




# “Disruptive load shedding and its dynamic impact on municipal financial performance in KwaZulu-Natal, South Africa”

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# DISRUPTIVE LOAD SHEDDING AND ITS DYNAMIC IMPACT ON MUNICIPAL FINANCIAL PERFORMANCE IN KWAZULU-NATAL, SOUTH AFRICA

## Abstract

Electricity energy consumption plays a significant role in both local and international financial development. However, an imbalance between demand and supply of energy, especially electricity, impedes financial performance on both national and local levels. The purpose of this study is to investigate the dynamic impact of load shedding on financial performance in KwaZulu-Natal. A panel Autoregressive Distributed Lag (ARDL) model, the Toda-Yamamoto Granger causality test, and Error Correction Model (ECM) approaches were applied to a data sample from seven district municipalities for a period from 2016 to 2022. The results reveal an inverse long-term relationship between load shedding and municipal financial performance. Additionally, the Toda-Yamamoto causality analysis indicates a short-run bidirectional causality between load shedding and financial performance. This implies that a high level of electricity cuts leads to poor financial performance. Based on these findings, the study recommends that the government and policymakers implement strategies to improve electricity generation and distribution, and foster a more competitive energy market by allowing the entry of multiple electricity producers beyond Eskom. Furthermore, it advocates for increased investment in alternative energy sources such as solar, wind, and biogas as a means to mitigate load shedding and its adverse effects.

## Keywords

electricity, shortages, financial performance, municipalities, South Africa, load shedding

## JEL Classification

D58, M41, L94, R51

## INTRODUCTION

South Africa's electricity supply crisis has been a persistent concern for over three decades (Kleynhans & Coetzee, 2019). Between 2001 and 2007, South Africa's residential electricity consumption increased by 50%, placing Eskom under significant strain. In response to the growing crisis, the South African government introduced several strategies, including boosting Eskom's production capacity, encouraging private sector participation, and reforming the energy sector (Kumba & Olanrewaju, 2024). However, persistent issues such as leadership failures, mismanagement, and underinvestment have hampered progress (Hendrickse, 2022). The situation reached critical levels in 2022, when the country experienced 81 days, equivalent to 1,949 hours, of load shedding (Ayamolowo et al., 2022). The primary cause of South Africa's electricity crisis is the imbalance between supply and demand, exacerbated by population growth, aging infrastructure, limited investment, and illegal electricity connections (Bohlmann & Inglesi-Lotz, 2018; BusinessTech, 2023). Illegal connections have costed Eskom over R60 billion and have damaged expensive infrastructure such as transformers (Ting & Byrne, 2020). In South Africa, load shedding has profound

implications not only for individuals and businesses but also for government institutions at national, provincial, and municipal levels. As noted by SALGA (2022), disruptions caused by load shedding directly impact municipal revenues and service delivery capacity. While existing studies have examined the macroeconomic effects of electricity shortages (Khobai et al., 2017; Pillay & Beharry-Ramraj, 2024; Simpson et al., 2019; Qeqe et al., 2022), few have explored the municipal-level financial consequences in detail. An empirical question dominating the discussion is: *Does load shedding have long-run and short-run effects on the financial performance of selected municipalities in KwaZulu-Natal, South Africa?* The response to this question fills the gap in the body of knowledge.

## 1. LITERATURE REVIEW

Financial distress arises when an institution's cash flow becomes insufficient to meet its financial obligations, reflecting an inability to satisfy ongoing financial commitments (Hajek & Munk, 2024). Financial distress theory serves as a useful lens for analyzing the conditions under which an organization, company, or institution faces financial crises. It provides a framework for understanding how financial constraints affect organizational performance and how such challenges may be navigated. As noted by Anzak et al. (2023), this theory can act as an entrepreneurial catalyst, especially for institutions or individuals undergoing economic hardship. The experience of financial distress is not limited to individuals or private companies; it can also affect public institutions and even nations. For example, the 2007–2008 global financial crisis saw numerous corporate and governmental entities plunge into distress (Aouaki & den Heijer, 2009). Depending on the quality of management and decision-making, financial distress may either serve as a turning point toward improvement or exacerbate existing vulnerabilities (Chrisantha & Suhartono, 2022; Mokoginta & Agung, 2022). Poorly managed distress often leads to rushed, uninformed decisions that worsen the financial condition. Conversely, effective management of such periods can strengthen risk management practices and improve long-term resilience (Say, 2024).

In the South African context, financial distress among municipalities has become a pressing issue. By 2016, over 90% of South African municipalities were reported to be experiencing financial strain (Mbulawa, 2019), significantly undermining their service delivery capabilities. The underlying causes are multifaceted and include declining revenue due to sluggish economic growth, poor financial management, irregular and wasteful ex-

penditure, corruption, and a lack of accountability (Glasser & Wright, 2020; Mbulawa, 2019; Mishi et al., 2022). While some improvements have been made, financial distress remains widespread, affecting over 60% of municipalities as of 2023 (McKenzie, 2023). This ongoing fiscal strain continues to hinder municipalities' ability to provide essential services to their communities.

Given the socio-economic impact of load shedding in South Africa, innovative and transformative solutions are essential. Disruptive innovation theory, introduced by Christensen (1997), offers a relevant framework. The theory explains how sophisticated and costly systems or products can be reimagined as simpler, more affordable alternatives that are widely accessible (Larson, 2016). While originally rooted in corporate and entrepreneurial contexts, the theory has since been extended to broader institutional and policy environments.

Applying this theory to South Africa's electricity crisis suggests a need for systemic reform in energy production and distribution. Current reliance on Eskom as a single utility provider has proven unsustainable. Instead, the adoption of decentralized energy systems, open-market electricity generation, and renewable energy technologies could fundamentally disrupt the status quo, improving supply, reducing costs, and enhancing system resilience (Wrigh, 2023).

Electricity consumption is integral to municipal functioning and financial sustainability. In South Africa, municipalities serve as intermediaries, purchasing electricity from Eskom and reselling it to consumers. In the 2020/2021 financial year, municipalities spent ZAR 95.1 billion on electricity and generated ZAR 118.1 billion in revenue, yielding a surplus of ZAR 23 billion to support municipal operations (Stats SA, 2022). However,

their reliance on electricity as a revenue source also exposes them to significant financial risk, particularly during periods of load shedding.

Municipalities do not generate electricity; rather, they distribute it to households, businesses, and institutions. Consequently, rising electricity prices or load shedding can reduce demand, negatively affecting revenue (Masuku, 2024). Moreover, deteriorating municipal infrastructure, high levels of non-payment, inadequate technical capacity, and governance failures have weakened municipal electricity distribution systems (Pillay & Beharry-Ramraj, 2024). These challenges not only compromise service delivery but also heighten financial vulnerability. As municipalities depend on electricity revenues to finance public services, disruptions in supply due to load shedding can significantly erode their financial performance, exacerbating the distress already experienced by many local governments.

