ISOLATING LONG CYCLES IN UNEMPLOYMENT RATES OF CROATIA USING SPECTRAL MODELLING

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on economic growth, development economics, investments, financial development, public policy and microfinance. He authored or co-authored many research papers and few books and has coordinated several large scale investment projects in Croatia.

**ABSTRACT.** This paper is the first to explore unemployment nature and determinants in Croatia in a comprehensive way (88 time series / variables analysed) using nonlinear multivariate singular spectrum modelling. An important empirical finding of this study is the cyclical nature of unemployment. Unemployment in Croatia exhibits quite remarkably precise recurring business cycles of 5–6 years. This cyclical behaviour of unemployment is important both from theoretical and practical point of view. If empirical results of this paper are validated by other studies, a ‘partial hysteresis’ hypothesis should be recognised in terms of unemployment since both the hysteresis hypothesis and the natural rate of unemployment hypothesis hold in Croatia. Both hysteresis and natural rate of unemployment govern unemployment dynamics in Croatia causing cyclical behaviour and the observed cycles of 5–6 years. Therefore, the empirical evidence of this study calls for researching the so-called ‘partial hysteresis’, with unemployment having not only some properties of random walk (non-stationarity) but also of stationary series (mean reversion). Spectral forecasting techniques show to be superior to other standard time series models of unemployment.

**KEYWORDS:** unemployment, persistence, causality, Croatian disease, partial hysteresis, spectral methods.

**JEL classification:** C14, C38, C54, E24, E61.

**Introduction**

Unemployment dynamics in Croatia is highly persistent (long memory behaviour). A shock in the unemployment dynamics is non-mean reverting, lasting in the long run. Unemployment rises faster during the recession phase and is falling slower in the expansion phase revealing strong nonlinear behaviour. This feature of the unemployment series in Croatia shows shocks pushing unemployment out of the equilibrium path, demand prompt and strong policy intervention. Labour market in Croatia is not adequately efficient and structured to deal and resolve problems in the unemployment dynamics rising out of the components of both permanent (trend) and transitory shocks (cycles), Benazić and Rami (2016). Unemployment dynamics in Croatia is influenced by different type of shocks, both permanent and transitory. These shocks include the so-called ‘ladder effect’ (highly skilled workers being unemployed), falling aggregate demand, technology shift, ‘Croatian disease’, seasonal shift, ‘hysteresis’ in unemployment rates, unemployment spells, transitional unemployment, sectoral shift, demand/supply mismatch, labour market rigidity, temporary employment drag (Koren et al., 2015), terms of trade change, fiscal austerity, exchange rate policy, businesses low accumulation rate, output volatility, uncertainty, poverty and golden triangle misalignment. MSSA model was used to extract more important oscillations (limit cycles).
from a series of shocks separating real shocks from noise (white and red background noise) in the unemployment data. Unemployment in Croatia rises faster during recessions than it falls during expansion periods as observed by Montgomery et al. (1998) and van Dijk et al. (2002). During 1994-2000, job destruction rate was mean-reverting followed by the increasing rate of job creation and unemployment increasing at slow pace. With job destruction rate surpassing job creation rate at the end of 1999, unemployment started to rise. During the ‘golden age’, i.e. from 2002 to 2008, job creation rate was higher or at least at pace with job destruction rate, resulting in unemployment rate drop from 22.3% to 13.2% in 2008. After 2008, a large gap between job destruction and job creation rate opened, as clearly visible in Figure 1. Job destruction rate after 2008 has been continuously rising (somewhat slowing at the end of 2013) with job creation rate being mean-reverting (slightly rising at the end of 2013). Job creation rate is closely connected to the dynamics of business expenditure. Whenever business expenditures are under pressure, job destruction rate advances. During the period from 1995 to 1998, the share of labour costs in business aggregate expenditure was in average 8.45% and in 2012 – 13%. Dynamic behaviour of the unemployment in Croatia has been mainly driven by the behaviour in aggregate demand, budget deficit, monetary policy, foreign shocks, anaemic labour market, low production capacity and nominal wages (Yildirim, 2015).

