TESTING THE UNEMPLOYMENT HYSTERESIS HYPOTHESIS IN SOUTH AFRICA: A LINEAR AND NON-LINEAR APPROACH

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Abstract: The purpose of this paper is to analyze the unemployment hysteresis hypothesis in South Africa over the period 2000 to 2023. The study employed the wavelet unit root process, namely the Discrete Wavelet Transform (DWT) and the Maximum Overlap Wavelet Transform (MODWT) unit root processes. Furthermore, the linear tests comprised of the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests were used, while the Fourier ADF tests were used as the non-linear end. Consequently, all the linear tests reveal some mean reversion while the Fourier ADF test confirms partial hysteresis: shocks to unemployment are indeed not permanent, but their effects do last over time.
Keywords: Unemployment, Hysteresis, Hypothesis, South Africa, Labor market

Introduction

The problem of unemployment has been central to the South African economy, compounded by structural shifts in the economy after the political liberalization of 1994. South Africa has recorded subpar growth performance since the political liberalization in 1994, averaging around 2.4% from the year 2000 to the year 2019, slightly above the population growth rate (Dadam & Viegi, 2024). Unemployment is expected to be high due to social exclusion and apartheid legacy effects. One of the theoretical perspectives that have been conceptualized to explain such dynamics is the unemployment hysteresis hypothesis (UHH) pioneered by Blanchard and Summers (1986). It implies that real economic disturbances may cause permanent changes in unemployment levels and cease to allow for a return to the natural rate as postulated by Friedman (1968). This is especially relevant given that unemployment in South Africa began rising sharply after the 2008-2009 international economic crisis and soared during the COVID-19 outbreak reaching 32.9% in the first quarter of 2024 (Stats SA, 2024). Researchers on UHH in South Africa provide evidence to support this theory. Elike, Anoruo, and Nwala (2018) stated that unemployment in South Africa fits neatly with the UHH.

In the same way, Raifu and Abodune (2020) conducted a statistical exercise and established that unemployment is a non-stationary process in Nigeria, thus the UHH was supported. Similarly, Nsenga et al. (2019) also found hysteresis in Newly Industrialized Economies (NIEs) comprising South Africa, among others. In light of the above, this study investigates the UHH in South Africa. Specifically, this study seeks to empirically test the persistence of unemployment in the South African labour market during 2000-2023. This is to

determine if unemployment reverts to its average in the long run or if it has hysteresis where the shocks persist.
The rest of the paper is organized as follows. Section 2 provides the literature review. The methodology is presented in Section 3. The findings are discussed in Section 4, while the conclusion is presented in Section 5.

Literature review
This literature review aims to assess the empirical literature on unemployment hysteresis in terms of methodologies employed, data, and results obtained from the analysis. It will also state the areas of literature which are lacking particularly in South Africa; it will also state the course this study is going to undertake. Section 2.1 of the literature reviews different theories that underpin the topic. Section 2.2 review empirical studies focusing on unemployment hysteresis in South Africa. Section 2.3 presents the gaps in the literature that the study intends to fill.

Theoretical literature
The analysis of unemployment hysteresis in South Africa can be viewed through key principles of concepts that are used to describe unemployment and its dynamics. Two dominant theories underpin this topic: The first explanation is the Hysteresis Hypothesis, and the subsequent one is the long-run Natural unemployment hypothesis. The Persistent Unemployment Theory/Hysteresis Hypothesis introduced by Blanchard and Summers (1986) postulates that non-employment is not only a cyclical phenomenon but can cause permanent changes to occur in unemployment, thus preventing the rate from returning to a natural long-run level. This theory is especially applicable to South Africa since the country has periodically failed to recover from such economic slump resulting in persistent high unemployment rates (Pikoko & Phiri, 2018). The hysteresis effect arises from rigidities in the market structure facilitated by features such as the dominance of labor unions and bargaining over wages that ensure that unemployment cannot decline even during recovery (Lindbeck & Snower, 1988). Also, structural factors such as human capital depletion during unemployment periods help explain this persistence (Guris et al., 2017). Consequently, cyclical variability may cause a transformational shift in the unemployment rate, including in post-recessionary contexts, such as in South Africa (Blanchard & Summers, 1987; Nsenga et al., 2019). The hypothesis regarding the natural rate of unemployment, advanced by Phelps in 1967 and Friedman in 1968 asserts that there is a fundamental rate of unemployment beyond which changes cannot occur due to structural factors. The main idea of this theory is that fluctuations from the NRU are only in the short run and unemployment will reach its Natural rate over time. Yet, the NRU can be altered by a shift in the labor market, for instance through technology or demography (Pikoko & Phiri, 2018). Consequently, structural factors such as industrial technology and the demographic structure of the labour market in South Africa are germane to unemployment. Altogether, these theories offer a framework for understanding the sustained presence of unemployment in South Africa that results from both cyclical factors and structural factors.