A growing body of literature examines how power disruptions affect financial performance at various levels. These impacts can be direct, such as lost revenue from halted services, or indirect, where load shedding undermines the economic activity that generates municipal income (e.g., taxes, service payments, and business licensing fees). Globally, studies confirm the positive relationship between reliable energy access and financial performance. Issa and Hanaysha (2023), using 2SLS and OLS methods across 13 European countries, found that renewable energy availability significantly improved company financial performance. Similarly, Dorigoni and Anzalone (2024) used panel data to show that energy production increased return on assets and market valuation, albeit without affecting the cost of capital. In Africa, Sulong and Farouq (2021) found that energy access positively influenced financial performance in oil-exporting countries, with the effect moderated by energy pricing. In Kenya, Kikanga et al. (2024) demonstrated that both excessively low and high energy prices hurt financial performance, highlighting the importance of price regulation. In Ghana, Frederick and Adarkwah (2016) observed that load shedding reduced business profitability, especially in areas with limited alternative power options. Similarly, Akyuz et al. (2020) found that in Niger, the cost of power out-

ages varied by business location and preparedness. Zhang et al. (2022), analyzing Chinese industrial firms, concluded that energy-saving measures had no significant impact on financial performance, underscoring that consistent energy availability is more critical than conservation alone.

South African research aligns with the findings of Qeqe et al. (2022), who found that rising electricity prices eroded household purchasing power, indirectly reducing demand for other municipal services. Khobai et al. (2017) used VECM and ARDL models to show that load shedding negatively affects both financial and economic performance. Pillay and Beharry-Ramraj (2024) found that small businesses, particularly in their early stages, were especially vulnerable to load shedding, often leading to failure within three years, thereby reducing municipal income from business activity. Simpson et al. (2019), in their study of Cape Town municipalities, showed that load shedding reduced income from electricity sales, leading to a 2.68% revenue loss between 2018 and 2019. The study also found that households and businesses increasingly adopted alternative energy sources, further reducing municipal electricity revenues. While long-run effects of energy supply vary, Guan et al. (2021) found that in developing countries, energy consumption had a short-run positive effect on financial performance, despite a long-run inverse relationship. These mixed results suggest the energy–financial performance nexus is context-specific. Musabayana (2023) highlighted the indirect effects of load shedding, showing that it reduces business income, employment, and community purchasing power, further diminishing municipal revenues.

Despite these insights, few studies have examined the direct impact of load shedding on municipal financial performance in South Africa. This gap underscores the significance of the present study, which seeks to contribute empirical evidence to inform more resilient municipal financial and energy strategies. Mabunda et al. (2023) explored the impact of load shedding on SMEs in Collins Chabane Local Municipality. Findings indicated severe income losses, inability to pay salaries, and workforce reductions, ultimately weakening the financial base on which municipalities depend. Similarly, Machimana et al. (2024) found that load

shedding disrupted scheduled water services in Greater Tzaneen Municipality, leading to revenue losses and impaired service delivery.

In conclusion, no empirical study investigated both the long-run and short-run effects of load shedding on the financial performance of municipalities. Only Simpson et al. (2019) emphasized the contribution of electricity and water sales in generating income for different municipalities in Cape Town. Hence, there is a need for empirical evidence on this topic in KwaZulu-Natal, South Africa, to address the specific load shedding issues toward financial performance. This study aims to investigate both the long-run and short-run effects of load shedding on the financial performance of selected municipalities in KwaZulu-Natal, South Africa.

Grounded on the reviewed literature, the central hypothesis of the study is that the disruptive load shedding in KwaZulu-Natal significantly decreases municipal financial performance as it reduces municipal revenue from electricity sales, while forcing municipalities to raise other service charges to fill the gap created by electricity revenue shortfalls. The study analyzes the following hypothesis:

$H_0$ : *Load shedding positively influences the municipal financial performance in KwaZulu-Natal, South Africa.*

$H_A$ : *Load shedding negatively influences the municipal financial performance in KwaZulu-Natal, South Africa.*

## 2. METHODOLOGY

To achieve the study's empirical objectives, the Panel ARDL model and its associated Error Correction Model (ECM) were adopted to ex-

plore both the short-run and long-run dynamics between load shedding and municipal financial performance. Quarterly time series panel data covering the period 2016 to 2022 were used for analysis. The dependent variable, municipal income (MINC), was used as a proxy for financial performance, and electricity supply (ELS), representing the extent of load shedding, was employed as an independent variable. To enhance model specification and account for other influential factors, two control variables (employment (EMP) and business confidence (BCON)) were considered. These variables were incorporated due to their established importance in influencing financial performance at both municipal and national levels.

Municipal income data (MINC) are measured in thousands of rands and sourced from Statistics South Africa (Stats SA), while electricity supply (ELS) is quantified in gigawatt-hours and obtained also from Stats SA. Employment (EMP) is measured as the number of formally and informally employed individuals within the municipalities, and business confidence (BCON) was expressed as an index value reflecting prevailing business sentiment. Both EMP and BCON variables were obtained from the South African Reserve Bank (SARB). The selected period, 2016 to 2022, was informed by the data availability. It is important to clarify that employment (EMP) and business confidence (BCON) are control variables included to isolate the effect of the primary independent variable (electricity supply) on the dependent variable (financial performance). As defined by Carlson and Wu (2012), control variables account for extraneous variance, often referred to as "nuisance" factors that could otherwise confound the results. Table 1 displays selected variables.

**Table 1.** Description of variables

Variable	Definition	Unit adopted	Source
Financial performance (income and expenditure)	Total of income and expenditure from the municipality	Thousands of rands	STATS SA database
Electricity	Total electricity supplied by the municipality	Gigawatt-hours	STATS SA database
Employment	Total number of employed people in the municipality's labor force	Thousands	SARB database
Business confidence	Standardized confidence indicator indicating future developments in business	Index	SARB database

## 2.1. Model selection and specification

Although the literature presents several useful cointegration approaches, this study employs the Panel-Autoregressive Distributed Lag (PARDL) model, as proposed by Pesaran et al. (1999) and refined by Pesaran et al. (2001). The Panel-ARDL model was selected based on its flexibility, such as accommodating variables integrated either at the level, first difference, or both. Additionally, the model produces reliable results even when applied to a small sample. The subsequent model, expressed in equation 1, was established to evaluate both short-term and long-term relationships among selected variables.

