencing, formal testing shows that all variables are stationary for intercept, trend and intercept, and none for the ADF and PP techniques (Table 2). Estimation using ARDL is appropriate for cointegration, given that variables are integrated of mixed orders I(0) and I(1). No variables included are integrated with orders greater than I(1). The ARDL estimation produces consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the underlying regressors are integrated of order (I[1]) only, integrated of order zero (I[0]) only or a mixture of I(1) and I(0) (Kripfganz & Schneider 2023:985).

TABLE 1: Augmented Dickey-Fuller and Phillips Perron test results (level form).

Variable	ADF			PP		
	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None
LTOTAL	-2.65*	-2.31	0.49	-6.92***	-8.87***	0.03
LMETAL	-2.31	-2.99	-0.23	-7.5616***	-7.73***	-0.47
LFOOD	-0.15	-3.18*	3.09***	-1.29	-7.53***	3.41***
LCHEM	-2.64*	-0.65	1.13	-3.28**	-4.39***	0.37
LWOOD	-1.98	-1.57	-0.25	-7.40***	-7.53***	-0.35
LTTR	-2.18	0.28	3.46***	-0.88	-5.44***	4.43***
TGE	-4.03***	-4.15	-0.74	-8.75***	-8.77***	-1.98**
DF	0.13	-1.97	0.99	-6.58***	-8.12***	-5.12***
LR	-5.10***	-6.10***	-3.48***	-1.80	-2.16	-1.63*
LNEER	-1.42	-3.11	-2.26**	-1.55	-3.04	-2.01**
M3	-1.76	-3.35**	-1.18	-2.19	-2.38	-1.29
LOIL	-2.54	-1.88	1.38	-2.52	-1.97	1.38

ADF, Augmented Dickey-Fuller; PP, Phillips Perron; DF, deficit financing; TGE, total government expenditure; LR, lending rates; LNEER, nominal effective exchange rate; M3, money supply; LTTR, total tax revenue; LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries; LOIL, price of brent crude oil.

*, 0.1 level of significance; **, 0.05 level of significance; ***, 0.01 level of significance.

TABLE 2: Augmented Dickey-Fuller and Phillips Perron test results (first difference).

Variable	ADF			PP		
	Intercept	Trend and Intercept	None	Intercept	Trend and intercept	None
LTOTAL	-4.68***	-4.93***	-4.67***	-43.92***	-49.05***	-43.29***
LMETAL	-4.30***	-4.43***	-4.34***	-34.27***	-38.40***	-34.40***
LFOOD	-6.44***	-6.39***	-3.30***	-25.87***	-25.47***	-15.14***
LCHEM	-10.75***	-11.40***	-10.65***	-20.20***	-27.70***	-18.82***
LWOOD	-4.66***	-4.85***	-4.68***	-34.04***	-37.20***	-34.32***
LTTR	-4.98***	-5.57***	-2.13**	-20.56***	-27.95***	-11.23***
TGE	-12.08***	-12.03***	-12.15***	-27.80***	-27.80***	-27.97***
DF	-5.83***	-6.11***	-5.71***	-27.88***	-27.54***	-27.62***
LR	-7.45***	-7.56***	-7.21***	-7.42***	-7.49***	-7.25***
LNEER	-7.56***	-7.52***	-7.35***	-7.55***	-7.52***	-7.27***
M3	-4.91***	-4.87***	-4.95***	-8.19***	-8.16***	-8.22***
LOIL	-8.23***	-8.49***	-8.06***	-8.21***	-8.44***	-8.07***

ADF, Augmented Dickey-Fuller; PP, Phillips Perron; DF, deficit financing; TGE, total government expenditure; LR, lending rates; LNEER, nominal effective exchange rate; M3, money supply; LTTR, total tax revenue; LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries; LOIL, price of brent crude oil.

, 0.05 level of significance; *, 0.01 level of significance.

Long-run regression results

The study uses the Akaike information criterion (AIC) for determining the lag structures, for the LTOTAL, LMETAL, LFOOD, LCHEM and LWOOD policy models (Table 3). According to Asteriou and Hall (2016:73), models that adopt the lowest AIC values are the best fit.

Computed F-statistic values for joint fiscal and monetary models for LTOTAL and all selected industries concerned exceed the upper critical values at the 5% level of Pesaran for bounds testing (Table 4). This implies a rejection of the null hypothesis of no cointegration for LTOTAL and all manufacturing industry subcategories, providing evidence of long-term relationships among variables.