Section 1 lists out the most important empirical findings on unemployment dynamics worldwide and in Croatia, whereas paper research methodology is explained in Section 2. Unemployment dynamics for Croatia exhibiting monthly data over the period from 1995 to 2013 is introduced in Section 3. Section 4 presents empirical findings of the study with concluding remarks in Section 5.

1. Theories of Unemployment


2. Outline of Data and Singular Spectrum Analysis

In this paper, a large database including 88 time series variables covering the monthly data from 1990 to 2013 is used. The data covering the period from 1990 to 2013 were collected from the Croatian National Bank online and from published databases, IFS financial
statistics, Croatian Bureau of Statistics online and published databases, World travel and tourism council on line databases (WTATCD, 2014).

Since monthly GDP data is not available, the index of industrial production is used. The missing data were reconstructed using SSA Reconstruction/Prediction filter (Kspectra program 3.4) following Harvey (1990), Hamilton (1994), Priestley (1981). Time series data (variables) used in this study are listed in the Appendix (Table 1A). From a set of 88 time series, 21 time series (variables) were selected as limit cycle (oscillations) candidates for the spectral analysis of unemployment dynamics.

2.1 Spectral Analysis Techniques

Spectral analysis techniques decompose unemployment series into different frequency band paths over the phase space. To capture overall variance in the unemployment behaviour, Squared Coherency (same as R2 in a linear time domain) is used.

2.2 Spectral Decomposition and Reconstruction

Decomposition is carried out by embedding the original time series (88) into lagged vector sequences of the form (trajectory matrix) following Golyandina and Zhigljavsky (2013) and Ghil et al.(1997; 2002; 1993; 2011; 1996)

\[
X = \begin{bmatrix} X_1 & \ldots & X_K \end{bmatrix} = \begin{pmatrix} f_1 & f_2 & \cdots & f_L \\ f_2 & f_3 & \cdots & f_{L+1} \\ \vdots & \vdots & \ddots & \vdots \\ f_K & f_{K+1} & \cdots & f_n \end{pmatrix}.\]

(1)

Eigentriple grouping takes the form \(X = X_{i_1} + \ldots + X_{i_n}\) with the input series LR decomposed as in

\[
x_n = \sum_{k=1}^{m} \hat{c}_n^{(k)} \]

(2)

with \(n = 1, 2, \ldots, N\) (Golyandina, Zhigljavsky, 2013).

Trajectory matrix takes the form (Golyandina et al., 2010; Golyandina, Zhigljavsky, 2013)

\[
\begin{bmatrix} f_{1,1} & \cdots & f_{1,L} & f_{p,1} & \cdots & f_{p,L} \\ f_{2,1} & \cdots & f_{2,L+1} & f_{p,2} & \cdots & f_{p,L+1} \\ \vdots & \ddots & \vdots & \ddots & \ddots & \vdots \\ f_{1,K} & \cdots & f_{1,n} & f_{p,K} & \cdots & f_{p,n} \end{bmatrix} \]

(3)

with the Toeplitz ‘grand’ block matrix (Ghil et al., 2002)
Covariance matrix takes the form

\[
\tilde{T}_x = \begin{pmatrix}
T_{1,1} & T_{1,2} & \cdots & T_{1,L} \\
T_{2,1} & T_{2,2} & \cdots & \cdot \\
\vdots & \vdots & \ddots & \vdots \\
T_{L,1} & \cdots & T_{L,L-1} & T_{L,L}
\end{pmatrix}
\]

(4)

\[
\tilde{C}_x = \frac{1}{N} \tilde{X}' \tilde{X} = \begin{pmatrix}
C_{1,1} & C_{1,2} & \cdots & C_{1,L} \\
\cdot & C_{2,2} & \cdots & \cdot \\
\vdots & \vdots & \ddots & \vdots \\
C_{L,1} & C_{L,2} & \cdots & C_{L,L}
\end{pmatrix}
\]

(5)

Monte Carlo test (MC-SSA) (Allen, Smith, 1996) against red noise null hypothesis following AR(1), (for more details see (Ghill et al., 1996; 1997; 2002) of the form

\[
X_t = a_1 X(t - 1) + X_0 + \epsilon_t + \epsilon_{X0}
\]

(6)

is used.