$$Y_{it} = \sum_{j=1}^m \phi_{ij} y_{i,t-j} + \sum_{j=0}^n \beta_{ij} X_{i,t-j} + e_i + \varepsilon_{it}, \quad (1)$$

where  $Y_{it}$  denotes the response variable;  $i$  represents the sum of examined municipalities (cross-section) where  $i = 1, 2, 3, \dots, N$ ;  $t$  denotes the time of the selected sample,  $X_{it}$  refers to  $k \times 1$  vector of independent variables;  $\beta_{ij}$  represents the coefficient of the vector  $k \times 1$ ; and  $\phi_{ij}$  represents the scalar of the dependent variable; while  $e_i$  is the fixed effect of each vector. In the case that the bound test results indicate that  $I(1)$  variables cointegrate, then the  $I(0)$  process is adapted for the error term for all cross-sections ( $i$ ). Subsequently, the error correction of short-run dynamics is estimated as follows:

$$\begin{aligned} \Delta y_{it} = & \phi_{ii} y_{i,t-1} - \beta_i' X_{it} \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} \\ & + \sum_{j=0}^{q-1} \delta_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it}, \end{aligned} \quad (2)$$

where  $\phi_i$  denotes the speed of adjustment within the error correction mechanism. For attaining long-run equilibrium, it is essential for the coefficient of the error correction term to be statistically significant and exhibit a negative sign (Habanabakize, 2019). The short-run parameters are denoted by the vector  $\beta_i'$  and  $\lambda_{ij}^*$ . The lag selection was performed using single-equation estimation. To assess the impact of load shedding on financial performance in the selected municipalities, equation 1 was improved, therefore equation 3 was formulated.

$$\begin{aligned} \Delta LINCEX_{it} = & \theta_i (LINCEX_{i,t-j} - \beta_i X_{i,t-j}) \\ & + \sum_{j=1}^{p-1} \gamma_j^i \Delta(LINCEX)_{i,t-j} + \sum_{j=1}^{q-1} \delta_j \Delta(X_i)_{i,t-j} \\ & + u_i + \varepsilon_i, \end{aligned} \quad (3)$$

where  $LINCEX$  is the proxy for financial performance of each municipality,  $X$  denotes the set of independent and control variables (load shedding, business confidence, and employment). The short-run coefficients are represented by  $\gamma$  and  $\delta$  for dependent and explanatory variables, respectively. Additionally, while the letter  $\beta$  denotes the long-run coefficient,  $\theta$  denotes the speed of adjustment towards the long-run equilibrium. Lastly, while  $i$  and  $t$  indicate municipality and time, respectively,  $e$  and  $u$  represent error term and fixed effect, respectively.

## 2.2. Toda-Yamamoto (T-Y) Granger causality test

The presence of a long-term relationship between variables suggests the possibility of a causal relationship among those variables (Habanabakize & Dickason-Koekemoer, 2023). In this context, the causal relationship suggests that variable  $X$  exerts a causal influence on variable  $Y$ , and vice versa. In other words, the past of one variable may be useful to explain the past of another variable (Granger, 1969). In addition to the Granger (1969) causality assessment, Toda and Yamamoto (1995) initiated another causality test. The latter includes an extra lag on integration order and uses the Block Exogeneity Wald, which provides a reliable causality result, irrespective of the variables' integration order (Mehrara, 2014). The Wald approach used in the T-Y causality test is built on VAR and, with an additional lag, is expressed as follows:  $(k + d_{\max})$ , where  $k$  is the selected lags and  $d_{\max}$  indicates the maximum integration order (Habanabakize & Dickason-Koekemoer, 2023). Therefore, the application of T-Y approach starts with the lag length estimation and then identifies the optimal integration order ( $d$ ) of a given variable. The current study applied the T-Y causality test expressed as follows:

$$\begin{aligned}
\Delta LINCEX_t = & \alpha_0 + \sum_{i=1}^k \lambda_i \Delta LINCEX_{t-i} \\
& + \sum_{j=k+1}^{k+d_{\max}} \lambda_j \Delta LINCEX_{t-j} + \sum_{i=1}^k \delta_i \Delta LEELS_{t-i} \\
& + \sum_{j=k+1}^{k+d_{\max}} \delta_j \Delta LEELS_{t-j} + \sum_{i=1}^k \eta_i \Delta LBCON_{t-i} \\
& + \sum_{j=k+1}^{k+d_{\max}} \eta_j \Delta LBCON_{t-j} + \sum_{i=1}^k \pi_i \Delta LEMPL_{t-i} \\
& + \sum_{j=k+1}^{k+d_{\max}} \pi_j \Delta LEMPL_{t-j} + e_t.
\end{aligned} \quad (4)$$

where  $\alpha_0$ ,  $\lambda_i$ ,  $\delta_i$ ,  $\eta_i$  and  $\pi_i$  represent the estimated parameters, while  $k$  and  $d_{\max}$  denote an optimal lag and the highest level of integration order in the model. The  $e_t$  represents the model's error term. The  $H_0$  of T-Y suggests the absence of a causal effect from one variable to another.

### 2.3. Stationarity

The validity and reliability of econometric estimations largely depend on the characteristics of the analyzed variables. Thus, stationarity and unit root tests are indispensable. There exist two primary methodological approaches for stationarity testing, namely parametric and non-parametric. Parametric methods are mostly applied in disciplines where time is a central analytical dimension, such as accounting, economics, and finance, whereas non-parametric methods are frequently used in fields like electrical engineering that focus on frequency domain analysis (Betha & Rhinehart, 1991).

### 2.4. Panel unit root tests

The Panel-ARDL framework is effective and produces reliable results only when applied to variables integrated at level  $I(0)$ , at first difference  $I(1)$ , or a combination of both  $I(0)$  and  $I(1)$  (Samargandi et al., 2015). Consequently, conducting a unit root test is essential prior to estimating the Panel ARDL (PARDL) model, so as to ensure that no variable under investigation is integrated at the second order,  $I(2)$ . To adequately address cross-sectional dependence (which often exists in panel data), this study conducted panel unit root tests

using first-generation methods, supplemented by second-generation tests for validation.

### 2.5. Levin, Lin and Chu (LLC) test

The Levin, Lin and Chu (LLC) panel unit root test was introduced by Levin et al. (2002) to rectify weaknesses when a unit root test is conducted for individual variables. Additionally, the Levin, Lin and Chu (LLC) test builds upon and improves the Dickey-Fuller test (Baltagi, 2005). It is expressed as follows:

The null hypothesis  $H_0$ :  $\phi = 0$ .

The alternative hypothesis  $H_1$ :  $\phi < 0$ .

The subsequent econometric equation is employed to test the hypothesis

$$\begin{aligned}
\Delta Y_{it} = & \alpha_i + \phi Y_{i,t-1} + \sum_{k=1}^n \theta_k \Delta Y_{it-k} \\
& + \delta_{it} + \theta_i + \varepsilon_{it},
\end{aligned} \quad (5)$$

where the first difference is symbolized by  $\Delta$ ,  $\alpha_i$  and  $\theta_i$  represent the time period and fixed effect, respectively, while  $n$  symbolizes the optimal lag length. Accordingly, the null hypothesis for all  $i$  suggests that  $\rho = 0$ , while in the alternative hypothesis  $\rho < 0$ .

The adjusted  $t$ -statistic of the LLC test is specified as:

$$t_p^* = \frac{t}{\sigma^* m \tilde{T}} \sim N(0,1). \quad (6)$$

The advantage of this unit root test is that it has two-way effects; that is, the model has unit-specific time effects and unit-specific fixed effects. The latter allows for heterogeneity, given that the coefficient of the lagged  $Y_i$  is restricted to become identical across all panel units. The tested series is stationary if  $\rho = 0$  and not stationary if  $\rho < 0$ . In other words, the null hypothesis is dismissed in favor of the alternative hypothesis if the critical value is greater than the  $t$ -statistic at a 5% significance level.

