Is it the natural rate or hysteresis hypothesis for unemployment rates in Newly Industrialized Economies?

Nsenga, Dieu and Nach, Mirada and Khobai, Hlalefang and Moyo, Clement and Phiri, Andrew

Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University

18 April 2018

IS IT THE NATURAL RATE OR HYSTERSIS HYPOTHESIS FOR UNEMPLOYMENT RATES IN NEWLY INDUSTRIALIZED ECONOMIES?

D. Nsenga

Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University, Port Elizabeth, South Africa, 6031.

M. Nach

Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University, Port Elizabeth, South Africa, 6031.

H. Khobai

Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University, Port Elizabeth, South Africa, 6031.

C. Moyo

Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University, Port Elizabeth, South Africa, 6031.

And

A. Phiri

Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University, Port Elizabeth, South Africa, 6031.

ABSTRACT: The focus of our study is on determining whether unemployment rates in 8 New Industrialized Economies conform to the natural rate hypothesis or the hysteresis hypothesis. To this end, we employ a variety of unit of unit root testing procedures to quarterly data collected between 2002:q1 and 2017:q1. In summary of our findings, conventional unit root tests which neither account for asymmetries or structural breaks produce the most inconclusive results. On the other hand, tests which incorporate structural breaks whilst ignoring asymmetries tends to favour the natural rate hypothesis for our panel of countries. However, simultaneously accounting for asymmetries and unobserved structural breaks seemingly produces the most robust findings and confirms hysteresis in all unemployment rates except for the Asian economies/countries of Thailand and the Philippines.

Keywords: Natural rate hypothesis; hysteresis hypothesis; Unemployment; unit root tests; Fourier function approximation; Newly Industrialized Economies.

JEL Classification Code: C22; C51; E24; J60.

1. INTRODUCTION

From the Great Depression of the 1930's, to the stagflation period of the 1970's and early 1980's, to the Asian Financial crisis of 2000, to the more recent global financial crisis and recession periods of 2007-2010, the social severity of any major crisis is measurable by the extent to which it impacts unemployment. In the face of a crisis, policymakers commonly rely on fiscal and/or monetary expansionary strategies aimed at stimulating the economy and reducing prevailing unemployment rates. With respect to the recent global crisis, implementing such policies were a success in a few industrialized economies such as the US and Germany but did not suffice in other European countries like Greece, Spain and Italy. Historical trajectories tend to support these occurrences tracing back to Friedman's (1968) contention for the existence of a natural rate of unemployment for the US economy, a situation whereby unemployment reverts back to its 'natural rate' after a shock to the series. On the other hand, Blanchard and Summers (1986) argument for hysteresis in unemployment for other European countries appears to hold since shocks to unemployment in these countries have permanent effects.

The current consensus based on the available empirical literature is that the issue of whether shocks exert transitionary or permanent effects on the unemployment rate can be tested straightforward via the following set of hypotheses:

H_0: Natural rate hypothesis ~ unemployment in a I(0) process
H_A: Hysteresis hypothesis ~ unemployment in a I(1) process

Nevertheless, the empirical testing of the above hypothesis is plagued with a number of technical complexities with respect to econometrically capturing the true data generating process of the unemployment series. In particular, whereas conventional, first generation unit root tests can be commended for providing a convenient platform for directly testing the natural rate versus hysteresis hypothesis, many of these integration tests fail to appropriately account for structural

breaks and asymmetries in the data generating process of the unemployment series. It is well known from the current literature that ignoring either structural breaks or asymmetries will produce low power in the testing for integration properties of a time series (Perron (1989), Kapetanois et al. (2003) and Kruse (2011)).

In order to appropriately address these concerns, our study adopts a flexible Fourier form (FFF) approximation to Kapetanois et al. (2003) nonlinear unit root testing procedure which is applied to 8 Newly Industrialized Economies (i.e. Brazil, China, Mexico, South Africa, Turkey, the Philippines, Malaysia and Thailand) between 2002 and 2017. The FFF methodology comes courtesy as a variant of Galliant (1981) seminal paper on Fourier approximation usage in in capturing the dynamics of an unknown periodic and non-periodic functions and has been more formally ushered into the time series paradigm by Becker et al. (2006), Christopoulos and Leon-Ledesma (2010), Rodriguez and Taylor (2012) and Enders and Lee (2012). Within the econometrics paradigm, flexible Fourier approximation possesses the remarkable ability of capturing a series of smooth structural breaks without a-prior knowledge of the break dates. This is a notable improvement on other 'structural break' unit root tests which cannot test for more than two structural breaks in a series due to concerns of losing testing power. Notably, FFF-based unit root tests have been recently applied with a high degree of success to investigate the integration properties of unemployment rates for various regions (see Cheng et al. (2014) for PIIGS countries; Furoka (2014) for 5 Asian Pacific countries and Bakas and Papapetrou (2014) for 13 Greek regions and Li et al. (2017)), but is yet to be applied to New Industrialized economies as a wider transcontinental-continental group of countries. Our study acknowledges this hiatus and extends on the literature towards these NIE's.

Against this background, the rest of the study is structured as follows. The next section of the paper presents the literature review whereas the third section outlines our empirical methodology. The data and empirical results are presented in section four whilst the study is concluded in section five.