Empirical literature
Unemployment hysteresis has been investigated in several empirical works, which have produced quite diverse findings depending on the countries under consideration and the

approach used. This section critically discusses empirical studies according to the methods used, data availability and analysis, and findings. Blanchard and Summers (1987) believe that the evidence of the persistent shocks in the unemployment trend is consistent with the hysteresis hypothesis. Initial research on hysteresis mainly relied on simple and traditional stationary tests, such as the ADF test by David Dickey and Wayne Fuller (1979) and the PP test by Peter Phillips and Pierre Perron (1988). These tests confirm or reject whether unemployment rates have returned to the natural rate after a shock or remained higher in a way consistent with hysteresis. For example, Chang et al. (2007) used ADF, DF-GLS, and PP stationary tests to analyze the regional unemployment rate in Taiwan and found that the results were not favorable for most regions of the hysteresis hypothesis. Similarly, Dritsaki and Dritsaki (2013) used both of these methods to test for the persistence of the rate of unemployment in Greece Ireland, and Portugal and concluded that hysteresis existed notably during recessions.

However, these methods based on linear tests are used in many different disciplines, and, in many cases, they work with their power limitations when applied to small samples or short time series. This was pointed out by Mednik et al. (2012) who utilized linear unit root tests for Latin American countries and observed inconclusive effects. They argued that rigidities in the labor market and the autonomy in fiscal policies caused the persistence of unemployment with inconclusive evidence of hysteresis in all countries. As linear unit root tests like the Augmented Dickey-Fuller may not appropriately describe the unemployment movement due to cyclicality, other forms of nonlinear unit root tests have gained popularity, due to their incorporation of features such as asymmetry and structural breaks. Peel and Speight (1998) pointed out that unemployment data are nonlinear and that a lack of recognition of this fact can lead to misidentification of hysteresis. Chang and Tsangyao (2011) examine hysteresis via both linear and nonlinear unit root techniques. They discovered that although linear tests provided evidence consistent with the hysteresis hypothesis, nonlinear approaches did not yield a satisfactory outcome. This implies that there was some degree of mean reversion in unemployment in the case of Taiwan, thus presenting a more complex picture than simple hysteresis. However, Munir & Ching (2015) used nonlinear techniques to identify hysteresis in 11 Asian countries. They found out that high unemployment rates in these countries mean reverting, a finding that opposes the hysteresis hypothesis. Based on these results, it can be inferred that while changes in unemployment due to short-term shocks can be identified, the longstanding trends were representative of the natural rate hypothesis.

Other more sophisticated econometric methods have also been used to control for structural breaks such as the Fourier ADF test. Marjanovic et al. (2014) used these techniques for the OECD and Central and Eastern European countries revealing that taking into account structural breaks might alter the understanding of the employment dynamics. In OECD countries, hysteresis was negated and in the CEE countries, hysteresis could not be ruled out, particularly in the centrally planned economies.

Recent developments in time series analysis have seen wavelet-based techniques as a useful tool in measuring unemployment persistence. Elike, Anoruo, and Nwala (2018) used Discrete Wavelet Transform (DWT) and Maximum Overlap DWT to examine hysteresis in 28 African countries including South Africa. Their evidence of the performance of wavelet-based methods was important as it compared with the unit root test methods most of which produced mixed results. In their study, unemployment hysteresis was not

supported in most countries, but it was supported only in the Rwandan case. Similarly, Yilanci et al (2024) examined unemployment hysteresis in Nordic countries by employing the Wavelet analysis. The results reveal evidence of unemployment hysteresis in the six unemployment rates in the short run. In addition, they also found the results for hysteresis in the three unemployment rates in the long run.

Investigations into hysteresis have also used panel data techniques, which amalgamate data from different countries or regions. Chang et al (2007) performed panel-based stationary tests on regional data of Taiwan and rejected the hysteresis hypothesis. Although using panel data methods enhances the statistical power of the analysis by considering cross-sectional variation, it might obscure regional heterogeneity in unemployment persistence.

Similarly, Munir and Ching (2015) also used panel data to estimate the unemployment hysteresis in Asia. They discovered that though some countries featured hysteresis, it was evident that most countries did not thereby support the natural-rate hypothesis. This stems from the nature of the panel data methods in that although they offer a more general picture, they might not be as attuned to regional features or shifts in structure. In a different region, Furuoka (2017) applied the ADF, Fourier ADF, ADF with a structural break (ADFSB) and Fourier ADF with a structural break (SBFADF) unit root tests to data for Nordic countries. The findings for the ADF showed that unemployment is hysteresis was valid for all countries in the analysis period while the ADFSB test reveals the validity in only Finland and Sweden. However, the results of SBFADF unit root test indicate the unemployment hysteresis hypothesis is invalid for all countries.

Finally, in Asia Li et al (2021) applied the sequential panel selection method and the Kapetanios–Snell–Shin (KSS) panel unit root test with Fourier functions. The results were invalid for men and women in most Asian regions. But, valid for adult females in Pakistan and Nepal.

Gap in the literature

Unemployment hysteresis has been defined as a factor that is evident in the developed world, but sadly, it has less existence in developing nations, not excluding the African region. Even though research such as Elike et al. (2018) has examined hysteresis in African countries, these works are limitedly concerned with a few nations and timelines. Some controversy exists regarding econometric approaches applied; early works employed “unit root tests” which are linear and thus less efficient for non-linear series or those with structural shifts. Some of the recent sources, including Raifu and Abodunde (2020), have used non-linear techniques although this approach has not had much backing. Moreover, institutions and policies connected to hysteresis like the rigidity of labor market structure and fiscal policies as highlighted by Mednik et al., (2012) are relatively ignored in the context of developing countries. This study aims to fill this gap in a South African context.