Long-run ARDL regressions are then estimated (Table 5). Long-run empirical results indicate positive, significant impacts of *LTTR* on LTOTAL, LFOOD and LWOOD. The positive coefficient associated with LTTR does not conform with a priori expectations but is aligned with the findings of Stoilov (2017) and Islam (2019). Higher taxes may suppose greater levels of public expenditure, some of which could foster increased growth. This is prevalent with personal income taxes and social contributions, which in South Africa constitute the largest and most significant source of tax revenue (Mohr 2020) and could explain this positive link. In contrast, LTTR is negative and significant for LMETAL, conforming to a priori expectations. Higher national tax revenue (TTR) is expected to lead to decreased

TABLE 3: Autoregressive distributed lag model lag length selection.

Model	LTOTAL	LMETAL	LFOOD	LCHEM	LWOOD
Lag length	4, 3, 3, 4, 1, 0, 3, 0	2, 4, 6, 6, 6, 6, 3, 3	1, 3, 1, 3, 1, 3, 2, 0	1, 4, 4, 4, 0, 4, 0, 4	1, 4, 4, 4, 0, 4, 0, 4

LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries.

TABLE 4: Bounds test for cointegration.

Test statistic	LTOTAL		LMETAL		LFOOD		LCHEM		LWOOD	
	Value	K	Value	K	Value	K	Value	K	Value	K
F-statistic	7.64***	7	6.96***	7	14.65***	7	7.11***	7	8.21***	7
Significance	I(0) bound	I(1) bound	I(0) bound	I(1) bound	I(0) bound	I(1) bound	I(0) bound	I(1) bound	I(0) bound	I(1) bound
10%	1.92	2.89	1.92	2.89	1.92	2.89	1.92	2.89	1.92	2.89
5%	2.17	3.21	2.17	3.21	2.17	3.21	2.17	3.21	2.17	3.21
2.5%	2.43	3.51	2.43	3.51	2.43	3.51	2.43	3.51	2.43	3.51
1%	2.73	3.9	2.73	3.9	2.73	3.9	2.73	3.9	2.73	3.9

LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries; K, number of regressors in model.

***, 0.1 level of significance.

TABLE 5: Estimation of long-run coefficients.

Variable	Category	LTOTAL	LMETAL	LFOOD	LCHEM	LWOOD
LTTR	Co-efficient	0.101	-0.097	0.364	0.021	0.114
	Standard error	0.025	0.057	0.034	0.047	0.056
	t-statistic	4.025***	-1.683*	10.608***	0.440	2.030**
TGE	Co-efficient	-0.006	-0.02	0.003	0.011	-0.007
	Standard error	0.002	0.006	0.002	0.005	0.004
	t-statistic	-2.636**	-3.270***	1.327	2.186**	-1.763*
DF	Co-efficient	0.003	0.004	0.001	0.015	-0.003
	Standard error	0.005	0.012	0.005	0.008	0.012
	t-statistic	0.612	0.328	0.201	1.836*	-0.283
LR	Co-efficient	-0.009	-0.018	0.001	-0.007	-0.018
	Standard error	0.003	0.008	0.003	0.006	0.008
	t-statistic	-2.828***	-2.280**	0.154	-1.277	-2.233**
LNEER	Co-efficient	0.084	0.097	0.129	-0.178	0.268
	Standard error	0.037	0.089	0.046	0.074	0.097
	t-statistic	2.277**	1.093	2.773***	-2.413**	2.770***
M3	Co-efficient	0.005	0.014	-0.004	-0.003	0.004
	Standard error	0.001	0.003	0.002	0.002	0.003
	t-statistic	3.734***	5.291***	-2.948***	-1.900*	1.632
LOIL	Co-efficient	0.006	0.052	-0.05	0.065	-0.07
	Standard error	0.015	0.037	0.022	0.03	0.04
	t-statistic	0.398	1.412	-2.280***	2.148**	-1.746*
C	Co-efficient	2.967	5.123	-0.066	4.72	2.587
	Standard error	0.402	0.994	0.541	0.83	1.072
	t-statistic	7.377***	5.152	-0.122	5.685***	2.412**

DF, deficit financing; TGE, total government expenditure; LR, lending rates; LNEER, nominal effective exchange rate; M3, money supply; LTTR, total tax revenue; LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries; LOIL, price of brent crude oil; C, intercept term.

*, 0.1 level of significance; **, 0.05 level of significance; ***, 0.01 level of significance.

output growth within manufacturing (Bakare-Aremu & Osobase 2015). For LCHEM, the fiscal LTTR variable is insignificant.