2. REVIEW OF ASSOCIATED LITERATURE

In his celebrated Presidential address in 1968, Milton Friedman formally coined the term "natural rate" of unemployment which refers to the rate of unemployment consistent with a steady rate of inflation (Phelps 1967; Friedman 1968). In describing the encompassing Natural Rate Hypothesis (NRH) also known as the Non-Accelerating Inflation Rate of Unemployment (NAIRU), Friedman (1968, 1977) and Phelps (1967, 1968) propose that natural unemployment is a combination of frictional as well as structural unemployment that is unavoidable in the long run and this natural rate is independent of monetary policy and consequentially inflation i.e. money neutrality. Therefore, according to the Friedman-Phelps synthesis monetary authorities cannot exploit the conventional Phillips (1958) curve trade-off and this served as a plausible explanation for the then paradox of soaring inflation and unemployment experienced during the stagflation periods of the 1970's.

Blanchard and Summers (1986) challenged the natural rate hypothesis by advocating for the concept of 'hysteresis' in which the natural rate can be influenced by the path of actual unemployment. According to the authors, there are two theoretical justifications for the existence of hysteresis in unemployment. The first justification is based on market rigidities. Lindbeck and Snower (1988) support the view that the existence of hysteresis is due to the power of labour unions that keep the equilibrium wage high, and therefore increase unemployment. The second justification for hysteresis is based on the anticipation of inflation in a Phillips Curve approach, whereby downward pressures on inflation lead to sustained high unemployment (Hall, 1979). Overall, under the assumption of hysteresis, cyclical fluctuations exert permanent effects on structural unemployment, in the presence of labour market restrictions (Albulescu and Tiwari, 2018).

In perspective, the issue of whether unemployment adheres to the natural rate hypothesis or to the hysteresis hypothesis boils down to the issue of whether unemployment converges back to it's steady state equilibrium after a transitory shock or whether long lasting unemployment spells arise from cyclical fluctuations. Pragmatically, empirical academics have sought to untangle this puzzle by employing unit root testing procedures, a strategy popularized by the influential seminal contribution of Nelson and Plosser (1982). The decision rule is that the natural rate holds if unemployment rates are mean-reverting whereas the hysteresis hypothesis holds if the series contains a unit root and the empirical works found in the literature can be best categorized according to their methodological influences.

The first group of studies which can be identified from the literature are those which relied on conventional unit root tests such as the ADF, PP, KPSS and DF-GLS (Brunello (1990) for Japan; Mitchell (1993) for 18 OECD countries; Roed (1996) for 16 OECD countries; Song and Wu (1997) for 48 US states; Symth (2003) for Australian states; Leon-Ledesma and McAdam (2004) for 12 CEE countries; Chang et al. (2007) for Taiwan; Mednik et al. (2010) for 13 Latin American countries; Liu et al. (2012) for Australian states; Bakas and Papapetrou (2014) for Greek regions; Marques et al. (2017) for 28 OECD countries). Notably, these conventional unit root tests fell under severe criticism as they failed to account for important structural breaks in the time series. This shortcoming was initially pointed out by Perron (1989) who demonstrated that failure to account for structural breaks leads to a bias against rejecting the null hypothesis in the unit root tests when the null should be rejected.

Henceforth, emerged the second group of studies in the literature which took heed of the arguments posed by Perron (1989), and began implementing unit root tests on the unemployment series which accounted for structural breaks (Zivot and Andrews, 1992; Lee and Strazicich, 2004, 2013). Some prominent studies which fall under this category of studies are the works of Song and Wu (1998), Gomes and daSilva (2008) for Brazil and Chile; Cuestas et al. for 8 CEE countries; Ayala et al. (2012) for 18 Latin American countries; and Garcia-Cintado et al. (2015) for Spanish

regions. Nonetheless, the unit root tests accounting for structural breaks could not explain intermediate theories of unemployment such as the persistence theory of Hall (1975) as well as the structuralist hypothesis of Phelps (1994) which argued that the movements in the unemployment rate are movements around the natural rate and that an increase in unemployment is the result of a combination of constant shocks whose speed of adjustment varies.

Ultimately, these intermediate theories characterize unemployment rate as a non-linear process which is stationary around an occasionally changing natural rate. Henceforth, these hypotheses could only be faithfully accounted for by either using fractional integrated or nonlinear unit testing procedure since conventional unit root tests suffer from low power properties in the presence of existing asymmetries (Lanzafame, (2009) and Bahmani-Oskooee et al. (2018)). This has led to a third and more recent group of 'nonlinear' studies which can be further sub-divided into two sub-groups. Under the first sub-group are studies which employ nonlinear unit root tests which do not account for structural breaks. In this regard, one of the most popular asymmetric unit root test found in the literature comes courtesy of Kapetanois et al. (2003), Ucar and Omay (2009) and Kruse (2011) and has been extensively applied in the works of Gustavsson and Osterholm (2006) for 5 EU countries; Yilanci (2008) for 19 OECD countries; and Lee (2010) for 29 OECD countries. Nevertheless, these nonlinear tests have proven to be unreliable in capturing structural breaks, which has led to the second sub-group of studies which augment the unit root testing procedures with flexible Fourier form (FFF). Belonging to this later group of studies are the works of Chang (2011) for 17 OECD countries; Cheng et al. (2014) for PIIGS countries; Furuoka (2014) for 5 Asian-Pacific countries; Bolat et al. (2014) for 17 Eurozone countries; Bakas and Papapetrou (2014) for 13 Greek regions; Furuoka (2017) for 5 EU countries and Meng et al. (2017) for 14 OECD countries; and Li et al. (2017) for PIIGS countries. Our current study extends on these recent works for the case of Newly Industrialized Economies.