Research methodology

Econometric framework and model specification

The first part of the analysis follows Elike et al (2018). In this regard, the study employs the wavelet unit root process, namely the Discrete Wavelet Transform (DWT) as well as the Maximum Overlap DWT (MODWT) with Haar and Daubechies wavelet filters as suggested by Fan and Gencay (2010). To complement the results from the DWT, the study

implements discrete wavelet transforms partition the frequency range into finer and finer blocks. At the first scale, the frequency range is split into two equal parts. The first, lower frequency part, is captured by the scaling coefficients, while the second higher frequency part, is captured by the wavelet coefficients. In addition, this decomposition affords the ability to identify which features of the original time series data are dominant at which scale. In particular, if the spectra (read wavelet/scaling coefficient magnitudes) at a given scale are high, this would indicate that those coefficients are registering behaviours in the underlying data which dominate at said scale and frequency region.

The second part follows Raifu and Abodunde (2020), by incorporating linear together with nonlinear econometric tests to investigate the Persistent Unemployment Theory/unemployment hysteresis hypothesis in South Africa from the year 2000 to 2023. The analysis employs linear breaks stationary tests such as the Augmented Dickey-Fuller (ADF) test by Dickey & Fuller (1979), the Phillips-Perron (PP) test by Phillips & Perron (1988), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) by Kwiatkowski, Phillips, Schmidt, and Shin (1992). These tests will form the first step in assessing whether the unemployment rate adheres to a stationary process or undergo hysteresis analysis. However, there is a likelihood of the presence of structural breaks in the series due to shocks from technical recession, international economic crisis and the COVID-19 outbreak amongst others. Therefore, the study also adopted the Fourier Augmented Dickey-Fuller (FADF) by Enders & Lee (2004, 2012). This test is especially helpful in detecting smooth structural breaks and non-linearities in the unemployment data and it is more effective when it comes to the hysteresis effect (Elike et al., 2018).

Based on the unit root tests (ADF, PP, KPSS), the models can be represented as follows:

ADF and PP model:

For levels:

$$\Delta UNEMPL_t = \alpha_0 + \beta_1 UENMPL_{t-1} + \sum_{i=1}^{p} a_i \Delta UNEMPL_{t-1} + \epsilon_t \quad (1)$$

Where: $\Delta UNEMPL_t$ is the first difference of the unemployment rate, α_0 is the intercept, β_1 tests for the presence of a unit root, a_i represents lagged changes in unemployment, p is the number of lags, and ϵ_t is the error term.

For the first difference, the model for ADF becomes:

$$\Delta^2 UNEMPL_t = \alpha_0 + \sum_{i=1}^{p} a_i \Delta^2 UNEMPL_{t-1} + \epsilon_t \quad (2)$$

KPSS model:

$$UNEMPL_t = \alpha_0 + \epsilon_t \quad (3)$$

FADF model:

$$\Delta UNEMPL_t = \alpha_0 + \beta_1 UENMPL_{t-1} + \gamma \cos\left(\frac{2\pi kt}{T}\right) + \delta \sin\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p} a_i \Delta UNEMPL_{t-1} + \epsilon_t \quad (4)$$

Where: k is the frequency of the Fourier component, T is the Sample size, and $\cos\left(\frac{2\pi kt}{T}\right)$ and $\sin\left(\frac{2\pi kt}{T}\right)$ represents the Fourier terms to capture smooth breaks.

The results obtained from the linear and non-linear tests will decide whether the unemployment rate in South Africa follows a mean reversion or process in other words, whether it supports the natural rate hypothesis or shows hysteresis (Raifu & Abodune, 2020). If the nonlinear tests fail to support the unit root hypothesis, it implies mean

reversion and failure of shocks to have a permanent impact. On the other hand, if the null hypothesis of the unit root could not be rejected, the evidence is in support of hysteresis, meaning that economic shocks like the global financial crises will have lasting impacts on unemployment.

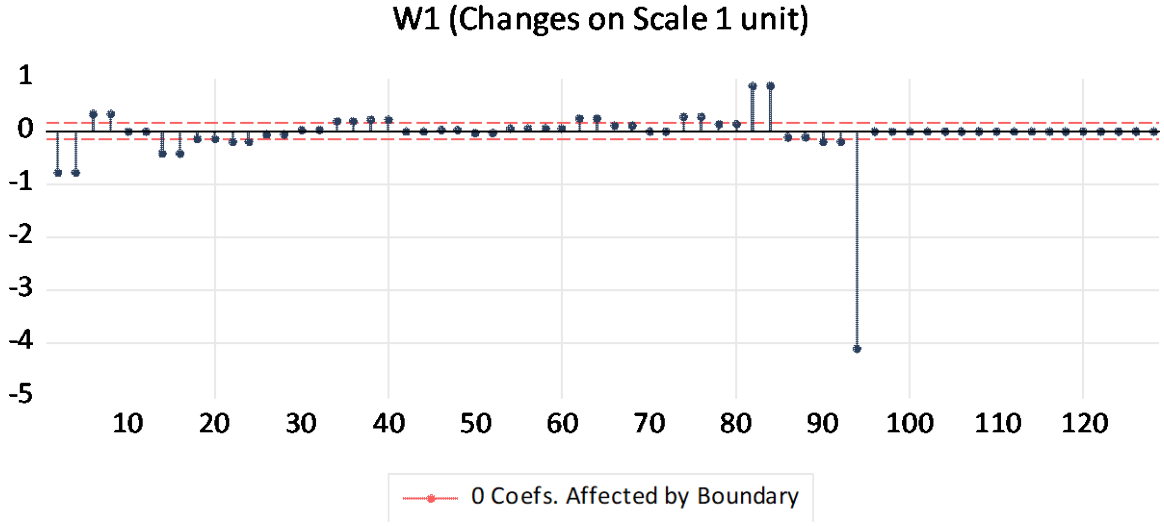
Data

The data used in the study are quarterly secondary time-series data for the period 2000 – 2023. Data for the variable unemployment rate was collected from the World Bank.

