Acta Universitatis Danubius
ŒCONOMICA

Testing Asymmetric Cointegration between Real Wage, Labour Productivity and Job Opportunity in South Africa

Thomas Habanabakize[1]

Abstract: Labour productivity and real wage are two dynamic economic indicators that, among many others, influence employment changes. Their effects on employment or job opportunities can either be positive or negative. This study investigates the asymmetric cointegration between real wage, labour productivity and job opportunity in South Africa between 1994 and 2018. The used methodology includes the application of a non-linear autoregressive distributed lag (NARDL) model, ECM and the dynamic multipliers. The obtained results from the bound testing suggested the existence of a long run relationship among the underlined variables. The estimated NARDL model revealed that real wage and labour productivity asymmetrically influence job opportunity dynamism. While positive component of productivity dominates over negative components; negative component of real wage dominates the positive component leading. Thus, labour productivity growth creates job opportunities whilst increase in real wage leads to a decline in the job opportunity. The study, therefore, recommends improvement in both labour productivity capacity through skills enhancement and real wage management through currency strengthening.

Keywords: asymmetry; employment; nonlinear; productivity; real wage; South Africa

JEL Classification: J01

1. Introduction

Over the last two decades, working opportunities (employment) has been and remains a concern in South Africa. Between 1995 and 2001 more than 1.6 million jobs were created within south African; however, owing to the growing labour force, in 2002 the number of unemployed people was over seven million (Bhorat, 2003). Unemployment situation worsened in 2008 where the country lost approximately five percent of its total employment due to the financial crisis (Klein, 2012). In 2019, the South African unemployment rate reached the rate of 29.9 percent (South African

[1] North-West University, South Africa, Address: Potchefstroom; Mafikeng; Vanderbijlpark, South Africa, Corresponding author: 26767007@nwu.ac.za.

Reserve Bank (SARB) 2020) and the total number of unemployed people extended ten million (Stats SA, 2020).

Besides the effect of the 2008 financial crisis on job opportunities, unemployment growth is caused by sluggish economic growth and labour market fluctuations associated with imbalances between labour productivity and rapid increase in real wages (Klein, 2012; Wittenberg, 2014). A number of studies was conducted to assess the effect of productivity and real wages on employment in South Africa

(Morton & Blair, 2020; Habanabakize *et al.*, 2019; Klein, 2012; Wakeford, 2004). Nonetheless, none of these studies considered asymmetric relationship among these economic indicators, they only were interested in assessing a linear (symmetric) association between of productivity, real wages and employment. This study aims to analyse the asymmetric effects of both real wages and labour productivity growth on job opportunity in South African.

The study is divided into five sections: the first section provides the introductory background, the second section briefly discusses the theoretical and empirical relationship among the underlined variables, the third section provides the study methodology, the four section deal with analysis findings and discussion; while the last section provides a concise conclusion and policy recommendations. Throughout the study, two concepts namely job opportunity and employment are used interchangeably.

2. Literature Review

2.1. Real Wages, Labour Productivity and Employment Theoretical Nexus

Wages and labour productivity are considered as the main driver of job opportunities in the labour markets (Elżbieta & Danuta, 2015; Landmann, 2004). The relationship between economic indicators is anchored within two main economic theories namely Keynesian and Neo-classical theory. The neoclassical theory argues that due to market-clearing, the economy operates always at full employment and productivity is determined by the state of technology within the economy (Landmann, 2004). The main drawback of this theory is the ignorance of technological and monetary fluctuations within the business cycle. Thus, the neoclassical theory was contested by Keynesian theory. The letter asserts that employment and productivity behaviours are mainly determined by adjustments in aggregate demand for both labour and output (Landmann, 2004). In Keynesian theory, wages can only have a significant short term impact on job opportunities, while the productivity impacts on long term employment levels.

Though contradictory in some ways, these two theories are still relevant to explain the real-world economic behaviours as each holds its own strengths and weaknesses

(Arestis & Bittes, 2018; Onyimadu, 2015). These theories discuss the interrelationships that may exist between labour productivity, job opportunities and wage shocks. In case the labour supply curve is not perfectly elastic, high productivity leads to both job opportunity and high wages (Pettinger, 2017).

An inverse relationship exists between job opportunity and real wages. Increasing real wages implies rising labour cost for a firm and the latter may decide to substitute labour with capital to increase its marginal productivity (Wakeford, 2004). On the other hand, it is not always that high labour productivity results in high real wage. It is possible to experience productivity growth with a constant real wage. This is because the equation of wage-productivity includes other economic factors such as labour cost adjustment and price legalities (Klein, 2012). Additionally, labour market regulations and employment protection are also factors that may cause the absence long-run relationship between labour productivity, real wage and workers bargaining power (Karabarbounis & Neiman, 2014).