The linkage of *TGE* with LTOTAL, LMETAL and LWOOD is significant and of a negative nature. The relationship between TGE and manufacturing output is expected to be positive (Aghioin, Hemous & Kharroubi 2014; Osinowo 2015). The negative signage could be because of crowding out (Fourie & Burger 2015; Tkalec & Vizek 2010). Insignificance in the LFOOD model concurs with prior research; there were findings of insignificance of TGE for the food and beverage industry in Croatia (Tkalec & Vizek 2010), countries that were part of the European Union before the 2004 expansion (EU15) and New Member States that joined the EU at a later date (NMS10) (Zislin & Barrett 2009). For LCHEM, a significant positive link is observed with TGE conforming to expectations (Aghioin et al. 2014; Osinowo 2015). Positive relations were identified in the chemicals industry in Croatia (Tkalec & Vizek 2010) and Japan (Zislin & Barrett 2009).

Concerning *DF*, there are findings of a significant, positive link for LCHEM. The positive signage does not conform to a priori expectations or industry research on NMS10 countries (Zislin & Barrett 2009). DF is expected to crowd out manufacturing production (Tkalec & Vizek 2010). DF is insignificant for LTOTAL, LMETAL, LFOOD and LWOOD in the long run. Insignificance in LMETALS concurs with the findings for the basic metals sector in Croatia, Japan and the United States (Tkalec & Vizek 2010; Zislin & Barrett 2009).

In terms of *LR*, the relation with manufacturing output is expected to be negative (Agbonrofo & Olusegun 2023; Kutu & Ngalawa 2016a). Empirical results for LTOTAL, LMETAL and LWOOD conform to significant negative relations. This aligns with findings on the US metals industry. The metals industry has strong linkages with construction activities, which are also strongly associated with residential investment. Residential investments are perceived to be highly sensitive to interest rate changes (Ahmad & Rangaraju 2020). Lending rates is insignificant for LFOOD and LCHEM. However, the insignificance of LR for LFOOD industries concur with the findings of prior research on the US food and beverages industry. Nondurable industries often display delayed or very mild responses towards monetary policy variations (Ahmad & Rangaraju 2020).

With *LNEER*, results for LMETAL find the variable to be insignificant. The responses of LTOTAL, LFOOD and LWOOD are significant and positive. Contrastingly, negative signage was observed in the context of the food and beverage industry for NMS10 nations within the EU (Zislin & Barrett 2009). Results for LWOOD conform to the significant, positive relation from prior research on the wood production industry in Croatia (Tkalec & Vizek 2010) but not with research in the United States (Thorbecke 2018). Concerning LCHEM, LNEER is significant at the 5% level but negative. The impact of exchange rates on manufacturing performance could vary (Sahoo et al. 2024). A significant positive linkage indicates that an appreciating exchange rate positively affects domestic manufacturing production levels.

In the long-run relationship between LTOTAL, LMETAL and *M3*, the positive significant coefficients concur with a priori expectations (Matola 2023; Omolade & Ngalawa 2016). However, LFOOD and LCHEM have a negative link with M3. This could suggest M3 is not being efficiently utilised in managing monetary variables in the long run and that the form of credit extended towards these industries is not conducive towards productivity (Aiyedogbon, Ohwofasa & Anyanwu 2015). Money supply is insignificant in the LWOOD industry. This is indicative that M3 occupies no significant role in LWOOD production.

The coefficient for *LOIL* is negative and significant at the 1% and 10% levels for the long-run LFOOD and LWOOD models, respectively. In the South African LCHEM industry, there is a significant positive link. The LOIL variable is relevant in explaining LCHEM at the 5% level. A negative relationship is expected between production and LOIL (Sarmah & Bal 2021). Findings thus contrast a priori expectations. Concerning LTOTAL, LOIL is insignificant. Following long-run estimations, the ECM models are obtained to confirm speed of convergence (Table 6).

Short-run regression results

Findings reveal that the coefficient of the ECM is negative and statistically significant at the 1% level for LTOTAL and all four industries within the sector, LMETAL, LFOOD, LCHEM and LWOOD, confirming the adjustment procedure over the short term. It indicates a correction of 92.01% (LTOTAL), 95.8% (LMETAL), 90.4% (LFOOD), 80% (LCHEM) and 88.9% (LWOOD) of uncertainty from the preceding period within the next quarter.

Concerning LMETAL, all variables except LOIL are significant. The LTTR coefficient is positive in the short run; this does not conform to a priori expectations or the long run but does align with Stoilov (2017) and Islam (2019). The positive coefficient of TGE also does not conform to long run findings but is per a priori expectations (Aghioin et al. 2014; Osinowo 2015). Unlike long run estimations, DF is significant and aligns with a priori expectations. A negative link is observed (Tkalec & Vizek 2010). The positive significant relation between LR and LMETAL in the short run conforms to neither long run findings nor a priori expectations.