Empirical analysis and findings

Results from the Discrete Wavelet Transform (DWT) and the Maximum Overlap DWT (MODWT) Discrete Wavelet Transform (DWT) - Haar wavelet filter

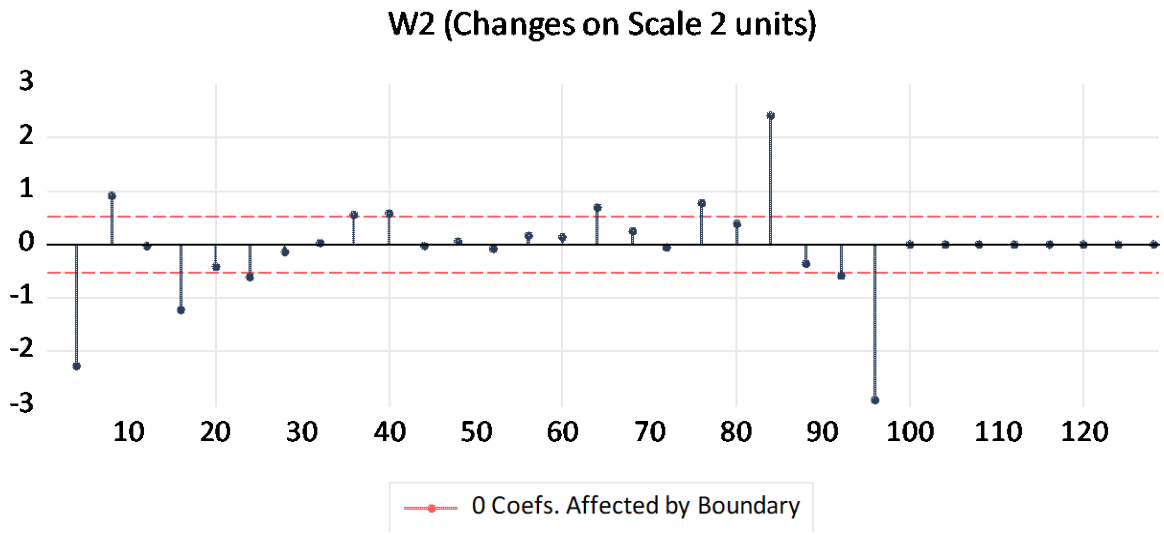
Figure 1. Discrete Wavelet Transform



Source: Author's compilation

From figure 1 above and figure 2 below. The spectra characterizing the wavelet coefficients are significantly less pronounced. This suggest that the unemployment series is possibly non-stationary. Furthermore, the wavelet plot with two dashed red lines shows that the majority of wavelet coefficients at scale 1 and 2 can be discarded. This is further evidence that high frequency forces in the unemployment series are not very pronounced.

Figure 2.