Besides the Keynesian and new classical economic theory, the standard economic theory represented by Hammermesh (1993) and supported by Borjas (2010) suggests a strong relationship between wages, productivity and job opportunity. Labour productivity includes both positive and negative impact on job opportunity. Productivity growth leads to jobless in both short and medium run to create more jobs in the long run (Gallegati *et al.*, 2016; Partridge et al., 2019). Additionally, the effect of productivity on employment differs among industries as it creates job opportunities in those with elastic demand and destroys jobs in those industries with inelastic demand (Blien & Ludewig, 2014).

2.2. Review of Empirical Studies

Many studies were conducted to assess the effect of labour productivity and real wages on employment or job opportunities. A brief summary of some of those studies and their findings is provided in Table 1.

Table 1. Effect of Labour Productivity and Real Wages Fluctuation on Job Opportunities

Author &Date	**Country**	**Sample period**	**Methods**	**Findings/study conclusion**
Habanabakize *et al.* (2019)	South Africa	1995 - 2019	ARDL	A negative relationship exists between real wage and employment.
Bjuggren (2018)	Sweden	1997 - 2003	Panel OLS	Productivity has no significant effect on employment.
Falk & Hagsten, 2018	EU countries	2002 - 2010	System GMM	A positive relationship between productivity and job opportunity
Graetz & Michaels, 2018	7 of developed countries	1993 - 2007	OLS & SLS	A positive relationship exists between labour productivity and real wages.
Autor& Salomons (2017)	OECD countries	1970-2007	Panel OLS	Productivity growth increases have an asymmetric effect on employment levels
Adudu & Ojonye (2015)	Nigeria	1990 - 2009	Granger causality	High job opportunity induces wage reduction and vice versa.
Bakker (2015)	OECD countries	2007 - 2014	OLS	An asymmetric relationship exists between real wage and employment.
Amassoma & Nwosa (2013)	Nigeria	1986 - 2010	ECM	Insignificant relationship between unemployment and productivity.
Junankar (2013)	developed and developing countries	1950 - 1989 1990 - 2010	GMM estimation	Trade-off and inverse relationship exist between productivity and employment.
Alani (2012)	Uganda	1972 -2008	OLS	An inverse relationship between labour productivity and employment.
Klein (2012)	South Africa	2008 - 2011	Panel OLS	A positive relationship between employment and labour productivity
Seputiene (2011)	EU countries	2000 - 2010	OLS	Asymmetric relationship exists between real wage and employment
Yusof (2008)	Malaysia	1992 - 2005	VECM	A positive relationship exists between employment growth and labour productivity; while an inverse relationship exists between employment and real wages.

3. Data Description and Research Methodology

3.1. Source and Definition of Data

The study employs quarterly time series data with a sample size spanning the period from 2002 to 2019. The used data is sourced from the South African Reserve Bank website. The analysed variables are job opportunity as a proxy of total employment (dependent variable), real wages and labour productivity (explanatory variables).

3.2. Methodology

The aforementioned variables are expected to have both linear and nonlinear relationship. The linear relationship (long-run and short-run) among variables can be expressed as follow:

$$LY_t = \alpha_0 + \beta_2 LLP_t + \beta_3 LRW_t + \varepsilon_t \quad (1)$$

Where LY_t denotes natural log of job opportunity, L LP_t is the natural log of labour productivity and LRW_t is the natural log of real wages, α_0 is the constant term, β_1 and β_2 are the model coefficients, ε_t is the error correction term and *t* denotes the period. Equation 2 is obtained by transforming the equation 1 into the generic ARDL estimation form:

$$\Delta(LY)_t = \alpha_0 + \theta_1 \Delta(LLP)_{t-1} + \theta_2 \Delta(LRW)_{t-1} + \Delta\theta_3 (LY)_{t-1} + \lambda_0 (LY)_t + \lambda_1 (LLP)_t + \lambda_2 (LRW)_t + \varepsilon_t \quad (2)$$

Where Δ denotes a differentiated variable, ε_t is the white noise, λ_0 to λ_2 denote long-run coefficients, θ_1 to θ_3 are short-run coefficients and (*t-1*) denotes a lagged period.