### 2.6. Im, Pesaran and Shin (IPS) test

Im et al. (2003) introduced the Im, Pesaran and Shin (IPS) panel unit root test to overcome the

shortcoming of the LLC test, which does not cater for the heterogeneity coefficient of  $y_{i,t-1}$ . The null hypothesis of Im, Pesaran and Shin (IPS) test suggests that each series in the panel has a unit root, while the alternative suggests that not series restrains unit root issues. Thus:

$$H_0: \varphi_i = 0 \text{ for all } i.$$

$$H_1: \varphi_i < 0 \text{ for at least one } i.$$

The IPS provides individual estimations for each  $i$  section and allows for separate specifications of lag lengths, variances of the residual, and parametric values. The hypothesis is tested using the following equation:

$$\Delta Y_{it} = \alpha_i + \varphi_i Y_{i,t-1} + \sum_{k=1}^n \phi_k \Delta Y_{it-k} + \delta_i t + \varepsilon_{it}. \quad (7)$$

The tested series is stationary if  $\varphi_i = 0$  and is not stationary if  $\varphi_i < 0$ .

## 2.7. Breitung's test

According to Baltagi (2005), the two previous panel unit root tests (LLC and IPS) lose their efficacy due to their sensitivity toward both the sample (N) and time (T). To achieve efficient results, LLC and IPS require the used cross-section dimension (N) to be lower than the time dimension (T). Although the Breitung's test uses a similar null hypothesis to those of LLC and IPS, the alternative hypothesis differs. The Breitung's test is applied to the following hypotheses:

$$H_0: \text{Each series has a unit root.}$$

$$H_1: \text{Each series is stationary.}$$

As in the previous two tests, in Breitung's test the series is stationary if  $\rho_i = 0$  and is not stationary if  $\rho < 0$ . The difference between this test and others is that it is not sensitive to N and T in the sample.

## 2.8. Test for cross-sectional dependence

The existence of cross-sectional independence in panel analysis increases the correlation be-

tween the panel data set and raises cross-sectional error (Bonizzi, 2017). It is essential to recognize that independence across sections is generally assumed when the ARDL model is used through mean group (MG) and pooled mean group (PMG) approaches. The Pesaran crossed pendency (CD) test (Pesaran et al., 2004), the Friedman (1937) nonparametric test and the Frees test (Frees, 1995; Frees et al., 2004) are some of the tests suggested by Pesaran (2015) for assessing cross-sectional dependence.

## 3. RESULTS AND DISCUSSION

### 3.1. Descriptive statistics

The summary statistics in Table 2 suggest that LINCEX has the highest mean and maximum, while the variable LEMPL possesses the highest minimum and the highest standard deviation with the employed data set. This implies that over the analyzed period, LEMPL experienced the greatest changes compared to other variables in the sample. Considering the skewness results, the variables LBCOM and LELS are negatively skewed, while LINCEX and LEMPL are positively skewed. Additionally, based on their values, the data for LINCEX and LBCOM are highly skewed. Nonetheless, given that their values fall between  $-2$  and  $+2$ , LBCOM, LINCEX, LELS, and LEMPL are normally distributed (Hair et al., 2017). The normality of the variables is confirmed by the J-B statistics and their associated probability values that exceed 0.05. The kurtosis result indicates that LBCOM and LEMPL have a kurtosis value of 1.979 and 1.903, respectively, falling between  $-2$  and  $+2$ , proving a normal univariate distribution of variables. Additionally, the kurtosis value of 2.566 suggests the persistence of a normal distribution for this variable, as the value is less than 3. Only LINCEX has a heavy tail as its kurtosis value is greater than 3. These findings uphold the assumptions of the disruptive innovation theory (Hajek & Munk, 2024) and are overwhelmingly supported by the financial distress theory (Larson, 2016).

**Table 2.** Summary statistics

Variable	LINCEX	LBCOM	LELS	LEMPL
Mean	5.586781	2.032168	3.998368	5.064398
Median	5.486726	2.033491	4.000781	4.803581
Maximum	7.312177	2.057413	4.028896	6.013228
Minimum	4.291569	1.946125	3.958946	4.395482
Std. Dev.	0.562231	0.018981	0.016330	0.566099
Skewness	1.669252	-1.073166	-0.260609	0.697580
Kurtosis	3.166981	1.979406	2.566198	1.902925
Jarque-Bera	2.913503	3.337785	2.485713	4.128645
Probability	0.232992	0.188456	0.288559	0.126904

### 3.2. Panel unit root

This study employed diverse panel unit root tests, which are presented in Table 3. The results from LLC, Breitung, IPS, ADF, and PP indicated that all the null hypotheses of unit root in variables at levels were rejected, except for the LEMPL variable. In other words, the data sample of the study contains a mixture of variables integrated at levels [I (0)] and those that become stationary after the

first difference [I (1)]. These results support the use of PARDL for the cointegration test.

### 3.3. Optimal lag specification

The present study employed the Akaike Information Criterion (AIC) due to its proven capability to yield robust and dependable results, particularly when handling large datasets (Habanabakize, 2019). The application of the AIC identified 20 potential Autoregressive Distributed Lag (ARDL) models, eventually leading to the selection of the most appropriate model for this study's data analysis (ARDL: 1, 1, 1, 1).

### 3.4. Panel ARDL cointegration and long-run relationship analysis

The results of the unit root tests indicated that the variables form a mixture of I(0) and I(1) variables. These results confirm that the PARDL is the most appropriate model to determine the cointegration amongst variables. Although the mean group (MG) and panel mean group (PMG) are often used in panel analysis, the estimation of the former approach is preferred over that of the latter.

**Table 3.** Panel unit root results

Variables	Deterministic term	LLC	Breitung	IPS	ADF	PP	Decision
<b>Level</b>							
LINCEX	Intercept	0.058*	–	0.000***	0.001***	0.000***	I(0)
	Intercept & Trend	0.014**	0.000***	0.000***	0.000***	0.000***	
LBCOM	Intercept	0.000***	–	0.000***	0.000***	0.000***	I(0)
	Intercept & Trend	0.000***	0.000***	0.000***	0.000***	0.000***	
LELS	Intercept	0.000***	–	0.000***	0.000***	0.000***	I(0)
	Intercept & Trend	0.000***	0.000***	0.000***	0.000***	0.000***	
LEMPL	Intercept	0.9995	–	1.0000	0.9903	0.8957	I(1)
	Intercept & Trend	0.5733	0.9835	0.9831	0.9864	0.8897	
<b>First difference</b>							
LINCEX	Intercept	0.0000***	–	0.000***	0.000***	0.000***	I(0)
	Intercept & Trend	0.0000***	0.000***	0.000***	0.000***	0.000***	
LBCOM	Intercept	0.000***	–	0.000***	0.000***	0.000***	I(0)
	Intercept & Trend	0.000***	0.000***	0.000***	0.000***	0.000***	
LELS	Intercept	0.000***	–	0.000***	0.000***	0.000***	I(0)
	Intercept & Trend	0.000***	0.000***	0.000***	0.000***	0.000***	
LEMPL	Intercept	0.000***	–	0.000***	0.000***	0.000***	I(1)
	Intercept & Trend	0.000***	0.000***	0.000***	0.000***	0.000***	

Note: \*, \*\*, and \*\*\* –  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.001$ , respectively.