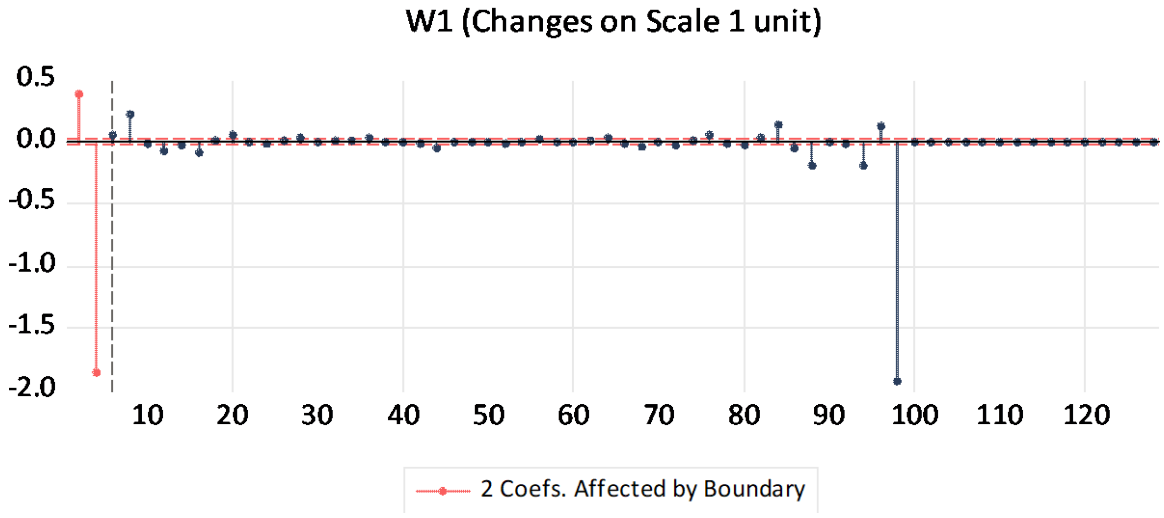


Source: Author's compilation

Discrete Wavelet Transform (DWT) – Daubechies wavelet filter

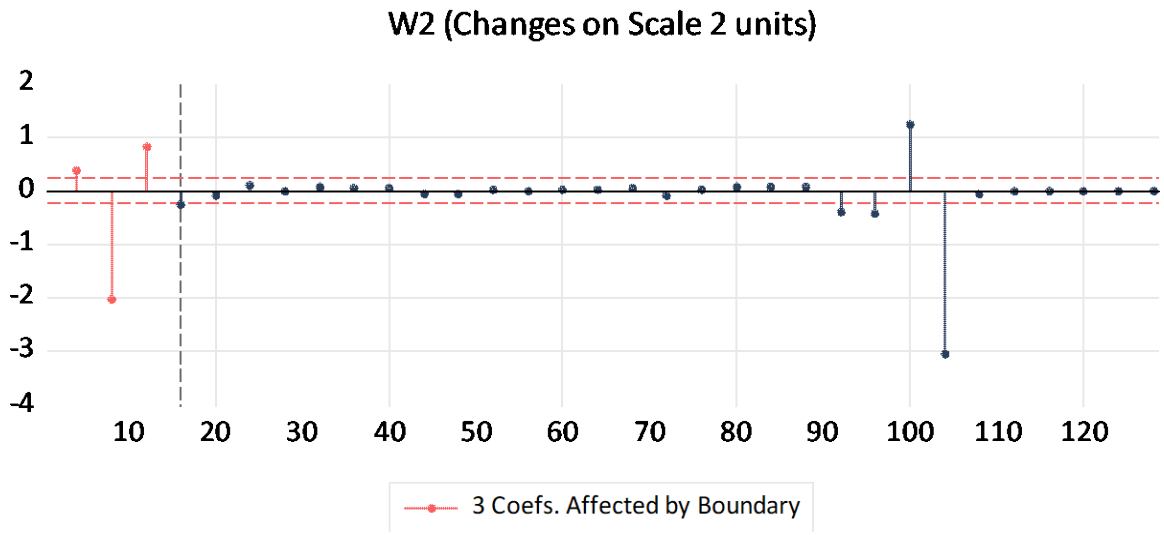
Like figures 1 and 2 above. The results from figures 3 and 4 confirms that the wavelet coefficients are significantly less pronounced. This suggest that the Daubechies wavelet filter suggest that unemployment series is possibly non-stationary as most wavelet coefficients at scale 1 and 2 can be discarded.

Figure 3.



Source: Author's compilation

Figure 4.