While analysing a time series data, it is important to determine the integration order for variables of interest. The knowledge of variables integration order assists in evading spurious regression (Gujarati & Porter, 2009). Variables can either be integrated of order zero (at level) and are noted as I(0), integrated of order one (after being differentiated once) and are noted as I(1) or integrated of order one (after being differentiated twice) and are noted as I(2). This study employed both Augmented Dickey-Fuller (ADF) suggested by Dickey and Fuller (1979) and KPSS suggested by Kwiatkowski *et al.* (1992) tests to ascertain variables integration order.

When variables order of integration is known, the next step is to perform a cointegration analysis. Various tests can assist in testing for cointegration among variables. These tests include Engle and Granger (1987) and Johansen-Juselius (1990) cointegration tests. However, both models are associated with some deficiencies and limitations. For instance, these tests cannot be applied to a mixture of I(0) and I(1) of variables. To overcome this inability, Pesaran *et al.* (2001) suggest the use of the Autoregressive Distributed Lag (ARDL) model. This approach is applicable when variables are either I(0), I(1) or a mixture of the two. This model was selected for the current study. To estimate the best-fitted model exhibited in equation 3, each variable was considered as the dependent variable and expressed as follows:

$$\begin{bmatrix}\Delta(LY)_t\\ \Delta(LLY)_t\\ \Delta(LRW)_t\end{bmatrix} = \begin{bmatrix}\delta_1\\ \delta_2\\ \delta_3\end{bmatrix} + \begin{bmatrix}\Delta(LY)_t\\ \Delta(LLY)_{t-1}\\ \Delta(LRW)_{t-1}\end{bmatrix} \begin{bmatrix}\begin{bmatrix}\theta_{11}\ \theta_{12}\ \theta_{13}\\ \theta_{21}\ \theta_{22}\ \theta_{23}\\ \theta_{31}\ \theta_{32}\ \theta_{33}\end{bmatrix}\end{bmatrix} + \sum_{s=1}^{p}\begin{bmatrix}\mu_{11}\ \mu_{12}\ \mu_{13}\\ \mu_{21}\ \mu_{22}\ \mu_{23}\\ \mu_{31}\ \mu_{32}\ \mu_{33}\end{bmatrix}\begin{bmatrix}\Delta(LY)_{t-s}\\ \Delta(LLY)_{t-s}\\ \Delta(LRW)_{t-s}\end{bmatrix} + \begin{bmatrix}\varepsilon_{1t}\\ \varepsilon_{2t}\\ \varepsilon_{3t}\end{bmatrix} \quad (3)$$

Where δ_1 to δ_4 denote constant terms, θ_{11} to θ_{44} represent long-run coefficients for both long and short-run relationships. The long-run relationship is tested under the following hypothesis:

(i) H_0 : no long-run relationship [θ_t= 0)]

(ii) H_A :long-run relationship exists [$\theta_t \neq 0$)]

(iii) H_0 : no short-run relationship [μ_s = 0)]

(iv) H_A : short relationship exists [$\mu_s \neq 0$)]

The decision and conclusion of the above-listed hypothesis are made based on a comparison between the F-statistics from the bound test for cointegration and the Pesaran *et al.* (2001) critical values. Subsequently, one of the following three conclusions is made.

(i) If the F-statistics is > upper bound critical value: variables cointegrate

(ii) If the F-statistics is < lower bound of critical value: variables do not cointegration

(iii) If the F-statistics is > lower bound and yet < upper bound of critical value: no conclusion

Once cointegration is established, the subsequent step is to estimate long and short-run coefficients. Using ARDL (m, q, p), the model equilibrium is expressed as follows:

$$LY_t = \alpha_0 + \beta_1 LLP_t + \beta_2 LRW_t + \varepsilon_t \quad (4)$$

$$\mathrm{L}Y_t = \sigma_0 + \sum_{k=1}^{m}\beta_k\, LY_{t-k} + \sum_{k=0}^{p}\mu_k\, LLP_{t-k} + \sum_{k=0}^{q}\pi_k\, LRW_{t-k} + \varepsilon_t \quad (5)$$

Using Schwarz information criteria (SIC), two lags were selected as the optimum lag length for the model. Short-run elasticities were also derived from the following error correction model:

$$\mathrm{L}Y_t = \sigma_0 + \sum_{k=1}^{n} \beta_k \,\Delta LY_{t-k} + \sum_{k=0}^{n} \mu_k \,\Delta LLP_{t-k} + \sum_{k=0}^{n} \pi_k \,\Delta LRW_{t-k} + \varphi ECT_{t-1} + u_t \quad (6)$$