**Table 4.** Estimated long-run results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LBCOM	1.326324	0.434948	3.049382	0.0025
LELS	3.496682	0.569072	6.144529	0.0000
LEMPL	0.181725	0.028602	6.353575	0.0000

Note: \*  $p < 0.05$ , represents significance at a 5% level.

According to Pesaran and Shin (1999), the PMG is preferred since it takes into account the parameter homogeneity and group-specific adjustments and produces robust estimates. The long-run relationship results are presented in Table 4.

The estimated long-run results, as presented in Table 4, indicate that independent and control variables are statistically significant. This suggests that fluctuations in electricity supply (the extent of load shedding) significantly influence municipalities' financial performance in the long term. Among all explanatory variables, electricity supply exerts the most pronounced influence on municipal financial performance, demonstrating a greater effect compared to employment and business confidence. Specifically, a 1% increase in electricity supply causes municipal financial performance to increase by 3.5%, while a 1% increase in load shedding results in a corresponding 3% decrease in financial performance. Moreover, a 1% rise in employment and business confidence leads to approximately 0.18% and 1.33%, respectively, increases in financial performance. Given that improvement in electricity supply positively influences the municipalities' financial performance, the latter is negatively associated with load shedding. Consequently, the study's null hypothesis is rejected in favor of the alternative hypothesis that suggests an inverse relationship between load shedding and financial performance.

The findings of this study are consistent with previous empirical research. For instance, Rao (2013) found that increased electricity supply enhances economic activity in India, thereby generating higher income levels. Similarly, Chakravorty and Pelli (2022) reported that improved electricity access contributes to increases in household income and expenditure. In the context of the present study, this translates into higher municipal income, as households purchase more electricity. In South Africa, Khobai et al. (2017) also found

a positive relationship between electricity availability and financial performance, noting that electricity shortages adversely affect institutional financial health.

Although the influence of employment (LEMP) and business confidence (LBCON) on financial performance is less frequently examined in the literature, some relevant studies exist. Moradi and Nematollahi (2013) found evidence of a bidirectional relationship between employment and financial performance, indicating a mutually reinforcing dynamic. Improved employment levels support financial growth, while enhanced financial performance creates opportunities for job creation. In light of these findings, South African municipalities are urged to prioritize job creation initiatives, as a symbiotic relationship exists between employment and municipal financial sustainability. These findings are overwhelmingly supported by Watson et al. (2005) as well as other research linked to municipal financial distress (Alaminos et al., 2018; Piermarini et al., 2023; Li et al., 2022; Antulov-Fantulin et al., 2021).

### 3.5. The error correction model (ECM) and short-run dynamics

The existence of long-run cointegration among the variables, ipso facto, requires the determination of short-run dynamics and the speed at which deviations from the long-run equilibrium are corrected. This analysis is possible through the Error Correction Model (ECM) (Brooks, 2014). For the model to be valid, the ECT coefficient must be negative and statistically significant (Habanabakize & Zerihun, 2024). A positive ECT coefficient would indicate that the employed model is explosive. As reported in Table 5, the ECT coefficient is  $-0.233105$  and is statistically significant at conventional levels. This satisfies the conditions for a valid ECM and suggests that approximately 23.3% of deviations from the long-run equilibrium are

**Table 5.** The error correction model (ECM) and short-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	27.35633	2.356423	11.60926	0.0000
D(LBCOM)	2.250438	0.930734	2.417918	0.0163**
D(LELS)	0.561562	0.214434	2.618808	0.0345**
D(LEMPL)	-5.988655	4.105739	-1.458606	0.1459
ECM	-0.233105	0.097998	-2.378674	0.0348**

Note: \*, \*\*, and \*\*\* –  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.001$ , respectively.

corrected each quarter. Accordingly, it would take about four quarters or one year for the model to fully adjust to equilibrium after a shock.

With regard to short-run dynamics, business confidence and electricity supply have a significant impact on municipalities' financial performance. Thus, a percent increase in business confidence will lead to approximately a 2.25 increase in municipalities' income and expenditures, while the latter will grow 0.56 percent in response to a percent increase in electricity supply. Employment (LEMPL) has no significant short-term effect on financial performance within the assessed municipalities. This is because it takes time to create new jobs, and new employees need time to adjust their expenditures, which are later reflected in municipalities' revenues and expenditures (financial performance).

### 3.6. Toda-Yamamoto test results

When the autoregressive distributed lag (ARDL) model is chosen for cointegration analysis, the Toda-Yamamoto causality test is favored instead of the traditional causality test based on Granger innovation. The reason is that the traditional Granger causality test works under the assumption that all the estimated series are stationary (Toda & Yamamoto, 1995). Therefore, in case the analyzed variables are a com-

ination of I(0) and I(1), the application of the traditional Granger causality test may provide erroneous results (Pesaran et al., 2001). The T-Y test results presented in table 6 confirm the short-run results presented in Table 4 as both suggest a short-run relationship and causality between LINCEN and LELS. That is, unidirectional causation exists between those two variables as the LELS causes changes in LINCEN in the short run. Besides the causation between the response and explanatory variables, there is also a one-way causation or unidirectional causation between LELS, LBCOM, and LEMPL. In other words, the electricity supply causes short-term changes in business confidence and employment. The results here indicate that the electricity supply has dominance as all variables under consideration are sensitive to its short-run changes.

### 3.7. Robustness and residual diagnostic tests

Guided by the results exhibited in Table 7, the estimated model passed all the diagnostic tests, as the probability value for each test is greater than 0.05, with the exception of the normality test, which has a  $p$ -value below 0.05. According to Kundu and Mishra (2011), it is difficult to fail to reject the null hypothesis of a normal distribution in a large sample of data. Therefore, the

**Table 6.** Toda-Yamamoto Granger causality results

Variable Excluded	Dependent variable			
	LINCEN	LBCOM	LELS	LEMPL
LINCEN	–	0.013185 (0.9934)	17.09388 (0.0002)	1.997175 (0.3684)
LBCOM	3.498458 (0.1739)	–	82.38235 (0.0000)	1.448454 (0.4847)
LELS	9.563303 (0.0084)**	6.731758 (0.0345)	–	7.022941 (0.0299)
LEMPL	3.739196 (0.1542)	2.719255 (0.2568)	2.495300 (0.2872)	–

Note: \*, \*\*, and \*\*\* –  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.001$ , respectively.