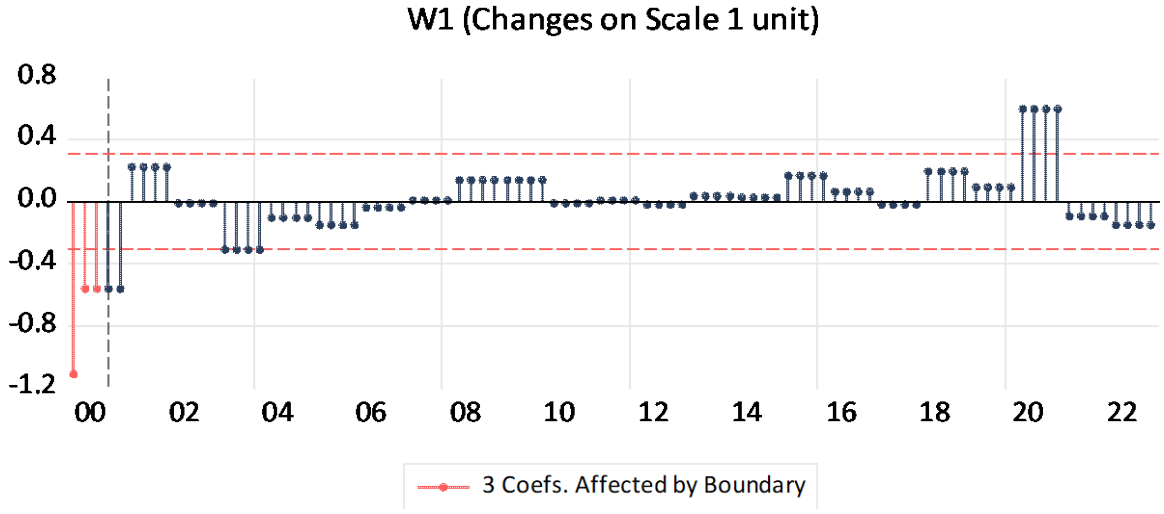


Source: Author's compilation

Maximum Overlap DWT (MODWT) with Haar wavelet filter

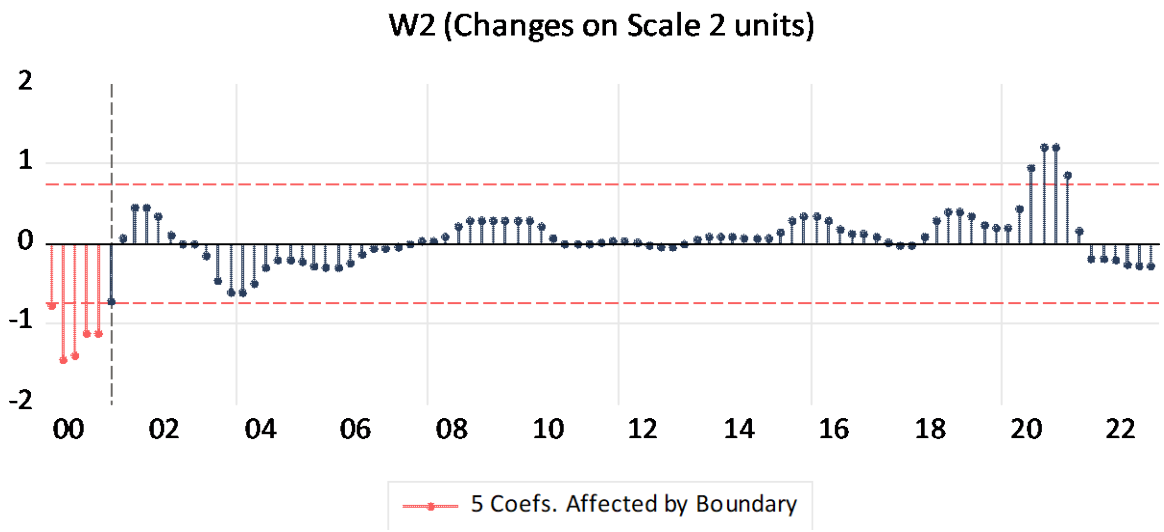
In this case, the results for the two plots were considered for comparison. These are the wavelet coefficients as shown by figures 5 and 6, while the scaling coefficients are presented in figure 7. The findings showed that the high frequency portion which is associated with the wavelet coefficients (figure 5 and 6) are significantly less pronounced. Meaning that the unemployment series is non-stationary, suggesting hysteresis.

Figure 5. Maximum Overlap DWT



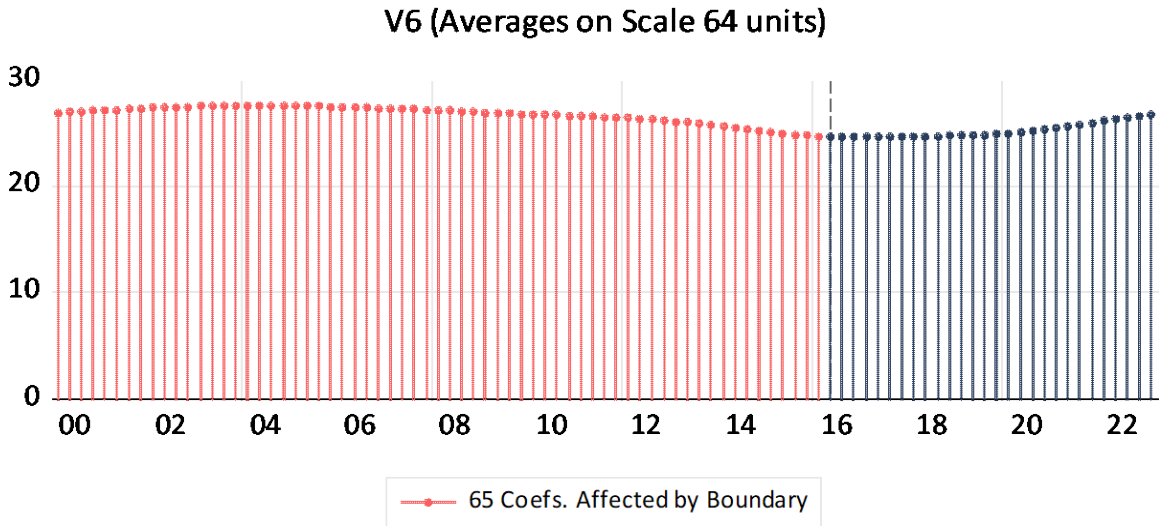
Source: Author's compilation

Figure 6.



Source: Author's compilation

Figure 7.