The ECT_t is expressed as:

$$\mathrm{ECT}_t = \mathrm{L}Y_t - \sigma_0 - \sum_{k=1}^{m} \beta_k \Delta\, LY_{t-k} - \sum_{k=0}^{p} \mu_k \,\Delta LLP_{t-k} - \sum_{k=0}^{q} \pi_k \,\Delta LRW_{t-k} \quad (7)$$

To examine a directional causal relationship among variables, the subsequent vector error correction (VECM) is considered during the analysis.

$$\begin{bmatrix} \Delta(LY)_t \\ \Delta(LLY)_t \\ \Delta(LRW)_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{bmatrix} + \sum_{s=1}^{p} \begin{bmatrix} \mu_{11}\, \mu_{12}\, \mu_{13} \\ \mu_{21}\, \mu_{22}\, \mu_{23} \\ \mu_{31}\, \mu_{32}\, \mu_{33} \end{bmatrix} \begin{bmatrix} \Delta(LY)_{t-g} \\ \Delta(LLY)_{t-g} \\ \Delta(LRW)_{t-g} \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \end{bmatrix} \mathrm{ECT}_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (8)$$

Since the core objective of the study is to examine the existence of an asymmetric relationship between job opportunity (employment), real wages and labour productivity, the nonlinear ARDL) suggested by Shin *et al.* (2014) is applied on variables. Thus, considering both positive and negative alterations of independent variables, the new denotation was expressed as follows: real wages (RW^+, RW^-); labour productivity (LP^+, LP^-). Decomposition of each variable is represented as:

$$\begin{cases} POS(LP)_t = \sum_{k=1}^{p} LLP_k^+ = \sum_{K}^{P} MAX(\Delta LLP_k\ ,0) \\ NEG(LP)_t = \sum_{k=1}^{p} LLP_k^- = \sum_{K}^{P} MIN(\Delta LLP_k\ ,0) \end{cases} \quad (9)$$

$$\begin{cases} POS(RW)_t = \sum_{k=1}^{p} LRW_k^+ = \sum_{K}^{P} MAX(\Delta LRW_k\ ,0) \\ NEG(RW)_t = \sum_{k=1}^{p} LRW_k^- = \sum_{K}^{P} MIN(\Delta LRW_k\ ,0) \end{cases} \quad (10)$$

Applying nonlinear features on Equation 2, the nonlinear ARDL is expressed in Equation 11:

$$\Delta(LY)_t = \alpha_0 + \sum_{i=1}^{p} \lambda_0\, \Delta(LY)_{t-1} + \sum_{i=0}^{p} \lambda_2^+\, \Delta\mathrm{POS}(LLP)_{t-i} + \sum_{i=0}^{p} \lambda_2^+\, \Delta\mathrm{NEG}(LLP)_{t-i} + \sum_{i=0}^{p} \lambda_3^+\, \Delta\mathrm{POS}(LRW)_{t-i} + \sum_{i=0}^{p} \lambda_3^+\, \Delta\mathrm{NG}(LRW)_{t-i} + \gamma_0 \mathrm{L}Y_{t-1} + \gamma_2 POS(LLP)_{t-1} + \gamma_2 NEG(LLP)_{t-1} + \gamma_3 POS(LRW)_{t-1} + \gamma_3 NEG(LLP)_{t-1} + \varepsilon_t \quad (11)$$

The relationship expressed in equation 11, follows the model proposed by Shin *et al.* (2014), and it is evaluated using the Pesaran *et al.* (2001) critical values.

4. Results and Discussion

4.1. Graphical Representation of Explanatory Components

The NARDL model is based on the assertion that a specific economic of financial variable possesses different impact during the positive and negative shocks. Therefore, the NARDL approach divides productivity and real wages into positive and negative components. Figure 1 and Figure 2 exhibit positive and negative components of both productivity and real wages. Looking at figure 1, between the third quarter of 2002 and the third quarter of 2003 productivity had a symmetric (linear) positive effect on employment. Then it had a slightly negative effect between the fourth quarter of 2003 and the fourth quarter of 2007. From 2007 up to 2019, the negative effect of productivity was gradually increasing.

Considering the effect of the negative component of real wages on employment was zero between 2002 and 2006. From 2007 to 2019, the negative component of real wages experiences an ongoing movement of stable – down – stable – down up to 2019. On the other hand, between 2002 and 2019.