**Table 7.** Diagnostic test results

Test	Null hypothesis	P-Value	Conclusion
Jarque-Bera (JB)	Residuals are normally distributed	0.017	Reject $H_0$
Lagrange Multiplier	No autocorrelation	0.649	$H_0$ not rejected
White	Presence of homoscedasticity	0.098	$H_0$ not rejected
Ramsey RESET	The study parameters are stable	0.235	$H_0$ not rejected

**Table 8.** Cross-section dependence test

Test	T-Statistic	Degrees of freedom	Probability
Breusch-Pagan Lagrange Multiplier	0.812597	55	0.4164
Pesaran scaled Lagrange Multiplier	18.93464	–	0.9998
Pesaran cross-section dependence	–0.983190	–	0.3255

findings of the study are trustworthy, even if the J-B null hypothesis is not rejected.

### 3.8. Cross-section dependence test

In addition to the residuals diagnostic test, we employed the Pesaran cross-sectional depen-

dence test to confirm the reliability of the study findings. The null hypothesis suggests that variables are independent (with no cross-sectional dependence). The results in Table 8 confirm that variables are independent, as none of the null hypotheses in all three performed tests were rejected.

## CONCLUSION

This study examined both the long-run and short-run effects of load shedding on the financial performance of selected municipalities in KwaZulu-Natal, South Africa. The findings indicate that load shedding significantly influences the financial performance of municipalities. Based on these findings, the study recommends a reduction in households' and businesses' dependence on power generated by Eskom by transitioning to alternative energy sources such as solar, wind, bioenergy, and thermal power. This would lower the national demand on Eskom, and, in turn, mitigate the frequency and severity of load shedding.

This study makes several contributions. It advances the discourse on the relationship between load shedding and municipal financial performance. The paper provides evidence-based insights to guide policymakers and municipal leaders in formulating responsive and resilient strategies. It further highlights the importance of enhancing financial resilience at the municipal level in the face of persistent load shedding. This study contributes to the broader debate on energy governance and infrastructure investment in South Africa. It also addresses a significant gap in the literature by focusing specifically on the municipal-level implications of electricity shortages.

This paper was subject to several limitations. Firstly, the analysis was restricted to selected municipalities within a single province. Secondly, the study employed proxy variables for both load shedding and financial performance due to the unavailability of direct municipal-level data. Thirdly, the analysis was based on only three explanatory variables, whereas municipal financial performance is likely influenced by a broader set of economic, social, and institutional factors. Thus, future studies should consider increasing the geographical scope, adopt a mixed methods design combining primary and secondary data, and lastly explore the impact of green energy adoption on municipal financial performance.

## AUTHOR CONTRIBUTIONS

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## REFERENCES

- Akyuz, M., Zackariah, I., & Opusunju, M. (2020). Effect of power supply on the performance of Abuja Electricity Company of Nigeria. *International Journal of Business Marketing and Management*, 5(8), 9-16. Retrieved from <https://www.academia.edu/download/64231840/MA%2038%20Effect%20of%20Power%20Supply%20on%20the%20Performance%20of%20Abuja.pdf>
- Alaminos, D., Fernández, S. M., García, F., & Fernández, M. A. (2018). Data mining for municipal financial distress prediction. In P. Perner (Ed.), *Advances in Data Mining* (pp. 296-308). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-319-95786-9\\_23](https://doi.org/10.1007/978-3-319-95786-9_23)
- Antulov-Fantulin, N., Lagravinese, R., & Resce, G. (2021). Predicting bankruptcy of local government: A machine learning approach. *Journal of Economic Behavior & Organization*, 183, 681-699. <https://doi.org/10.1016/j.jebo.2021.01.014>
- Anzak, A., Tahir, Z., Rehman, S., & Bahar, G. (2023). Emergence of entrepreneurs by facing financial distress: The mediating mechanism of entrepreneurial motivation. *The Asian Bulletin of Green Management and Circular Economy*, 3(1), 170-187. <https://doi.org/10.62019/abgmce.v3i1.56>
- Aouaki, N., & den Heijer, J. P. (2009). *Financial distress: A measure of financial distress between publicly traded and privately held firms in the EU during times of economic crisis*. Department of Business Economics, Erasmus School of Economics, Erasmus University Rotterdam. Retrieved from <http://hdl.handle.net/2105/5916>
- Ayamolowo, O. J., Manditereza, P., & Kusakana, K. (2022). South Africa power reforms: The path to a dominant renewable energy-sourced grid. *Energy Reports*, 8(1), 1208-1215. <https://doi.org/10.1016/j.egy.2021.11.100>
- Baltagi, B. H. (2005). *Econometrics analysis of panel data* (3<sup>rd</sup> ed.). John Wiley & Sons Ltd.
- Bethea, R. M., & Rhinehart, R. R. (1991). *Applied engineering statistics*. Marcel Dekker Inc.
- Bohlmann, J. A., & Inglesi-Lotz, R. (2018). Analysing the South African residential sector's energy profile. *Renewable and Sustainable Energy Reviews*, 96, 240-252. <https://doi.org/10.1016/j.rser.2018.07.052>
- Bonizzi, B. (2017). Institutional investors' allocation to emerging markets: A panel approach to asset demand. *Journal of International Financial Markets, Institutions and Money*, 47, 47-64. <https://doi.org/10.1016/j.intfin.2016.11.009>
- Brooks, C. (2014). *Introductory Econometrics for Finance* (3<sup>rd</sup> ed.). Cambridge University Press. Retrieved from <https://centaur.reading.ac.uk/38411/>
- BusinessTech. (2023, January 29). *Sabotage at Eskom is rampant: Report*. Retrieved from <https://businesstech.co.za/news/energy/660361/sabotage-at-eskom-is-rampant-report/>
- Carlson, K. D., & Wu, J. (2012). The illusion of statistical control: Control variable practice in management research. *Organizational Research Methods*, 15(3), 413-435. <https://doi.org/10.1177/1094428111428817>
- Chakravorty, U., & Pelli, M. (2022). Electrification and development: Empirical evidence on the effect of electricity provision on household welfare. *Environmental Economics in Developing Countries*. <http://dx.doi.org/10.2139/ssrn.4076332>
- Chrisantha, F., & Suhartono, S. (2022). Financial distress sebagai determinan, pemediasi dan pemoderasi dari praktik manajemen laba [Financial distress as a determinant, mediator and moderator of earnings management practices]. *Jurnal Bina Akuntansi*, 9(2), 126-149. (In Indonesian). <https://doi.org/10.52859/jba.v9i2.217>
- Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business Review Press. Retrieved from <https://www.hbs.edu/faculty/Pages/item.aspx?num=46>
- Dorigoni, S., & Anzalone, G. A. (2024). Production of energy from