The positive relations observed for LNEER with LMETAL concurs with long run estimations and indicate that an appreciating exchange rate positively affects local manufacturing production in the short term. Similarly to the short run findings of the model for LTOTAL, the negative link observed between LMETAL and M3 could suggest that M3 is not being efficiently utilised in managing monetary

TABLE 6: Error correction models.

Variable	Category	LTOTAL	LMETAL	LFOOD	LCHEM	LWOOD
D(LTOTAL(-1))	Co-efficient	-0.109476	-	-	-	
	Standard error	0.088438	-	-	-	
	t-statistic	-1.237891	-	-	-	
D(LMETAL(-1))	Co-efficient	-	-0.209377	-	-	-
	Standard error	-	0.096896	-	-	-
	t-statistic	-	-2.160844**	-	-	-
D(LTTR(-1))	Co-efficient	0.277041	0.687646	-0.670824	-0.190815	-0.095335
	Standard error	0.055001	0.102742	0.070742	0.088866	0.088116
	t-statistic	5.036987***	6.692945***	-9.482621***	-2.147212**	-1.081917
D(TGE(-1))	Co-efficient	0.002613	0.010445	-	-0.007048	0.007654
	Standard error	0.001041	0.002472	-	0.001579	0.001215
	t-statistic	2.509232**	4.225578***	-	-4.461968***	6.297451***
D(DF(-1))	Co-efficient	-0.000954	-0.022971	0.01055	0.018227	0.017561
	Standard error	0.002723	0.006295	0.00288	0.004152	0.004878
	t-statistic	-0.350444	-3.648811***	3.663231***	4.390201***	3.600445***
D(LR(-1))	Co-efficient	-	0.033318	-	-	0.027455
	Standard error	-	0.01299	-	-	0.010013
	t-statistic	-	2.564819**	-	-	2.742072***
D(LNEER(-1))	Co-efficient	-	0.247829	-0.132871	-0.044277	-0.054866
	Standard error	-	0.095518	0.067864	0.085686	0.086081
	t-statistic	-	2.594595**	-1.957896*	-0.516736	-0.637377
D(M3(-1))	Co-efficient	-0.004434	-0.009551	0.003111	-	-0.01521
	Standard error	0.001632	0.002893	0.001935	-	0.002506
	t-statistic	-2.716141***	-3.301662***	1.607741	-	-6.068735***
D(LOIL(-1))	Co-efficient	-	0.025488	-	-0.037397	-0.042631
	Standard error	-	0.042245	-	0.034616	0.032836
	t-statistic	-	0.603331	-	-1.080316	-1.298292
CointEq(-1)*	Co-efficient	-0.920193	-0.958357	-0.90451	-0.799275	-0.888696
	Standard error	0.104417	0.110972	0.074445	0.093729	0.09396
	t-statistic	-8.812646***	-8.636011***	-12.14999***	-8.527470***	-9.458256***

LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries; LTTR, total tax revenue; TGE, total government expenditure; DF, deficit financing; LR, lending rates; LNEER, nominal effective exchange rate; M3, money supply; LOIL, price of brent crude oil; D, differentiated term; CointEq, co-integrating equation.

*, 0.1 level of significance; **, 0.05 level of significance; ***, 0.01 level of significance.

TABLE 7: Residual diagnostic checks for selected manufacturing industries.

Test	Null hypothesis	LTOTAL	LMETAL	LFOOD	LCHEM	LWOOD
Jarque-Bera (normality)	The error term is normally distributed	0.83	0.49	0.44	0.97	0.27
Breusch-Pagan-Godfrey	The error term is homoscedastic	0.21	0.33	0.20	0.55	0.70
Serial correlation LM test	The error term is not auto-correlated	0.35	0.93	0.27	0.06	0.80

LTOTAL, total manufacturing; LMETAL, metals, metal products, machinery and equipment industries; LFOOD, food, beverage and tobacco industries; LCHEM, petroleum products, chemicals, rubber and plastic industries; LWOOD, wood and paper, publishing and printing industries.

variables in the short run, and that the form of credit extended towards LMETAL is not conducive towards productivity (Aiyedogbon et al. 2015 & Anyanwu 2015). LOIL is both positive and insignificant in the short term, thus mirroring long run findings.

differentiated term the case of the LFOOD, LTTR, DF and LNEER are significant in the short run. The LTTR coefficient is negative in the short run; this does not conform to the long run but is in alignment with a priori expectations (Bakare-Aremu & Osobase 2015). Unlike long run estimations, DF is significant in the short run but does not conform to a priori expectations with a positive link being observed. The negative linkage observed for LNEER does not concur with long run estimations but indicates that an appreciating exchange rate, in the short run, negatively affects manufacturing.