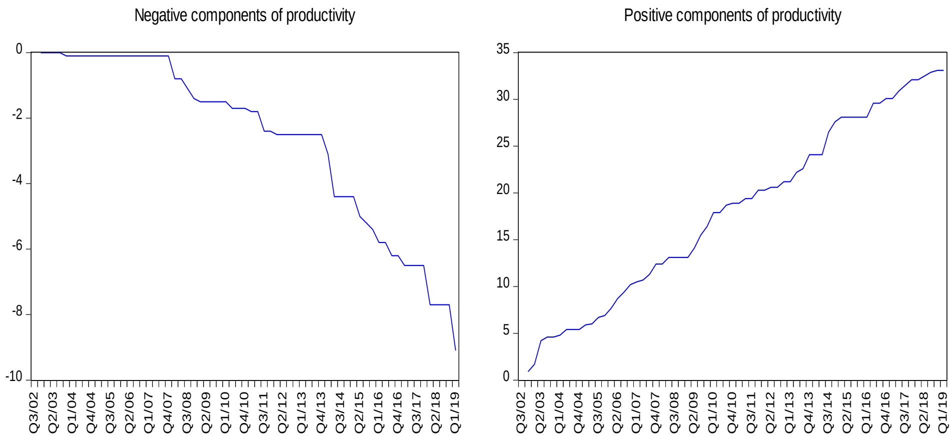

Figure 1. Negative and Positive Components of Productivity

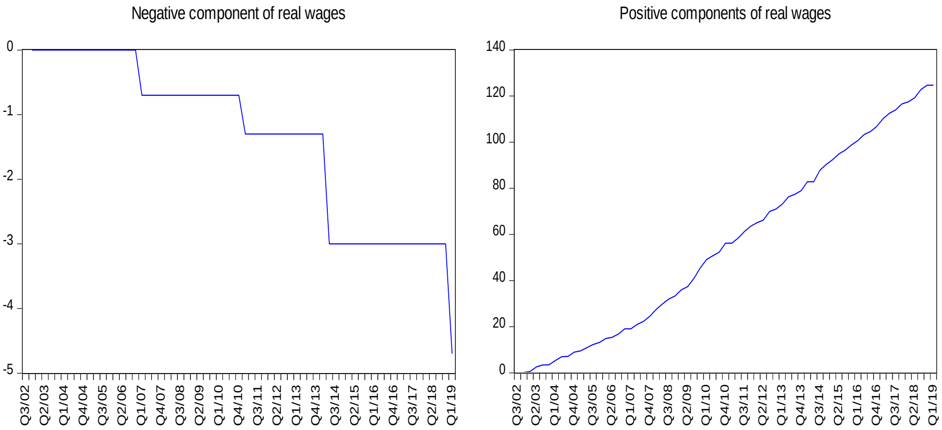

Figure 2. Negative and Positive Components of Real Wages

4.2. Test for Stationarity and Unit Root

Using both ADF and PP unit root tests, the result in Table 2 shows that job opportunity, labour productivity has a unit root at levels and become stationary at first difference. However, the stationarity test (KPSS) indicates that both job opportunity and real wages are stationary at levels while labour productivity becomes stationary at first difference. Since, the stationarity results infer that variables are a mixture of I(0) and I(1), and that the stationarity results are considered to produce more accurate results (Jafari *et al.*, 2012), the ARDL model was selected based on KPSS results.

Table 2. Stationarity and Unit Root Results

Variable	**Levels**				**1st Difference**		
		ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
LD (Y)	**intercept**	0.854	0.857	1.062	0.000*	0.000*	0.093*
	Intercept & trend	0.475	0.706	0.136*	0.002*	0.000*	0.087*
LRW	**intercept**	1.000	1.000	1.184	0.064	0.000*	1.206
	Intercept & trend	0.905	0.928	0.309	0.000*	0.000*	0.109*
LLP	**intercept**	0.402	0.305	1.194	0.000	0.000	0.418*
	Intercept & trend	0.976	0.987	0.284	0.000	0.000	0.098*

Note: * the series has no unit root (is stationary) at 5% significant level

4.4. Asymmetric Bound Test for Cointegration

Bound test testing for cointegration was used to assess the presence of a joint long-run relationship among variables. The results in Table 3 confirm the rejection of null hypothesis suggesting the absence of cointegration among variables. The decision was made based on that fact that the computed F-statistics of 8.743383 greater than all the upper bound critical values.

Table 3. Asymmetric ARDL Bounds Test and Critical Bounds Value.