- renewable sources and financial performance of European utilities: A panel-data analysis. *Energy Policy*, 194, 114323. <https://doi.org/10.1016/j.enpol.2024.114323>
18. Frederick, N., & Adarkwah, J. (2016). Effect of Power Supply on the Performance of Small and Medium Scale Enterprises. *A Comparative Analysis between SMEs in Tema and Northern part of Ghana* (MPRA Paper No. 74196). The University of Cape Coast, Department of Economics, UCC, Ghana. Retrieved from <https://mpr.aub.uni-muenchen.de/id/eprint/74196>
  19. Frees, D., Chastanet, A., Qazi, S., Sørensen, K., Hill, P., Msadek, T., & Ingmer, H. (2004). Clp ATPases are required for stress tolerance, intracellular replication and biofilm formation in *Staphylococcus aureus*. *Molecular Microbiology*, 54(5), 1445-1462. <https://doi.org/10.1111/j.1365-2958.2004.04368.x>
  20. Frees, E. W. (1995). Assessing cross-sectional correlation in panel data. *Journal of Econometrics*, 69(2), 393-414. [https://doi.org/10.1016/0304-4076\(94\)01658-M](https://doi.org/10.1016/0304-4076(94)01658-M)
  21. Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*, 32(200), 675-701. <https://doi.org/10.1080/01621459.1937.10503522>
  22. Glasser, M. D., & Wright, J. (2020). South African municipalities in financial distress: What can be done? *Law, Democracy & Development*, 24(1), 413-441. <https://doi.org/10.17159/2077-4907/2020/ldd.v24.17>
  23. Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 37(3), 424-438. <https://doi.org/10.2307/1912791>
  24. Guan, D., Comite, U., Sial, M. S., Salman, A., Zhang, B., Gunnlaugsson, S. B., Mentel, U., & Mentel, G. (2021). The impact of renewable energy sources on financial development, and economic growth: The empirical evidence from an emerging economy. *Energies*, 14(23), Article 8033. <https://doi.org/10.3390/en14238033>
  25. Habanabakize, T. (2019). *Time-series analysis of the interactions between productivity, real wage, investment spending and sectoral employment in South Africa* (Doctoral Thesis). North-West University. Retrieved from <https://repository.nwu.ac.za/items/28a93ba7-c0d7-4e86-9f39-71120e1c0437>
  26. Habanabakize, T., & Dickason-Koekemoer, Z. (2023). Inflation sensitivity towards fuel price and electricity distribution in South Africa. *Expert Journal of Economics*, 11(1), 1-18. Retrieved from [https://economics.expertjournals.com/ark:/16759/EJE\\_1104dickason32-39.pdf](https://economics.expertjournals.com/ark:/16759/EJE_1104dickason32-39.pdf)
  27. Habanabakize, T., & Zerihun, M. F. (2024). Impact of electricity supply, inflation and exchange rate shocks on import flows in South Africa. *Acta Universitatis Danubius. (Economica)*, 20(2), 88-108. Retrieved from <https://dj.univ-danubius.ro/index.php/AUDOE/article/view/2645>
  28. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). Sage. Retrieved from [https://eli.johogo.com/Class/CCU/SEM/\\_A%20Primer%20on%20Partial%20Least%20Squares%20Structural%20Equation%20Modeling\\_Hair.pdf](https://eli.johogo.com/Class/CCU/SEM/_A%20Primer%20on%20Partial%20Least%20Squares%20Structural%20Equation%20Modeling_Hair.pdf)
  29. Hajek, P., & Munk, M. (2024). Corporate financial distress prediction using the risk-related information content of annual reports. *Information Processing & Management*, 61(5), 103820. <https://doi.org/10.1016/j.ipm.2024.103820>
  30. Hendrickse, R. (2022). Towards a South African developmental state: The Electricity Supply Commission (Eskom) – Victor or villain in this endeavour? *International Journal of Research in Business and Social Science*, 11(9), 289-299. <https://doi.org/10.20525/ijrbs.v11i9.2208>
  31. Issa, A., & Hanaysha, J. R. (2023). Powering profits: How renewable energy boosts financial performance in European non-financial companies. *International Journal of Accounting & Information Management*, 31(4), 600-622. <https://doi.org/10.1108/IJAIM-03-2023-0055>
  32. Khobai, H., Le Roux, P., & Mugano, G. (2017). The causal relationship between electricity supply and economic growth in South Africa. *Studies in Economics and Econometrics*, 41(2), 69-86. Retrieved from <https://hdl.handle.net/10520/EJC-920009b0f>
  33. Kikanga, F. M., Njoroge, C., & Mathuva, E. (2024). Effect of fuel price controls on the financial performance of oil marketing companies in Kenya. *Journal of African Interdisciplinary Studies*, 8(6), 152-162. Retrieved from [https://cedred.or.ke/jais/images/june2024/PDF\\_Kikanga\\_et\\_al\\_Effect\\_of\\_Fuel\\_Price\\_Controls\\_on\\_the\\_Financial\\_Performance\\_of\\_Oil\\_Marketing\\_Companies\\_in\\_Kenya.pdf](https://cedred.or.ke/jais/images/june2024/PDF_Kikanga_et_al_Effect_of_Fuel_Price_Controls_on_the_Financial_Performance_of_Oil_Marketing_Companies_in_Kenya.pdf)
  34. Kleynhans, E. P., & Coetzee, C. (2019). Assessment of financial conditions of South African municipalities: A unique model for KwaZulu-Natal. *Southern African Business Review*, 23(1). <https://doi.org/10.25159/1998-8125/4396>
  35. Kumba, H., & Olanrewaju, O. A. (2024). "Towards sustainable development: analyzing the viability and integration of renewable energy solutions in South Africa" – A review. *Energies*, 17(6), Article 1418. <https://doi.org/10.3390/en17061418>
  36. Kundu, G. K., & Mishra, B. B. (2011). Impact of reform and privatization on consumers: A case study of power sector reform in Orissa, India. *Energy Policy*, 39(6), 3537-3549. <https://doi.org/10.1016/j.enpol.2011.03.053>
  37. Larson, C. (2016, November 15). *Disruptive innovation theory: What it is & 4 key concepts*. Harvard Business School Online. Retrieved from <https://online.hbs.edu/blog/post/4-keys-to-understanding-clayton-christensens-theory-of-disruptive-innovation>