3. METHODOLOGY

3.1 KSS nonlinear unit root test

We begin our analysis in pursuit of Kapetanois et al. (2003), and assume that the unemployment rate, which we denoted as $UNEMP_t$, evolves as the following ESTAR data generating process:

$$\Delta UNEMP_t = \phi_i UNEMP_{t-1} + \gamma_i UNEMP_{t-1}[1 - \exp(-\Phi UNEMP_{t-d}^2)] + e_t \quad (1)$$

Where $e_t \sim iid(0, \sigma^2)$ and Φ is a smoothness parameter. Following Kapetanois et al. (2003) we assume that $\phi_i = 0$ and d=1 i.e.

$$\Delta UNEMP_t = \gamma_i UNEMP_{t-1}[1 - \exp(-\Phi UNEMP_{t-1}^2)] + e_t \quad (2)$$

In which the series is assumed to be globally stationary if the condition $-2 < \gamma < 0$ is satisfied. Nevertheless, the unit root hypothesis can be formally tested as H_0: $\Phi = 0$, and yet testing this hypothesis is problematic due to the unidentified, nuisance parameters existing under the alternative hypothesis (Davies, 1987). To circumvent this problem, a first order-order Taylor series approximation to equation (2) around $\Phi = 0$ resulting in the following auxiliary regression:

$$\Delta UNEMP_t = \delta_i UNEMP_{t-i}^3 + e_t \quad (3)$$

And in augmenting equation (3) with lags for correction of serial correlation in the disturbance term, we obtain:

$$\Delta UNEMP_t = \delta_i UNEMP_{t-i}^3 + \sum_{j=1}^{p} \rho_i \Delta UNEMP_{t-i} + e_t \quad (4)$$

The null hypothesis of a linear unit root process can be now tested as H_0: $\delta_i = 0$ against the alternative of stationary ESTAR process (i.e. H_1: $\delta_i = 0$). In similarity to the conventional ADF test, the asymptotic critical value of the Kapetanios et al. (2003) unit root test is computed as:

$$t_{KSS} = \frac{\widehat{\beta}}{\sqrt{\widehat{var}(\widehat{\beta})}} = \frac{\sum_{t=1}^{T} y_{t-1}^{3} \Delta y_t}{\sqrt{\widehat{\sigma^2} \sum_{t=1}^{T} y_{t-1}^{6}}} \quad (5)$$

Note that the t_{KSS} statistic does not follow an asymptotic standard normal distribution, and hence Kapetanios et al. (2003) tabulate the relevant critical values.

3.2 Flexible Fourier form (FFF) augmented tests

A major criticism with the testing procedure of Kapetanois et al. (2003) surrounds its failure to appropriately capture structural breaks in the testing procedure. The seminal papers of Becker et al. (2006), Christopoulos and Leon-Ledesma (2010), Rodriguez and Taylor (2012) and Enders and Lee (2012) develop unit root testing procedures which uses selected frequency component of a Fourier function to estimate the deterministic components of the series. Denoting α(t) as a function with an unknown number of unspecified form, the Fourier approximation to function produces the following series:

$$\alpha(t) = \alpha_o + a_i \sum_{k=1}^{n} \sin\left(\frac{2\pi K t}{T}\right) + b_i \sum_{k=1}^{n} \cos\left(\frac{2\pi K t}{T}\right) + \zeta_t, \quad n < \frac{T}{2} \quad (6)$$

Whereas k is the frequency selected for the approximation and n denotes the number of frequencies, which as suggested by Becker et al. (2006) and Enders and Lee (2012) should be kept at kept to a single-frequency component (i.e. n = 1) which is sufficient to capture a series of smooth structural breaks and circumvent the problem of over-fitting and loss of regression power. i.e.

$$\alpha(t) = \alpha_o + a_i \sin\left(\frac{2\pi Kt}{T}\right) + b_i cos(\frac{2\pi Kt}{T}) + \zeta_t, \quad (7)$$

And in augmenting the nonlinear unit root testing regression (4) with equation (7) results in:

$$\Delta UNEMP_t = \delta_i UNEMP_{t-i}^3 + \sum_{j=1}^{p} \rho_i \Delta UNEMP_{t-i} + a_i \sin\left(\frac{2\pi Kt}{T}\right) + b_i cos(\frac{2\pi Kt}{T}) + \zeta_t, \quad (8)$$

Becker et al. (2006), Christopoulos and Leon-Ledesma (2010), Rodriguez and Taylor (2012) and Enders and Lee (2012) commonly suggest that regression (8) be estimated after conducting a grid search in optimal values of $K \in [1, 5]$ and lag length, p. As before, the test statistic testing the null hypothesis of a unit root (i.e. H_0: $\delta_i = 0$) is derived using equation (5).

4. DATA AND EMPIRICAL RESULTS

4.1 Data description

The data used in our empirical study has been retrieved from the International Monetary Fund (IMF) online statistics and consists of the total unemployment rate for 8 NIE economies (i.e. Brazil, China, Mexico, South Africa, Turkey, the Philippines, Malaysia and Thailand) has been collected on a quarterly basis spanning from 2002:q1 to 2017:q1. The descriptive statistics of the time series are reported in Table 1 whereas the associated time series plots are presented in Figure 1.