Test Statistic	**Value**	
F-statistic	8.743383	
Critical Value Bounds		
Significance	**I (0) Bound**	**I(1) Bound**
10%	2.2	3.09
5%	2.56	3.49
1%	3.29	4.37

Having established the presence of cointegration among variables, it is now possible to estimate the asymmetric effect of both labour productivity and real wages on job opportunity. Following the results in Table 3, the long-run coefficients suggest that the positive effect of both productivity and real wages are 4.96 percent and -0.72 percent respectively; while the negative effects are 1.5 percent for productivity and 5.96 for real wages. These results imply that positive shocks in productivity level increase the quantity of job opportunity whilst negative changes in productivity level has a small effect on the job opportunity. On the other side, an increase in real wages leads to a reduction in job opportunity while a decline of real wages stimulates employers to demand more labour. These results support economic theories suggesting a positive relationship between productivity and job opportunity, and an inverse relationship between real wage growth and job opportunity (Gans *et al.*, 2011). Besides the relationship proposed by those theories, some empirical findings also pointed out that productivity growth results in a rise in job opportunity whilst high real wage inversely relates to job opportunity (Apergis, 2008; Das *et al.*, 2017; Klein, 2012). In regards to short-run shocks, positive fluctuations of productivity result in a positive response to job opportunity while the negative changes in productivity are not statistically significant to impact on job opportunity behaviour. Similarly, both positive and negative components of real wages have no significant effects on job opportunities. This result of no significant effect of wage on employment is supported by the findings of Bocean (2015). The estimated coefficient of the error correction model (ECM) was -0.105633. As presented in Table 4, the value of the ECM is negative and statistically significant with 99 confidence level. This implies that approximately 11 percent of the model short-run shocks are adjusted each quarter and converge to long-run the equilibrium.

Table 4. Asymmetric ARDL Coefficients and the ECM Results

Variable	Long-run Coefficient	Std. Error	t-Statistic	Prob.
LNPROD+	4.963	2.879	1.723	0.090
LNPROD⁻	1.518	1.883	0.806	0.423
LNWAGE+	-0.720	0.497	-1.447	0.153
LNWAGE⁻	5.960	5.519	1.079	0.284
C	15.727	0.087	181.81	0.000
Variable	**Short-run Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(LNPROD+)	-0.386	0.185	-2.093	0.040*
D(LNPROD⁻)	0.082	0.386	0.211	0.833
D(LNWAGE+)	-0.125	0.089	-1.404	0.166
D(LNWAGE⁻)	0.075	0.484	0.155	0.877
ECT(-1)	-0.106	0.017	-6.062	0.000*

Note: * depict significance at 5 percent.

To validate the NARDL results, diagnostic tests were conducted before drawing inferences of explanatory variables on the dependent variable. As indicated by the results in Table 4, the NARDL model has passed all performed tests. Thus, the model is stable and the obtained NARDL findings are accurate.

Table 5. NARDL Diagnostic Statistics

Tests	P-Value of X^2	Conclusion based on P-value
Ramsey Reset Test	0.2679*	Model is accurately specified
LM	0.9798*	No Serial Correlation
White	0.8157*	No Heteroscedasticity

Note: * specifies a p-value that is greater than 0.05

4.5. NARDL Dynamic Multipliers

To assess asymmetric adjustment within the existing long-run equilibrium post to new long-run equilibrium owing to negative and positive shocks, a graph of dynamic multiplier was plotted for NARDL as depicted by both figure 5 and 6. On these figures, the asymmetry curves depict the linear mixture of the dynamic multipliers due to negative and positive shocks in productivity and real wages. These positive and negative fluctuations provide evidence for the asymmetric alteration of employment to negative and positive changes in productivity and real wages at a given period. The overall outcome of dynamic multiplier graphs suggests that while a positive shock in productivity levels influences more job opportunity fluctuations compared to negative shocks; the negative shocks from real wages influence job opportunity level compared to positive shocks.