Concerning LCHEM, LTTR, TGE and DF are significant in the short term. The coefficient of LTTR is negative; this does not conform to long run estimations but is in alignment with a priori expectations, as well as short run findings observed for LTOTAL, LMETAL and LFOOD. Unlike long run estimations, TGE is negative; this does not conform to a priori expectations but could be explained as the crowding-out effect, with attempts to stimulate economic activity via increased public spending harming private spending (Fourie & Burger 2015). The sign of the relationship for DF does conform to a priori expectations but contrasts long run estimations; *DF* is expected to crowd out production (Tkalec & Vizek 2010).

For LWOOD, TGE and DF are significant, positive fiscal variables in the short run. The positive links do not conform to long run estimations. In terms of a priori expectations, however, the relationship between TGE and manufacturing output is expected to be of a positive nature (Osinowo 2015). A negative relation is predicted in that *DF* will crowd out manufacturing production. However, in the domestic context, positive relations have been empirically observed (Ocran 2011). In addition, the signs for LR and M3 do not conform to either a priori expectations or long run estimations but interestingly concur with short run findings for LMETAL.

Diagnostic testing results

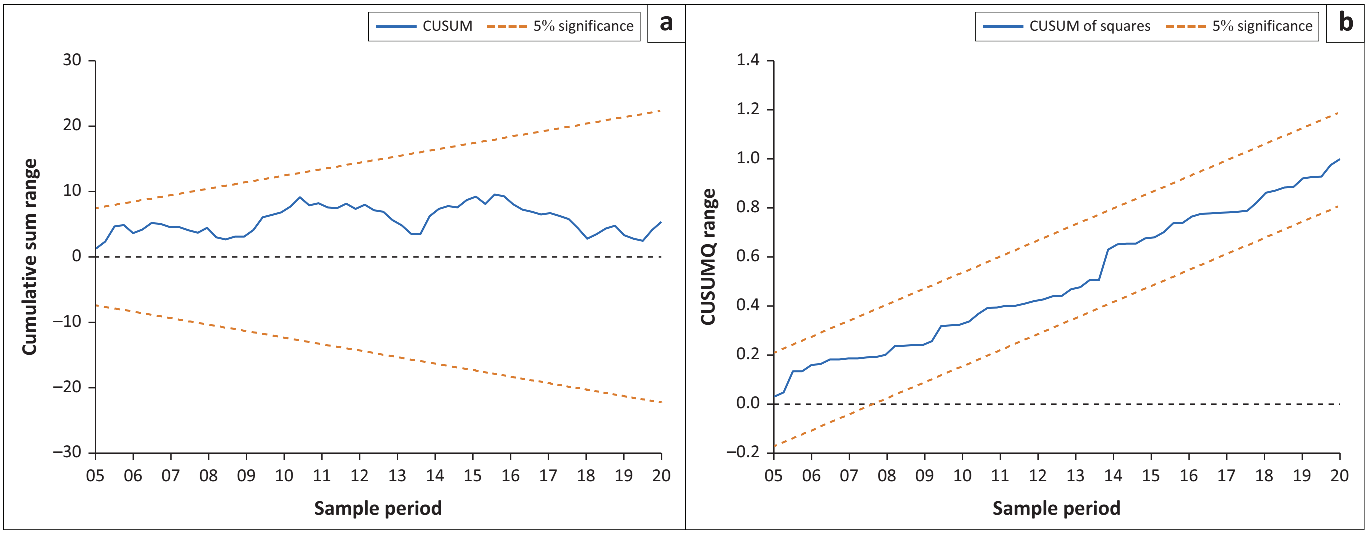
Diagnostic tests include those examining normality (Jarque-Bera), heteroscedasticity (Breusch-Pagan-Godfrey) and serial correlation (Lagrange multiplier). The *p*-values for all tests exceed the 5% level for LTOTAL and the selected industry policy models (Table 7). The null hypotheses of normally distributed residuals, homoscedasticity and no serial correlation are accepted.

Stability results

Visual representations of CUSUM and CUSUMQ for LTOTAL and all industry subcategories are provided (Figure 1 to Figure 5). The null cannot be rejected where statistics remain within the critical bounds of 5%. All plots for CUSUM and CUSUMQ stay within the critical bounds for LTOTAL, LMETAL, LFOOD, LCHEM and LWOOD, confirming the stability of long-run regressor coefficients.