As can be easily noted, the lowest unemployment rates for all NIE countries is found for Thailand (1.34%) followed by Malaysia (3.32%), China (4.10%), Mexico (4.12%), the Philippines (8.02%), Brazil (8.63%), Turkey (10.10%) whilst the highest unemployment averages are for South Africa (25.23%). Based on the reported standard deviations, we find the highest volatile

unemployment rates in Brazil (2.76) followed by South Africa (2.06), the Philippines (2.04), Turkey (1.43), Mexico (0.81), Thailand (0.48), Malaysia and the lowest volatility being found in China (0.12). Lastly, we note that a number of unemployment rates display non-normality for China, Turkey, the Philippines and Thailand, an observation will advocates for preliminary signs of asymmetries within the unemployment series of Newly Industrialized Economies.

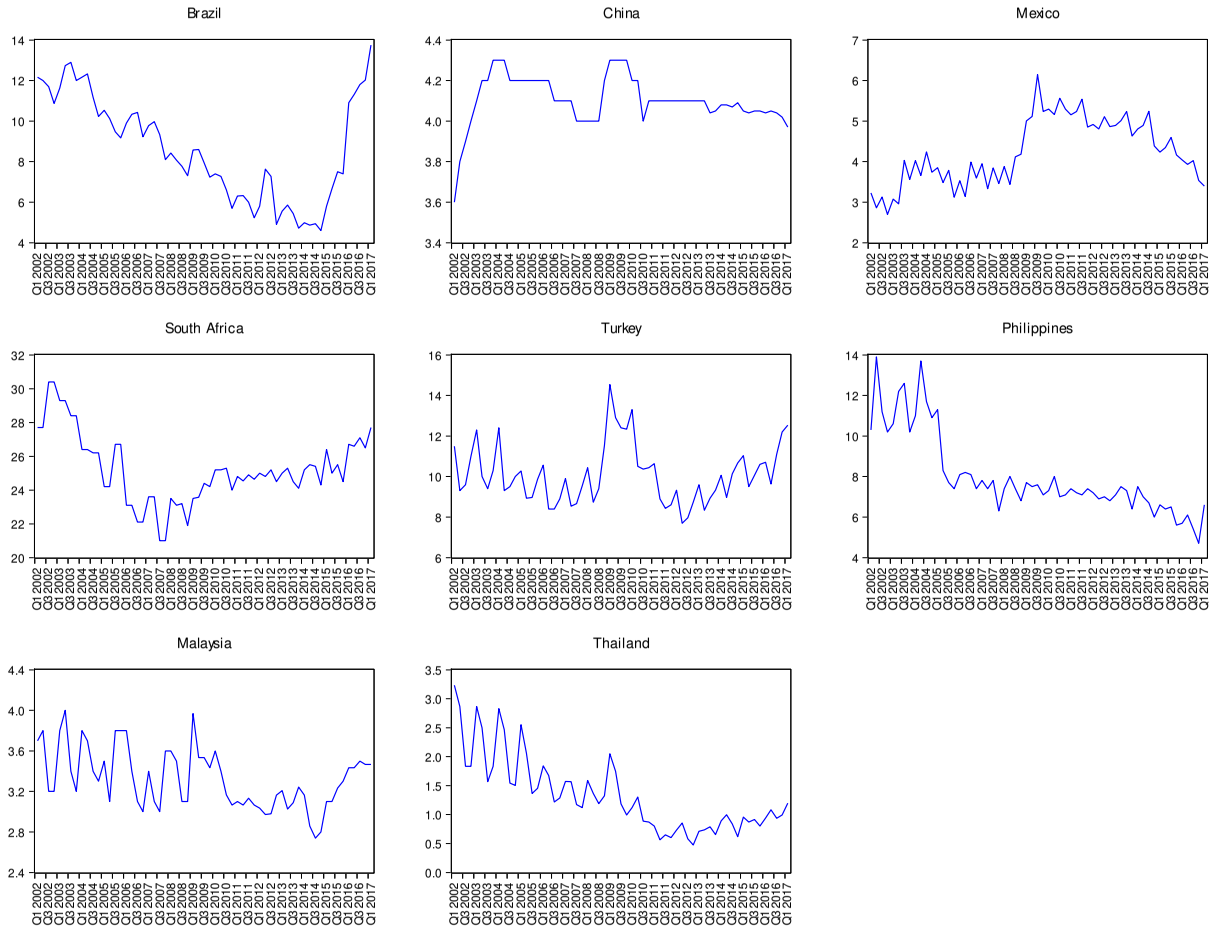
In terms of continental distribution African and South American countries (South Africa and Brazil) have highest and most volatile unemployment rates whereas North American (Mexico) and Asian countries (China, Philippines, Malaysia and Thailand) have the lowest and least volatile unemployment rates with Euro-Asian (Turkey) being intermediate. Judging by the report J-B statistics, unemployment in Asian and Euro-Asian countries are non-normal, an observation which advocates for preliminary signs of asymmetries existing within the observed unemployment series.

Table 1: Descriptive statistics

	Brazil	China	Mexico	South Africa	Turkey	Philippines	Malaysia	Thailand
Mean	8.63	4.10	4.24	25.23	10.10	8.02	3.32	1.34
Median	8.42	4.10	4.12	25.00	9.90	7.40	3.24	1.18
Maximum	13.75	4.30	6.15	30.40	14.53	13.90	4.00	3.23
Minimum	4.60	3.60	2.69	21.00	7.70	4.70	2.74	0.48
Std. dev.	2.76	0.12	0.81	2.06	1.43	2.04	0.30	0.65
Skewness	0.11	-1.01	0.11	0.44	0.85	1.26	0.38	1.10
Kurtosis	1.80	6.42	2.06	3.24	3.41	3.91	2.36	3.57
Jarque-bera	3.81	39.99	2.39	2.13	7.80	18.36	2.53	13.14
Prob.	0.15	0.00	0.30	0.34	0.02	0.00	0.28	0.00
Observations	61	61	61	61	61	61	61	61