38. Levin, A., Lin, C. F., & Chu, C. (2002). Unit root test in panel data: Asymptotic and finite sample properties. *Journal of Econometrics*, 108(1), 1-25. [https://doi.org/10.1016/S0304-4076\(01\)00098-7](https://doi.org/10.1016/S0304-4076(01)00098-7)
39. Li, X., Ge, X., & Chen, C. (2022). Several explorations on how to construct an early warning system for local government debt risk in China. *Plos One*, 17(2), Article e0263391. <https://doi.org/10.1371/journal.pone.0263391>
40. Mabunda, M. V., Mukonza, R. M., & Mudzanani, L. R. (2023). The effects of loadshedding on small and medium enterprises in the Collins Chabane Local municipality. *Journal of Innovation and Entrepreneurship*, 12(1), Article 57. <https://doi.org/10.1186/s13731-023-00327-7>
41. Machimana, L. I., Gumbo, A. D., Moyo, H., & Mugari, E. (2024). The impact of load-shedding on scheduled water delivery services for Mohlaba-Cross Village, Greater Tzaneen, South Africa. *Water*, 16(14), Article 2033. <https://doi.org/10.3390/w16142033>
42. Masuku, B. (2024). Rethinking South Africa's household energy poverty through the lens of off-grid energy transition. *Development Southern Africa*, 41(3), 467-489. <https://doi.org/10.1080/376835X.2023.2300411>
43. Mbulawa, A. (2019). Understanding the impact of financial sustainability on South African municipalities. *The Journal for Transdisciplinary Research in Southern Africa*, 15(1), Article a656. <https://doi.org/10.4102/td.v15i1.656>
44. McKenzie, M. (2023). *A framework for municipal distress resolution based on audit outcomes* (Doctoral Thesis). University of Johannesburg. Retrieved from <https://hdl.handle.net/10210/506357>
45. Mehrara, M. (2014). The nexus between prices and macroeconomic variables in Iran. *World Scientific News*, 6(1), 1-9. Retrieved from <https://worldscientificnews.com/the-nexus-between-prices-and-macroeconomic-variables-in-iran/>
46. Mishi, S., Mbaleki, N., & Mushonga, F. B. (2022). Financial mismanagement and efficiency trade-off in local municipalities: Lessons from Eastern Cape, South Africa. *Journal of Local Government Research and Innovation*, 3(1). Retrieved from [https://hdl.handle.net/10520/ejc-jolgr\\_i\\_v3\\_i1\\_a68](https://hdl.handle.net/10520/ejc-jolgr_i_v3_i1_a68)
47. Mokoginta, D. D., & Agung, T. R. (2022). Pengawasan manajemen risiko dan financial distress dalam agency theory [The monitoring of risk management and financial distress in the point of view of agency theory]. *E-Jurnal Akuntansi*, 32(7), 1675-1687. (In Indonesian). Retrieved from <https://repositori.ukwms.ac.id/id/eprint/39131>
48. Moradi, J., & Nematollahi, M. (2013). Investment, employment and financial performance evidence from cooperative enterprises of Fars province. *International Journal of Research in Business and Social Science*, 2(2), 1-15. Retrieved from <https://core.ac.uk/download/pdf/230936904.pdf>
49. Musabayana, G. T. (2023). The effects of electricity load-shedding on the performance of small and medium enterprises in Pretoria, South Africa: A case study of Marabastad Business Community. *Journal of Energy in Southern Africa*, 34(1), 1-15. <https://doi.org/10.17159/2413-3051/2023/v34i1a16768>
50. Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, 34(6-10), 1089-1117. <https://doi.org/10.1080/07474938.2014.956623>
51. Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed lag modelling approach to cointegration analysis. In Ström, S. (Ed.), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium* (pp. 371-413). Cambridge: Cambridge University Press. <https://doi.org/10.1017/CCOL521633230.011>
52. Pesaran, M. H., Schuermann, T., & Weiner, S. M. (2004). Modeling regional interdependencies using a global error-correcting macroeconomic model. *Journal of Business & Economic Statistics*, 22(2), 129-162. <https://doi.org/10.1198/073500104000000019>
53. Pesaran, M. H., Shin, Y., & Smith, R. J. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621-634. <https://doi.org/10.1080/01621459.1999.10474156>
54. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326. <https://doi.org/10.1002/jae.616>
55. Piermarini, D., Sudoso, A. M., & Piccialli, V. (2023). *Predicting municipalities in financial distress: A machine learning approach enhanced by domain expertise*. Cornell University. <https://doi.org/10.48550/arXiv.2302.05780>
56. Pillay, A., & Beharry-Ramraj, A. (2024). Load shedding and its crippling effect on the South African economy: An entrepreneurial perspective. *e-BANGI*, 21(2), 438-447. <https://doi.org/10.17576/ebangi.2024.2102.36>
57. Qeqe, B., Kapingura, F., & Mgxekwa, B. (2022). The relationship between electricity prices and household welfare in South Africa. *Energies*, 15(20), Article 7794. <https://doi.org/10.3390/en15207794>
58. Rao, N. D. (2013). Does (better) electricity supply increase household enterprise income in India? *Energy Policy*, 57, 532-541. <https://doi.org/10.1016/j.enpol.2013.02.025>
59. SALGA. (2022). *Load shedding impact on the provision of other municipal services EG. Water supply*. Retrieved from <https://www.salga.org.za/Documents/Media%20Room/Media%20Statements/ms22/Impact%20of%20Loadshedding%20to%20Water%20Supply%20Media%20Statement%207%20June%202022.pdf>
60. Samargandi, N., Fidrmuc, J., & Ghosh, S. (2015). Is the relationship between financial development and economic growth

- monotonic? Evidence from a sample of middle-income countries. *World Development*, 68, 66-81. <https://doi.org/10.1016/j.worlddev.2014.11.010>
61. Say, S. (2024). Determining financial distress with the help of the Altman z-score model. *Toplum Ekonomi ve Yönetim Dergisi*, 5(2), 327-341. <https://doi.org/10.58702/teyd.1416150>
62. Simpson, N. P., Simpson, K. J., Shearing, C. D., & Cirolia, L. R. (2019). Municipal finance and resilience lessons for urban infrastructure management: A case study from the Cape Town drought. *International Journal of Urban Sustainable Development*, 11(3), 257-276. <https://doi.org/10.1080/19463138.2019.1642203>
63. Stats SA. (2022). *How financially independent are municipalities?* Retrieved from [https://www.statssa.gov.za/?page\\_id=1854&PPN=P4141](https://www.statssa.gov.za/?page_id=1854&PPN=P4141)
64. Sulong, Z., & Farouq, I. S. (2021). Energy-finance nexus: Evidence from African oil exporting countries. *International Energy Journal*, 21, 171-181. Retrieved from <https://www.academia.edu/download/109293293/pdf.pdf>
65. Ting, M. B., & Byrne, R. (2020). Eskom and the rise of renewables: Regime-resistance, crisis and the strategy of incumbency in South Africa's electricity system. *Energy Research & Social Science*, 60, 101333. <https://doi.org/10.1016/j.erss.2019.101333>
66. Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1-2), 225-250. [https://doi.org/10.1016/0304-4076\(94\)01616-8](https://doi.org/10.1016/0304-4076(94)01616-8)
67. Watson, D. J., Handley, D. M., & Hassett, W. L. (2005). Financial distress and municipal bankruptcy: The case of Prichard, Alabama. *Journal of Public Budgeting, Accounting & Financial Management*, 17(2), 129-150. <https://doi.org/10.1108/JPBAFM-17-02-2005-B001>
68. Wright, G. (2023, January 31). *Disruptive technology (disruptive innovation)*. TechTarget. Retrieved from <https://www.techtarget.com/whatis/definition/disruptive-technology>
69. Zhang, Y., Zhao, X., & Fu, B. (2022). Impact of energy saving on the financial performance of industrial enterprises in China: An empirical analysis based on propensity score matching. *Journal of Environmental Management*, 317, 115377. <https://doi.org/10.1016/j.jenvman.2022.115377>