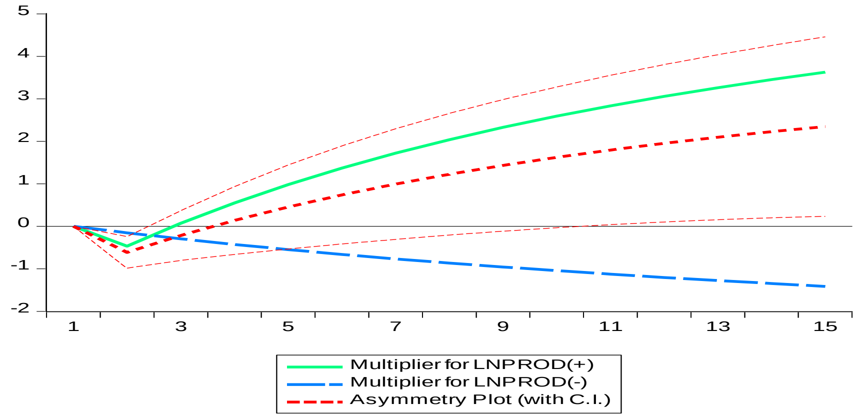

Figure 5. NARDL Dynamic Multiplier Graph for Labour Productivity

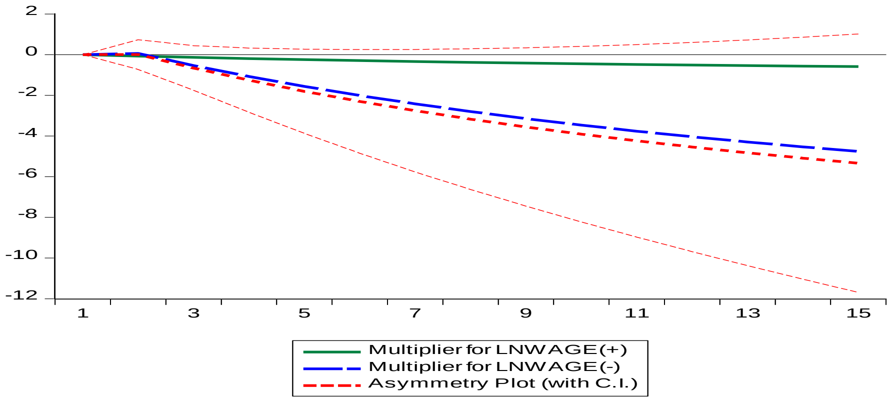

Figure 6. NARDL Dynamic Multiplier Graph for Real Wages

5. Conclusion and Recommendations

The study attempts to provide both theoretical and empirical frameworks that explain how changes in both productivity and real wages influence the South Africa job opportunity. The theoretical assumptions were that positive change in productivity would lead to a rise in job opportunity whilst a decline in productivity would cause a job opportunity to decline. On the other side, it was assumed that real wages have an inverse relationship with job opportunity levels. For empirical assessment, the performed NARDL and Wild tests confirmed the presence of an asymmetric long-run relationship among variables. Findings suggest that the positive effects of the labour productivity on job opportunity dominate over negative effects component. Contrarily to labour productivity components, negative effects of real wages on job opportunity was found to exceed positive effects. However, findings indicated that real wages have no significant effect short-run on job opportunity. Only positive component of productivity was found to impact on short term job opportunities.

Given the gravity of unemployment on the South African economy and welfare, serious measures should be introduced. Firstly, the labour union should encourage its members to first consider their productivity level before fighting for wages increment. Secondly, the monetary authorities would have to put in place policies that protect the value of received wages (protect the currency against depreciation). Since labour productivity, leads job opportunity, it is substantial to provide adequate knowledge and skills to the labour force through the provision of solid education and training to cope with new technologies.

References

Adudu, S.A & Ojonye S.M. (2015). Employment–real wage relationship and economic growth in Nigeria. *Journal of Economics and Sustainable Development*, 6(2), 179-188.

Alani, J. (2012). Effects of Productivity Growth on Employment Generation, Capital Accumulation and Economic Growth in Uganda. *International Journal of Trade, Economics and Finance* 3(3), 170-183.

Amassoma, D. & Nwosa P.I. (2013). The impact of unemployment rate on productivity growth in Nigeria: An error correction modelling approach. *International Journal of Economics and Management Sciences* 2(8), 1-13.

Apergis N. (2008). The employment-wage relationship: was Keynes right after all? *American review of political economy* 6(1), 40 – 50.

Arestis, P. & Bittes, T.F.H. (2018). Keynesian macroeconomic policy: Theoretical analysis and empirical evidence. *Panoeconomicus*, 65(1), 1-20.

Autor, D. H. & Salomons, A. (2017). *Does productivity growth threaten employment?* Paper prepared for the ECB Forum on Central Banking.

Bakker, M.B. (2015). *Employment and the Great Recession*. International Monetary Fund, Washington.

Bhorat, H. (2003). *Employment and unemployment trends in post-apartheid South Africa*. Government Gazette, Pretoria.