Notes: Authors Own computation

Figure 1: Time series plots of unemployment rates for 8 NIE's



4.2 First generation unit root test

Our initially empirical analysis involves the testing of the integration properties for the unemployment in the 8 NIE's using the ADF, PP, DF-GLS and KPSS. Whereas the ADF, PP and DF-GLS test the null of a unit root against the alternative of a stationary process, the KPSS tests the stationary null against the alternative of a unit root. Moreover, the ADF and DF-GLS critically depend on the number of appropriate lags include in the test regression, which in our analysis is determined through the AIC and SC information criterion. The findings of these tests performed with an intercept and a trend are respectively reported in Panels A and B of Table 2.

As can be observed from Panel A, when an intercept is used, the KPSS detects a unit root for Brazil (5%), Mexico (5%), Philippines (1%), Malaysia (5%) and Thailand (1%) whereas when the ADF and PP test are used with an intercept then the unit root null is rejected for China, Turkey, Malaysia and Thailand at all critical levels whilst the DF-GLS test finds stationarity for Brazil (10%), Mexico (10%), South Africa (10%), Turkey (10%), Philippines (10%) and Malaysia (1%). From Panel B, when trend is included in the KPSS test, all countries fail to reject the stationary null hypothesis. However, the ADF and PP test mutually reject the unit root null hypothesis for China (1%), Turkey (5%), Philippines (5%), whilst the PP exclusively does so for the Malaysia (1%) and Thailand (1%) as well as the DF-GLS test for Philippines (1%) and Malaysia (1%). Nevertheless, the inconclusiveness of these unit root tests in distinguishing between the natural rate and the hysteresis hypothesis for the 8 NIE's is unsurprising considering that the employed integration tests do not account for important structural breaks in the data, mainly attributed to the different global crisis experienced within the timeframe of the data (i.e. Asian financial crisis (1998-1999), global financial crisis (2007-2008), Sovereign Euro debt crisis (2010))

Table 2: Conventional unit root test results

	Panel A: Intercept				Panel B: Trend			
	H_0: stationary	H_0: unit root	H_0: unit root	H_0: unit root	H_0: stationary	H_0: unit root	H_0: unit root	H_0: unit root
	KPSS	ADF	PP	DF-GLS	KPSS	ADF	PP	DF-GLS
Brazil	0.50**	-1.85 [4]	-1.02	-1.66* [4]	0.19	-0.90 [4]	1.43	-1.94 [4]
China	0.14	-4.61*** [0]	-4.46***	-1.02 [0]	0.10	-5.30*** [0]	-5.01***	-1.58 [0]
Mexico	0.49**	-2.26 [4]	-2.24	-1.63* [4]	0.20	-1.46 [4]	-2.23	-1.90 [4]
South Africa	0.23	-2.27 [0]	-2.15	-1.86* [0]	0.20	-1.61 [3]	-1.77	-2.04 [0]
Turkey	0.07	-3.96*** [8]	-3.68***	-1.71* [9]	0.07	-3.83** [8]	-3.64**	-2.22 [9]
Philippines	0.77***	-2.21 [0]	-1.86	-1.76* [0]	0.18	-3.87** [0]	-3.81**	-3.88*** [0]
Malaysia	0.63**	-4.27*** [0]	-4.22***	-3.36*** [0]	0.11	-4.69*** [0]	-4.67***	-4.68*** [0]
Thailand	0.95***	-2.08 [4]	-3.55***	0.06 [4]	0.24	-0.06 [3]	-5.00***	-0.62 [4]
Critical values								
1%	0.74	-3.55	-3.54	-2.61	0.22	-4.13	-4.12	-3.75
5%	0.46	-2.91	-2.91	-1.95	0.15	-3.49	.3.49	-3.17
10%	0.35	-2.60	-2.59	-1.61	0.12	-3.17	-3.17	-2.87

Notes: Optimal lag length of ADF and DF-GLS tests reported in brackets [].

4.3 Second generation unit root tests

The so-called second-generation tests of Lee and Strazicich (2004, 2013) develop on the influential works of Perron (1989), Zivot and Andrews (1992) and Lumsdaine and Papell (1997) who initially criticized conventional unit root tests on the premise of ignoring structural breaks in the testing procedure which then heightens the possibility of accepting the unit root hypothesis when the alternative stationary hypothesis is true. Lee and Strazicich (2004, 2013) particularly

contributed to the paradigm by accounting for 'breaks' under both the unit root null hypothesis as well as in the stationary alternative as opposed to testing the unit root null against the alternative of structural breaks of which the alternative hypothesis could either be structural breaks with unit root or structural breaks with stationarity. The authors thus propose endogenous minimum Lagrange Multiplies (LM) testing procedures which are invariant to breakpoint nuisances and these tests can account for single (Lee and Strazicich, 2004) or double (Lee and Strazicich, 2004) structural breaks.

We apply two variations of these models to our empirical data, the first being the 'crash' model which allows for a one-time change in level, whilst the second is the 'break' model which allows for a change in level and trend slope. The results of the 'crash' and 'break' model unit root tests for the NIE economies are reported Tables 3 and 4, respectively. Starting with the results from the crash model as found in Table 3, Panel A and B respectively report the findings of the single-break and double-break tests mutually rejects the unit root hypothesis in support of the natural rate hypothesis for South Africa (5%), Turkey (1%), Philippines (1%) and Malaysia (1%) whilst accepting the hysteresis hypothesis for Brazil, China, Mexico and Thailand.