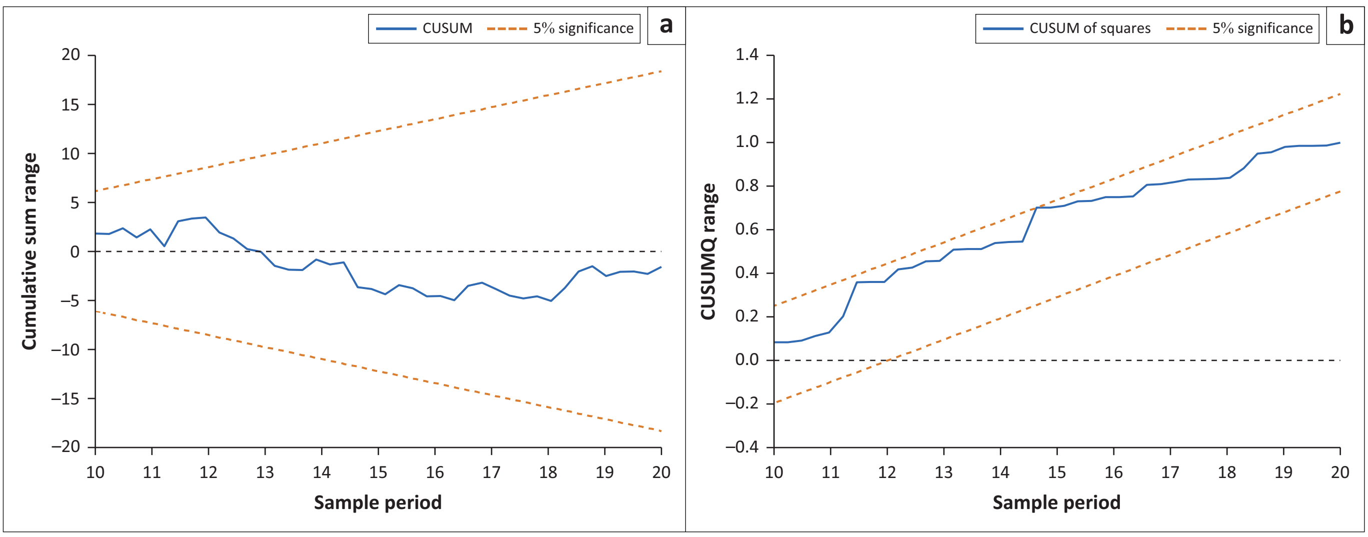
Conclusion

The objective of this study was to empirically examine the combined policy impact of fiscal and monetary variables on aggregate manufacturing and production within selected South African manufacturing industries. Growth in South African manufacturing is required for convergence and increased nonagricultural employment. The use of disaggregated data in this study has allowed for aggregate policy effects to be examined within manufacturing industry-



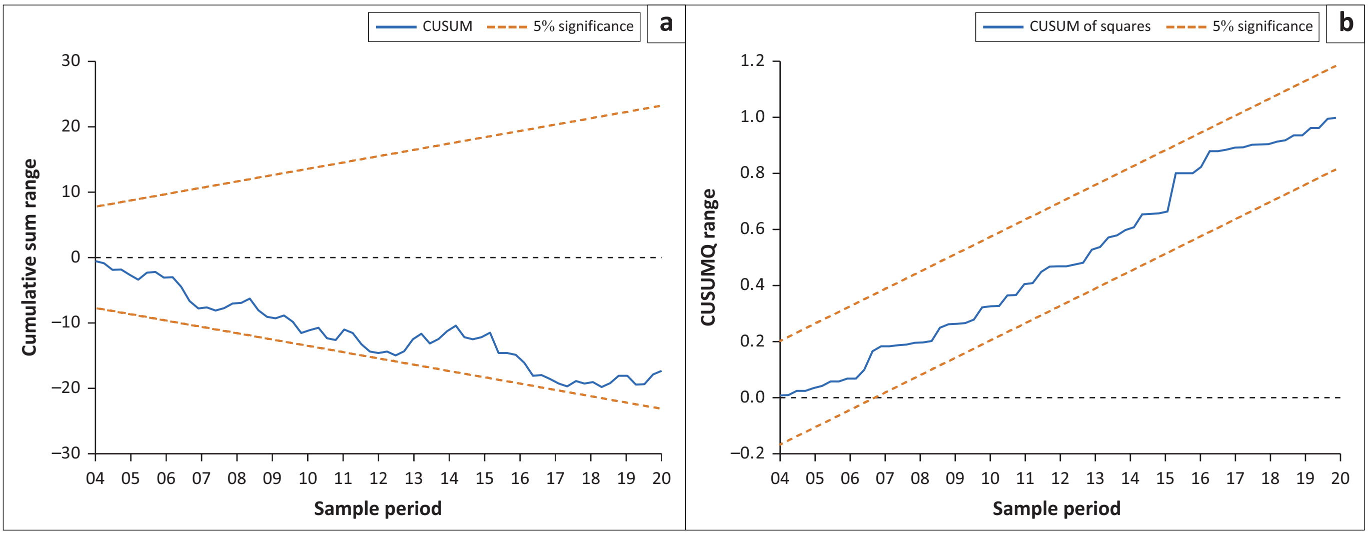
CUSUM, cumulative sum; CUSUMQ, cumulative sum of squares; LTOTAL, total manufacturing.