Bjuggren, C M. (2018). Employment protection and labour productivity. *Journal of Public Economics* 157, 138-157.

Bocean C.G. (2015). Relationships between wages and employment indicators. *Revista tinerilor economişti/ The journal of young economists*, 24, 41-50.

Borjas, G. (2010). *Labour Economics*, 5th ed. New York: McGraw Hill.

Das, P., Basu R. & Halder, A. (2017). Employment, Wage and Productivity: Analysis of Trend and Causality in Indian Manufacturing Industries. *The Journal of Industrial Statistics,* 6(1), 41-56.

Dickey, D.A. & Fuller, W.A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American statistical association*,74(1), 427–431.

Elżbieta, K. & Danuta, K. (2015). Wages in Labour Market Theories. *Folia Oeconomica Stetinensia*, 15(2), 177-190.

Falk, M. & Hagsten, E. (2018). Employment impacts of market novelty sales: evidence for nine European Countries. *Eurasian Bus Rev* 8, 119–137.

Gallegati, M., Gallegati, M. & Ramsey, J. B., Semmler, W. (2016). Productivity and unemployment: A scale- by- scale panel data analysis for the G7 countries. *Studies in Nonlinear Dynamics & Econometrics*, 20(4), 477–493.

Gans J., King, S., Stonecash R. & Mankiw, N.G. (2011). *Principles of economics*, 4th ed. Melbourne: Cengage Learning.

Graetz, G. & Michaels, G. (2018). Robots at work. *Review of Economics and Statistics*, 100(5), 753-768.

Habanabakize T, Meyer D.F. & Oláh, J. (2019). The Impact of Productivity, Investment and Real Wages on Employment Absorption Rate in South Africa. *Social Sciences*, 8(12), 1-15.

Hammermesh., D. (1993). *Job opportunity.* New Jersey: Princeton University Press.

Jafari, Y., Othman, J. & Nor, A.H.S.M. (2012). Energy consumption, economic growth and environmental pollutants in Indonesia. *Journal of Policy Modeling* 34(6), 879-889.

Junankar, P.N. & Madsen, J.B. (2013). Unemployment in the OECD: Models and Mysteries. *IZA Discussion Paper* No. 1168. Institute for the Study of Labour, Bonn.

Karabarbounis, L., Neiman, B. (2014). The global decline of the labor share. *The Quarterly journal of economics* 129(1), 61-103.

Klein, N. (2012). Real wage, labor productivity, and employment trends in South Africa: A closer look (No. 12-92). *International Monetary Fund*, Washinton.

Kwiatkowski, D., Phillips, P.C., Schmidt, P. & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of econometrics* 54(3), 159-178.

Landmann, O. (2002). *Employment, productivity and output growth*. ILO. Mimeographed.

Onyimadu, C. (2015). *Beyond the Neoclassical Paradigm: A Real World Economics Proposal*. Munich Personal RePEc Archive.

Morton, B. & Blair, C. (2020). *Real Wages, Productivity and Employment.* https://www.21century.co.za/real-wages-productivity-and-employment/. Date of access: 14 July 2020.

Partridge, M., Tsvetkova, A. & Betz, M. (2019). Are the Most Productive Regions Necessarily the Most Successful? Local Effects of Productivity Growth on Employment and Earnings. *Journal of Regional Science*, 1-32.

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.

Pettinger, T. (2017). *Real Wage Unemployment.* https://www.economicshelp.org/blog/1507/economics/wages-and-unemployment/. Date of access: 13 July 2020.

Seputiene, J. (2011). The estimation of the relationship between wages and unemployment in the European Union. *International Journal of Social Sciences and Humanity Studies* 3(2), 277-285.

Shin, Y., Yu. B. & Greenwood-Nimmo, M. (2014). *Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework*. New York: Springer.

South African Reserve Bank. (2020). *Quarterly bulletin*, March 2020. Pretoria: South African Reserve Bank.

Statistics South Africa. (2020). *Quarterly employment statistics*. http://www.statssa.gov.za/?p=13185. Date of access: 13 July 2020.

Wakeford, J. (2004). The productivity–wage relationship in South Africa: an empirical investigation. *Development Southern Africa*, 21(1), 109-132.

Wittenberg, M. (2014). *Analysis of employment, real wage, and productivity trends in South Africa since 1994*. Geneva: International labour organisation.

Yusof, S.A. (2008). The long-run and dynamic behaviors of wages, productivity and employment in Malaysia. *Journal of Economic Studies,* 35(3), 249 – 262.