However, the unanimity for results is not observed for the break model as the single-break version as found in Panel A of Table 4 rejects the hysteresis hypothesis in favour of the natural rate for all countries (Brazil (1%), China (10%), Mexico (5%), South Africa (1%), Turkey (5%), Philippines (1%) and Malaysia (1%) with the sole exception of Thailand. On the other end of the spectrum, the double-break tests found in Panel B of Table 4 only rejects the hysteresis hypothesis for Brazil (1%), China (5%), South Africa (1%), Turkey (5%), the Philippines (1%) and Malaysia (1%). Based on an overall summary of these second generation tests we conclude that all performed tests mutually reject the hysteresis hypothesis only for South Africa, Turkey, the Philippines and Malaysia and yet consistently rejects the natural rate hypothesis for Thailand.

Table 3: LS unit root test results: “Crash” model

Country	Panel A: LS (one break)		Panel B: LS (double breaks)		
	Minimum LM-stat	Break	Minimum LM-stat	break1	break2
Brazil	-2.87 [7]	2003:q1	-2.85 [7]	2013:q1	2014:q2
China	-1.31 [2]	2006:q2	-1.59 [7]	2010:q2	2013:q2
Mexico	-2.49 [8]	2006:q2	-2.97 [8]	2006:q2	2007:q4
South Africa	-3.72** [4]	2005:q4	-5.36*** [5]	2004:q4	2005:q4
Turkey	-5.47*** [8]	2009:q1	-5.50*** [8]	2005:q1	2013:q3
Philippines	-4.12*** [8]	2004:q2	-4.07** [8]	2003:q3	2007:q3
Malaysia	-5.96*** [1]	2014:q4	-6.47*** [1]	2010:q2	2014:q4
Thailand	-1.96 [8]	2007:q2	-2.28 [8]	2007:q4	2008:q4
Critical values					
1%	-4.08		-4.07		
5%	-3.49		-3.56		
10%	-3.19		-3.30		

Notes: “***”, “**”,”*” denote the 1%, 5% and 10% critical levels, respectively. Optimal lag length of LS tests reported in brackets [].

Table 4: LS unit root test results: “Break” model

Country	Panel A: LS (one break)		Panel B: LS (two breaks)		
	Minimum LM-stat	Break	Minimum LM-stat	break1	break2
Brazil	-7.17*** [4]	2013:q4	-8,38*** [4]	2013:q4	2014:q4
China	-4.08* [4]	2005:q1	-5.12** [4]	2010:q1	2013:q3
Mexico	-4.58** [4]	2008:q4	-3.43 [4]	2004:q1	2007:q4
South Africa	-4.96*** [6]	2006:q1	-5.68*** [4]	2007:q2	2010:q4
Turkey	-4.32** [4]	2014:q1	-4.96** [4]	2009:q1	2014:q3
Philippines	-4.81*** [6]	2006:q2	-6.24** [6]	2008:q1	2011:q2
Malaysia	-6.65*** [1]	2015:q2	-8.67*** [1]	2004:q4	2005:q4
Thailand	-2.80 [5]	2008:q1	-3.69 [5]	2008:q1	2010:q3
Critical values					
1%	-4.24		-5.15		
5%	-3.57		-4.51		
10%	-3.21		-4.21		

Notes: “***”, “**”,”*” denote the 1%, 5% and 10% critical levels, respectively. Optimal lag length of LS tests reported in brackets [].

4.4 Nonlinear and flexible Fourier function-based unit root tests

The unit root tests present thus far have not addressed the issue of possible asymmetries dictating the evolution of the time series. In this section of the paper we present the findings of the KSS nonlinear unit root tests performed without a FFF and without a FFF and the findings from this empirical exercise are presented in Tables 1 and 2, respectively. To recall, FFF approximation is a low frequency component which captures a number of smooth breaks without requiring prior knowledge of the structural break dates. So whilst nonlinearity may be an important consideration

in determining the integration properties of the unemployment time series, the inclusion of the FFF approximation strengthens the reliability of the nonlinear test by accounting for unobserved structural breaks.

For control purposes, we begin our analysis by focusing on the KSS test performed without a FFF approximation as found in Table 5. The results point to the hysteresis hypothesis being rejected for only the Philippines (10%) and Thailand (1%) whilst for the remaining economies Brazil, China, Mexico, South Africa, Turkey and Malaysia, the hysteresis hypothesis hold. Moreover, similar results are obtained when the FFF approximation is included in the test regression, with the slight exception that the hysteresis hypothesis is mutually rejected at a 5 percent critical level for both the Philippines and Thailand. Collectively, these results emphasize the importance of simultaneously account for nonlinearities and unobserved structural breaks when testing the integration properties of the unemployment series.

Table 5: KSS unit root test without FFF

Country	KSS Stat	Optimal lag	AIC	SC
Brazil	-1.08	5	2.285	2.505
China	-0.37	2	-2.898	-2.791
Mexico	-0.75	6	0.411	0.669
South Africa	-0.88	4	2.999	3.180
Turkey	-0.55	5	2.320	2.539
Philippine	-2.07*	2	2.488	2.595
Malaysia	-0.29	3	0.087	0.230
Thailand	-2.46***	4	-0.409	-0.229
Critical values				
1%	-2.82			
5%	-2.22			
10%	-1.92			

The optimal lag lengths for the tests are based on minimization of AIC and SC information criterion. Optimal frequency approximation, K*, is selected via a minimization of the SSR. The critical values associated with KSS tests are derived from Kapetanois et al. (2003).