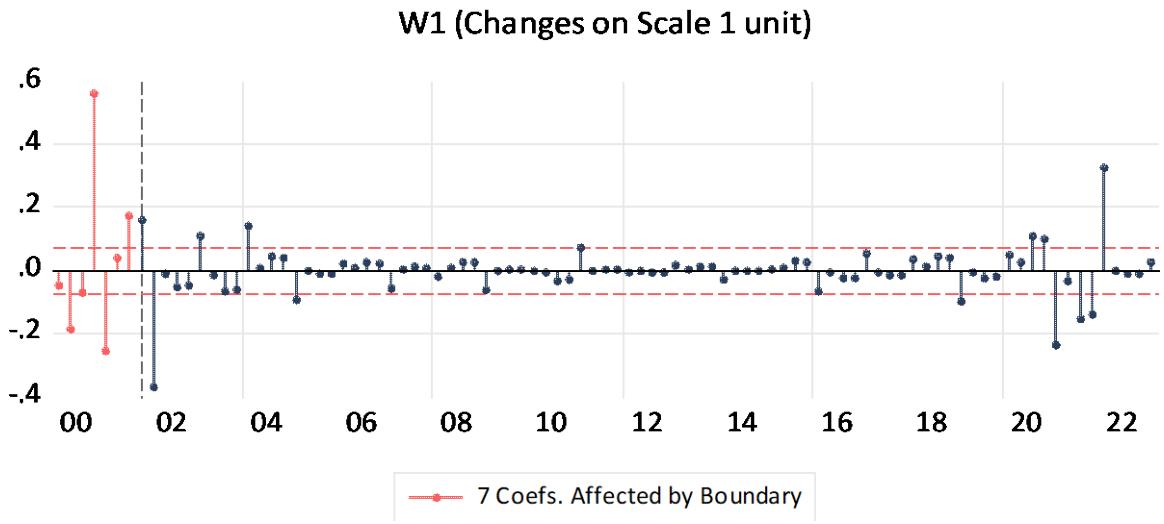


Source: Author's compilation

Maximum Overlap DWT (MODWT) with Daubechies wavelet filter

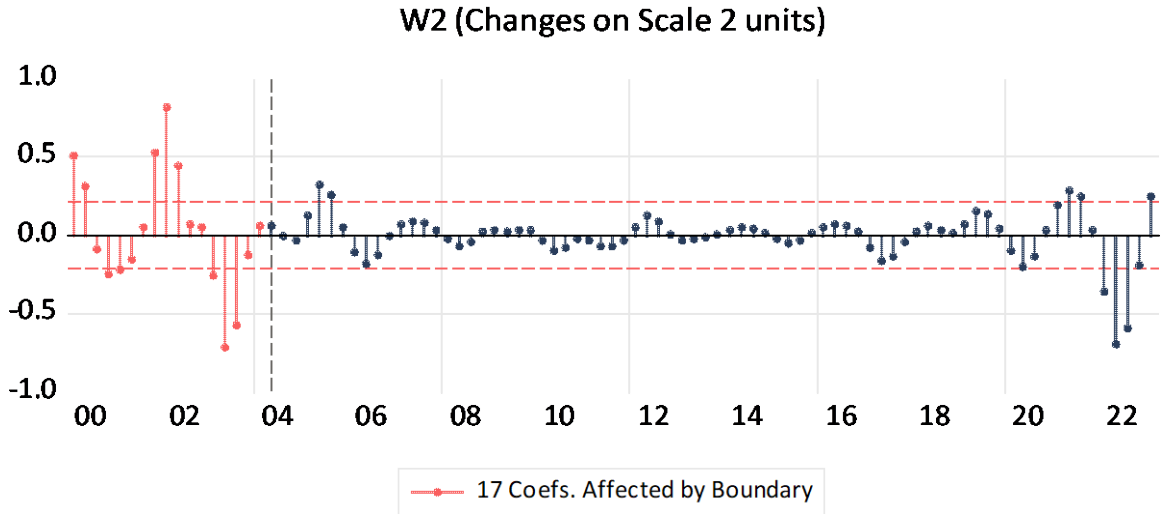
In this instance, the Daubechies wavelet filter was applied. The results are similar to the case where Haar wavelet filter. That is, the wavelet coefficients as shown by figures 8 and 9 are less pronounced than the scaling coefficients (figure 10). This support the earlier findings that the unemployment series is non-stationary, suggesting hysteresis.

Figure 8.



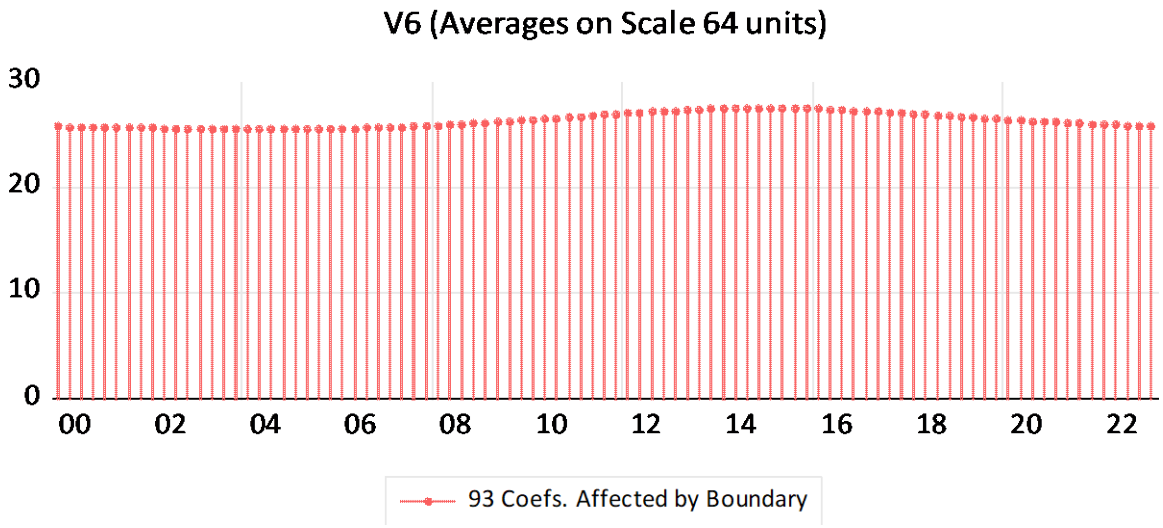
Source: Author's compilation

Figure 9.



Source: Author's compilation

Figure 10. Maximum Overlap DWT (MODWT) with Daubechies wavelet filter



Source: Author's compilation

Stationary tests: ADF, PP, and KPSS

While testing the theory of unemployment hysteresis hypothesis within the South African context from the year 2000 to 2023. The ADF test by Dickey and Fuller (1979), the PP test formulated by Phillips and Perron (1988), and the KPSS test which was formulated by Kwiatkowski, Phillips, Schmidt, and Shin (1992) were applied to assess the stationarity of the variable. The ADF test, PP test, and KPSS test are employed to guarantee the validity of the results. The findings are presented in Table 1, where the variable is tested in both levels and the first differences with two model specifications: intercept only and trend & intercept.