FIGURE 1: Stability test results for (a) CUSUM and (b) CUSUMQ for LTOTAL.



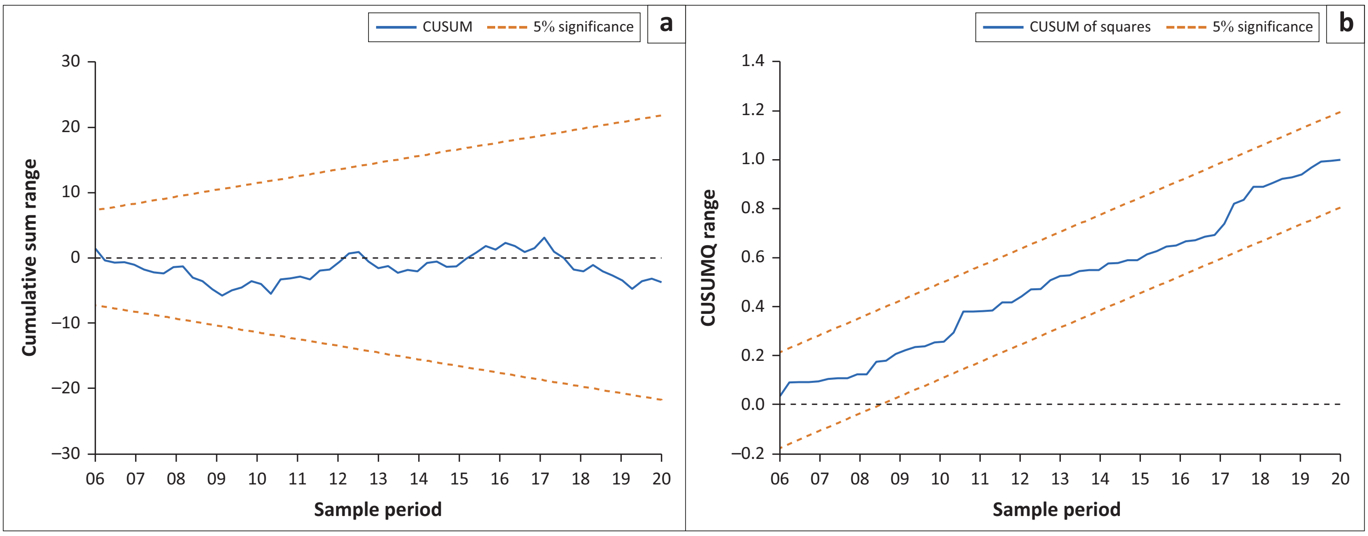
CUSUM, cumulative sum; CUSUMQ, cumulative sum of squares; LMETAL, metals, metal products, machinery and equipment industries.

FIGURE 2: Stability test results for (a) CUSUM and (b) CUSUMQ for LMETAL.