Table 6: KSS unit root test with FFF

Country	KSS stat	Optimal lag	K*	SSR
Brazil	-0.37	6	5	21.990
China	-0.33	6	3	0.132
Mexico	-0.989	6	1	3.212
South Africa	-0.436	6	2	44.928
Turkey	-0.19	6	2	22.844
Philippine	-2.57**	6	3	28.494
Malaysia	-0.81	6	4	2.450
Thailand	-2.38**	6	3	1.529
Critical values				
1%	-2.82			
5%	-2.22			
10%	-1.92			

The optimal lag lengths for the tests are based on minimization of AIC and SC information criterion. Optimal frequency approximation, K*, is selected via a minimization of the SSR. The critical values associated with KSS tests are derived from Kapetanois et al. (2003).

5. CONCLUSION

Using quarterly data collected between 2002:q1 and 2017:q1, this study sought to determine whether unemployment rates in 8 Newly Industrialized Economies (countries) adhere to the natural rate or the hysteresis hypothesis. We consider our empirical exercise important since the advent of the most recent sub-prime crisis and the ensuing global recession periods, has crippled the global economy with increased unemployment rates being the yardstick measure of the social repercussions of the of the global downturn. The crisis itself poses as an econometric challenge as techniques which account such structural breaks must be utilized in order to overcome problems of low testing power in detecting possible unit root patterns.

Our study bypasses conventional structural unit root testing procedures which can only account for a maximum of two known structural breaks and relies on unit root testing procedures which simultaneously account for a series of unobserved structural breaks as well as possible asymmetries. However, a preliminary exercise we firstly perform a variety of unit root test which ignore structural breaks and others which endogenously account for either one or two structural breaks. These preliminaries provide mixed inferences with the endogenous structural break tests more-or-less pointing to the natural rate hypothesis in most countries. However, when the more rigorous tests which account for asymmetries and unobserved structural breaks, the unemployment in most Newly Industrialized Economies conform to the hysteresis hypothesis, with the sole exception of two Asian countries, Thailand and the Philippines, whose unemployment rates are fount to be mean stationary. It would therefore be advised that policymakers in the remaining countries should direct efforts towards labour markets reforms aimed at reducing unemployment rates.

REFERENCES

Albulescu C. and Tiwari A. (2018), "Unemployment hysteresis in EU countries: New evidence using bounded unit root tests", *Applied Economic Letters*, 25(12), 807-810.

Ayala A., Cunado J. and Gil-Alana L. (2012), "Unemployment hysteresis: Empirical evidence for Latin America", *Journal of Applied Economics*, 15(2), 213-233.

Bahmani-Oskooee M., Chang T. and Ranjbar O. (2018), "Testing hysteresis effect in U.S. state unemployment: New evidence using a nonlinear quantile unit root test", *Applied Economics Letters*, 25(4), 249-253.

Bakas D. and Papapetrou E. (2014), "Unemployment in Greece: Evidence from Greek regions using panel unit root tests", *The Quarterly Review of Economic and Finance*, 54(4), 551-562.

Becker R., Enders W. and Lee J. (2006), "A stationarity test in the presence of an unknown number of smooth breaks", *Journal of Time Series Analysis*, 27(3), 381-409.

Blanchard O. and Summers L. (1986), "Hysteresis and the European unemployment problem", NBER Macroeconomic Annual, Volume 1, MIT Press, Cambridge.

Bolat S., Tiwari A. and Erdayi A. (2014), "Unemployment hysteresis in the Eurozone are: evidences from nonlinear heterogeneous panel unit root test", *Applied Economics Letters*, 21(8), 536-540.

Brunello G. (1990), "Hysteresis and 'the Japanese unemployment problem': A preliminary investigation", *Oxford Economic Papers*, 42, 483-500.

Chang T., Yang M., Liao H. and Lee C. (2007), "Hysteresis in unemployment: Evidence from Taiwan's region data based on panel unit root tests", *Applied Economics*, 39(10), 1335-1340.

Cheng S., Wu T., Lee K. and Chang T. (2014), "Flexible Fourier unit root test on unemployment for PIIGS countries", *Economic Modelling*, 36(C), 142-148.

Christopoulos D. and Leon-Ledesma M. (2010), "Smooth breaks and non-linear mean reversion: Post-Bretton Woods real exchange rates", *Journal of International Money and Finance*, 29(6), 1076-1093.

Cuestas J., Gil-Alana L. and Staehr K. (2011), "A further investigation of unemployment persistence in European transition economies", *Journal of Comparative Ec*onomics, 39(4), 514-532.

Davies R. (1987), “hypothesis testing when a nuisance parameter is present only under the alternative”, *Biometrika*, 74(1), 33-43.

Enders W. and Lee J. (2012), “The flexible Fourier form and Dickey-Fuller type unit root tests”, *Economic Letters*, 117, 196-199.

Friedman M. (1968), “The role of monetary policy”, *American Economic Review*, 58(1), 213-217.

Friedman M. (1977), “Nobel lecture: Inflation and unemployment”, *The Journal of Political Economy*, 85(3), 451-472.

Furoka F. (2014), “Are unemployment rates stationary in Asia-Pacific countries? New findings from Fourier ADF test”, *Economic Research-Ekonomska Istrazivanja*, 27(1), 34-45.