Table 1: Results of Stationary tests (ADF, PP, and KPSS) in levels, and first difference for the variable unemployment

Model Specifications	ADF	PP	KPSS	ADF	PP	KPSS
	Levels	Levels	Levels	1st Diff	1st Diff	1st Diff
Intercept	-1.20	-0.68	0.66***	-3.93**	-4.00**	0.59***
Trend & Intercept	-2.18	-2.59	0.28	-3.86**	-3.97**	0.07**

Source: Author's compilation. Note: *** and ** denote rejection of the null hypothesis at the 1% and 5% significance levels respectively.

From the results presented in Table 1, there is inconclusive evidence on stationarity in the unemployment rate. ADF and PP tests in levels (both intercept and trend & intercept) indicate that the null hypothesis of stationary is accepted, and it is indicative of a non-stationary series that supports hysteresis in unemployment. This is in line with the observations made by Raifu & Abodunde (2020) in Nigeria where linear tests showed hysteresis.

However, when testing in the first differences we have; ADF and PP tests fail to reject the null hypothesis suggesting stationarity. This means that after differencing, unemployment remains fixed, implying that any changes in unemployment persist unless adjusted. The KPSS test, however, accepts the null hypothesis in support of hysteresis meaning that the series has a unit root. In terms of the first differences, all tests indicate that the null hypothesis is soundly rejected, and this confirms that unemployment is stationary after

differencing. This accords with the findings of Kouassi & Sethlare (2018) who for Southern Africa discovered mean reverting unemployment. To account for non-linearities and structural breaks, the FADF model is specified. The findings are presented in Table 2.

Table 2: Fourier ADF test

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.833	0.252	3.306	0.001
UNEMPL(-1)	-0.044	0.012	-3.626	0.000
@TREND	0.006	0.002	3.300	0.001
COS_T	-0.008	0.033	-0.266	0.790
SIN_T	-0.046	0.034	-1.328	0.188
D(UNEMPL(-1))	0.679	0.080	8.438	0.000
D(UNEMPL(-11))	-0.050	0.073	-0.682	0.497

Source: Author's compilation

The findings of the FADF aid in understanding the persistence of unemployment in South Africa over the period 2000Q1 to 2023Q4. The estimation results show that the coefficient of the lagged unemployment variable, UNEMPL(-1), estimate is -0.0445 with t = -3.6266 and P = 0.0005, hence rejecting the null of no effect and implying relevance at the 1% significance level. This result implies that past unemployment rates have a significant negative relationship with the current unemployment rate, which means that shocks could be mean-reverting. In addition, the impulse response displays that there is a positive trend coefficient of 0.0066, with an associated p-value of 0.0015, which shows an ever-rising unemployment in the sample period, suggesting structural issues in the labor market. Nonetheless, the values of estimated coefficients for the trigonometric components COS_T and SIN_T included to capture cyclical patterns, prove to be insignificant, which suggests that cyclical factors do not have a major impact on the persistence of unemployment.

The results from the FADF estimation, especially the UNEMPL(-1) coefficient, partly support the hysteresis hypothesis. The only evidence they can present is that high levels of unemployment may not be permanent and that means reversion occurs occasionally, although the process is long.

These results are consistent with other previous studies that have identified little empirical support for unemployment hysteresis in South Africa using other sophisticated methods including the Fourier ADF test. Kouassi & Sethlare (2018) and Yaya, Ogbonna, and Mudida (2019) noted that only seven out of 42 African nations including South Africa, supported the unemployment hysteresis. This means that their assessment pointed to the fact that shocks to unemployment in many African nations, including South Africa, were mainly temporary. Kouassi and Sethlare (2018) also observed similar lagged effects of unemployment in several Southern African Development Community (SADC) economies, while the panel unit root test indicated that shock persistence may not be permanent in all countries.

On the contrary, previous studies that employed conventional linear tests like Pikoko and Phiri (2019) found hysteresis for most categories of unemployment in South Africa except the older age group. Using their results, they stressed that unemployment in South Africa may be more permanent than tests such as the FADF for non-linear characteristics suggest. The results of this study, however, provide a different perception towards the hysteresis of unemployment incidence; they only imply that it is less of a concern suggesting that policy

measures can go a long way in influencing the level of unemployment over time since shocks are not permanent.

Conclusion

This study examined the unemployment hysteresis hypothesis in South Africa from 2000 to 2023. In this regard, the study employed both linear and nonlinear stationary tests. This includes tests such as the Discrete Wavelet Transform (DWT), the Maximum Overlap Wavelet Transform (MODWT), the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and the Fourier ADF tests. The above findings reveal that the results are a bit 'mixed.' The linear tests present some evidence of stationarity in the first differences pointing to a mean reverting process; however, the Fourier ADF confirms partial hysteresis in South Africa's unemployment from 2000 to 2023. The results indicate that unemployment is nonstationary, so economic shocks, such as the 2008 financial crisis and the COVID-19 pandemic, affects unemployment trends over long time periods. Some mean reversion might take place but the persistent unemployment highlights the structural problems with the labor market. These results stress the need for early, active policy interventions such as labor market reforms and skill development programs to minimize the long-term impacts of such shocks on unemployment. Recommendations for future policies are that the long-term unemployment persistence requires addressed by active measures including skill development programs and labor market reforms.

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