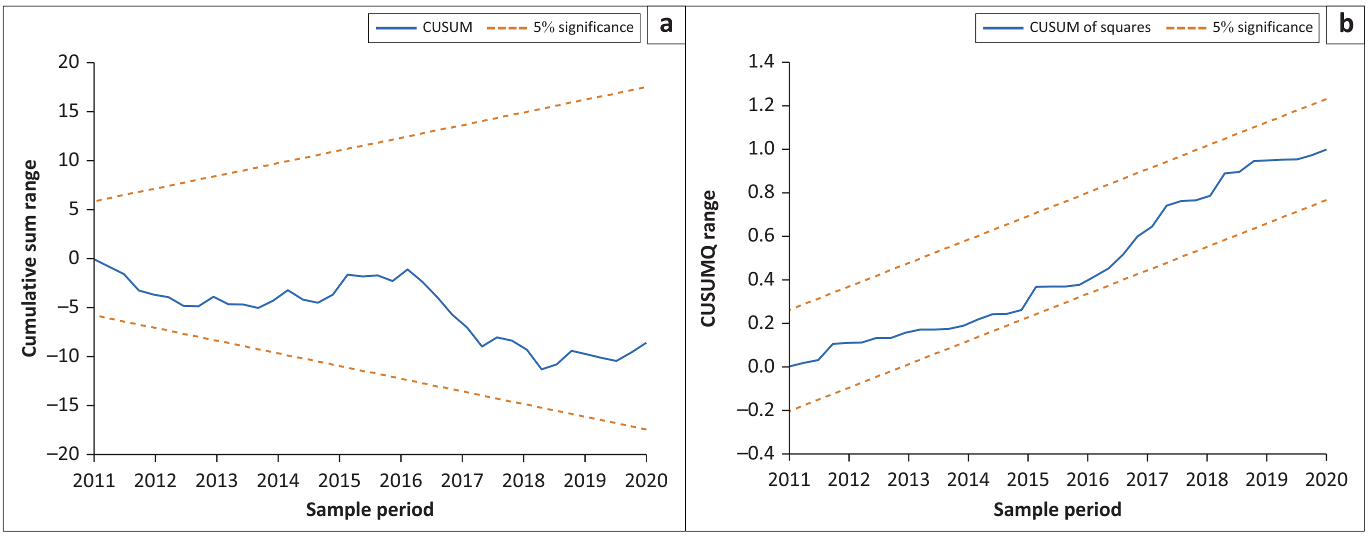
CUSUM, cumulative sum; CUSUMQ, cumulative sum of squares; LFOOD, food, beverage and tobacco industries.

FIGURE 3: Stability test results for (a) CUSUM and (b) CUSUMQ for LFOOD.



CUSUM, cumulative sum; CUSUMQ, cumulative sum of squares; LCHEM, petroleum products, chemicals, rubber and plastic industries.

FIGURE 4: Stability test results for (a) CUSUM and (b) CUSUMQ for LCHEM.



CUSUM, cumulative sum; CUSUMQ, cumulative sum of squares; LWOOD, wood and paper, publishing and printing industries.

FIGURE 5: Stability test results for (a) CUSUM and (b) CUSUMQ for LWOOD.

specific divisions in South Africa. The objective of examining policy impacts was to observe the role of fiscal and monetary instruments in aiding production efforts within South African manufacturing. Empirical research has conventionally focused on stabilisation policy and aggregate economic growth, manufacturing activities or sectoral rather than industry performance. Findings indicate that all industries show varied responses to joint fiscal and monetary policy impacts in South Africa. This brings to light the relevance of further research into policy heterogeneity, particularly in the context of African nations, in aiding growth prospects.

Policy implications

The policy implications are as follows:

- Government authorities should exercise caution and demonstrate restraint concerning the use of fiscal policy during recessionary periods.
- Government spending and taxation should be restructured and industry focused.
- Inflation-targeting frameworks could yield unwarranted increases in repurchase rates, negatively influencing manufacturing industry production and growth.
- Reserve banking authorities should consider heterogeneous output fluctuations in setting monetary policy.

Limitations of the study

The study focused primarily on the effect of domestic stabilisation policy. The interplay between industry-specific policies and production process dynamics was therefore not considered. Results at the disaggregated industry level were also restricted to a select few South African manufacturing sector industries. Similar outcomes may not necessarily be achieved with alternative domestic industries or sectors. Industry selection was based on the relative significance of industry contributions towards overall domestic growth. Industry characteristics were not included in regression modelling because of limited data availability. South Africa is also perceived to be an emerging nation and findings may thus not be relevant to nations with more advanced economic development structures.

Areas of future research

The effects of industry-specific policies on manufacturing and industry-specific production are deferred for future research. Research analysis can be extended to other South African manufacturing industries, or sectors, not included in the study. Examinations could also be expanded to incorporate SADC panel datasets. Industry characteristics such as differences in industry size, interest costs and the intensity of working capital must be noted as factors that could contribute towards differential policy responses. The inclusion of these characteristics into regression modelling could provide vital insights into the functioning of domestic industry production. However, research into the precise nature of their contribution may prove difficult because of limited data availability.

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Competing interests

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Authors' contributions

D.L.H. conducted the research, wrote and reviewed the article. A.T. and F.M.K. supervised the study, made revisions and recommendations and approved the final article for submission.

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Data availability

Data sharing does not apply to this study, as no new data were created or analysed.

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