Furoka F. (2017), “A new test for analysis hysteresis in European unemployment”, *Applied Economic Letters*, 24(15), 1102-1106.

Galliant R. (1981), “On the basis in flexible functional form and an essentially unbiased form: the flexible Fourier form”, *Journal of Econometrics*, 15(2), 211-245.

Garcia-Cintado A., Romero-Avila D. and Usabiaga C. (2015), “Can the hysteresis hypothesis in Spanish regional unemployment be beaten? New evidence from unit root tests with breaks”, *Economic Modelling*, 47, 244-252.

Gomes F. and da Silva C. (2008), “Hysteresis vs natural rate of unemployment in Brazil and Chile”, *Applied Economic Letters*, 15(1), 53-56.

Gustavsson M. and Osterholm P. (2006), "Hysteresis and non-linearities in unemployment rates", *Applied Economics Letters*, 13(9), 545-548.

Hall R. (1979), "A theory of the natural unemployment rate and the duration of unemployment", *Journal of Monetary Economics*, 5, 153-170.

Kapetanios G., Shin Y. and Snell A. (2003), "Testing for a unit root in the nonlinear STAR framework", *Journal of Econometrics*, 112(2), 359-379.

Kruse R. (2009), "A new unit root test against ESTAR based on a class of modified statistics", *Statistical Papers*, 52(1), 71-85.

Lanzafame M. (2010), "The nature of regional unemployment in Italy", *Empirical Economics*, 39, 877-895.

Lee C. (2010), "Testing for unemployment hysteresis in nonlinear heterogeneous panels: International evidence", *Economic Modelling*, 27(5), 1097-1102.

Lee J. and Strazicich M. (2004), "Minimum Lagrange multiplier unit root with two structural breaks", *The Review of Economics and Statistics*, 85(4), 1082-1089.

Lee J. and Strazicich M. (2013), "Minimum LM unit root with one structural break", *Economics Bulletin*, 33(4), 2483-2493.

Leon-Ledesma M. and McAdam P. (2004), "Unemployment, hysteresis and transition", *Scottish Journal of Political Economy*, 51(3), 377-401.

Li J., Ranjbar O. and Chang T. (2017), "Unemployment hysteresis n PIIGS countries: A new test with both sharp and smooth breaks", *The Singapore Economic Review*, 62(5), 1165-177.

Lindbeck A. and Snower D. (1988), "Cooperation, harassment, and involuntary unemployment: An insider-outside appraoch", *America Economic Review*, 78(1), 167-188.

Liu D., Sun C. and Lin P. (2012), "Hysteresis hypothesis in unemployment and labour force participation rates: Evidence from Australian states and territories", *Australian Economic Papers*, 51(2), 71-84.

Lumsdaine R. and Papell D. (1997), "Multiple trend breaks and the unit-root hypothesis", *Review of Economics and Statistics*, 79(2), 212-218.

Marques A., Lima G. and Troster V. (2017), "Unemployment persistence in OECD countries after the Great Recession", *Economic Modelling*, 64, 105-116.

Mednik M., Rodriguez C. and Ruprah I. (2012), "Hysteresis in unemployment: Evidence from Latin America", *Journal of International Development*, 24(4), 448-466.

Meng M., Strazicich M. and Lee J. (2017), "Hysteresis in unemployment? Evidence from linear nonlinear unit root tests and tests with non-normal errors", *Empirical Economics*, 53(4), 1399-1414.

Mitchell W. (1993), "Testing for unit roots and persistence in OECD unemployment rates", *Applied Economics*, 25(12), 1489-1501.

Nelson C. and Plosser C. (1982), "Trends and random walks in macroeconomic time series: Some evidence and implications", *Journal of Monetary Economics*, 10(2), 139-162.

Perron P. (1989), “The great crash, the oil price shock, and the unit root hypothesis”, *Econometrica*, 57(6), 1361-1401.

Phelps E. (1967), “Phillips curves, expectations of inflation and optimal unemployment over time”, *Economica*, 34(135), 254-281.

Phelps E. (1968), “Money-wage dynamics and labor-market equilibrium”, *Journal of Political Economy*, 76(4), 678-711.

Phillips A. (1958), “The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957”, *Economica*, 25(100), 283-299.

Rodrigues P. and Taylor R. (2012), “The flexible Fourier form and local generalized least squares de-trending unit root tests”, *Oxford Bulletin of Economics and Statistics*, 74(5), 736-759.

Roed K. (1996), “Unemployment hysteresis – Macro evidence from 16 OECD countries”, *Empirical Economics*, 21(4), 589-600.

Song F. and Wu Y. (1997), “Hysteresis in unemployment: Evidence from 48 U.S. states”, *Economic Inquiry*, 35(2), 235-243.

Song F. and Wu Y. (1998), “Hysteresis in unemployment: Evidence from OECD countries”, *The Quarterly Review of Economics and Finance*, 38(2), 181-192.

Smyth R. (2003), “Unemployment hysteresis in Australian states and territories: Evidence from panel data unit root tests”, *Australian Economic Review*, 36(2), 181-192.

Ucar N. and Omay T. (2009), “Testing for unit root in nonlinear heterogeneous panels”, Economic Letters, 104(1), 5-8.

Yilanci, V. 2008. “Are unemployment rates non-stationary or non-linear? Evidence from 19 OECD countries”, *Economic Bulletin,* 3(47), 1-5.

Zivot and Andrew (1992), “Further evidence on the Great Crash, the oil-price shock, and the unit-root hypothesis”, *Journal of Business and Economic Statistics*, 10(3), 251-270.