Granger causality test (based on SSA) takes the form (Hassani et al., 2010; 2009; 2013), Patterson et al. (2011)

\[
F^{(h,d)}_{X|Y} = \frac{\Delta_{X_{K+H_x},Y_{K+H_y}}}{\Delta_{X_{K+H_x}}}
\]

(7)

where \( \Delta_{X_{K+H_x}} \equiv \mathcal{L}(X_{K+H_x} - \hat{X}_{K+H_x}) \) representing mean square forecast error from univariate SSA, \( \Delta_{X_{K+H_x},Y_{K+H_y}} \equiv \mathcal{L}(X_{K+H_x} - \hat{X}_{K+H_x}) \) having \( X_T \) and \( Y_{T+1} \) (lagged differenced series) being a mean square forecast error from MSSA. The rule of thumb is \( F^{(h,d)}_{X|Y} < 1 \), \( Y_{T+1} \) Granger cause (better forecast) \( X_T \) and if \( F^{(h,d)}_{X|Y} > 1 \) no association between \( X_T \) and \( Y_{T+1} \) exists. A bivariate Granger causality (forecasting feedback) exists if both \( F^{(h,d)}_{X|Y} < 1 \) and \( F^{(h,d)}_{Y|X} < 1 \).
3. Unemployment and Labour Market Dynamics in Croatia

3.1 Transition Unemployment Nonlinearity

Macroeconomic misalignment during the transition phase (particularly in early 1990s) resulting in an overestimated absorption capacity of the private sector and a lack of state support for the private sector expansion together with war damages led to the rise in unemployment. Due to the aforementioned conditions, job creation rate in the private sector was far below the speed and dynamics of the job destruction rate in the state sector. As a consequence, the natural rate of unemployment increased with high inflow rates to unemployment and low outflow rates. High rates of job destruction and job creation followed by low job finding rate formed the natural rate of unemployment dynamics in Croatia over the transition phase (Figure 1).

![Job Creation and Destruction Rate, 1994-2013](image)

*Source: own calculations.*

*Figure 1. Job Creation and Destruction Rate, 1994-2013*

Job creation rate equals

\[ JCR = \frac{\text{created jobs}}{\text{Total employment}} \]  (8)

with job destruction rate

\[ JCR = \frac{\text{destroyed jobs}}{\text{Total employment}} \]  (9)

following Davis *et al.* (1998). Distinct nonlinear dynamics between job creation and destruction rates is visible in Figure 1.

3.2 Job Finding, Job Losing and Structural Unemployment

Further on, job finding rate and job losing (separation) rate in Croatia from 1994 to 2013 is measured. Job losing rate equals as in Shimer (2005)
with job finding rate

\[ u_{t+1} = \frac{(1 - e^{-s}) l_t s_t}{f_t + s_t} + e^{-s} u_t \]

where: \( f_t \) = job finding rate; \( s_t \) = job losing (separation) rate; \( F_t = 1 - e^{-s} \) \([0,1]\) probability of finding/losing job; \( l_t \) = labour force; \( u_t \) = number of unemployed workers; \( e_t \) = number of employed workers.

Measured job finding and losing rates are displayed in Figure 2.

Source: own calculations.

*Figure 2. Job Finding and Losing Rates in the Period, 1994-2013*

Job finding rate is above the dynamics of the job losing rate over the observed period. The gap between the two is clearly visible during the golden years 2003-2008 and has been shrinking since the onset of the crisis in 2008. Job finding rates are extremely low in comparison to other countries, with average job finding rate in the EU being 5-7% in the period from 2008 to 2013 (European Commission, 2013). Job separation rates in Croatia are also around the EU average of 1-2% in the same period. This describes an anaemic situation in the labour market in Croatia and high cyclicality in the dynamics of job finding and losing. It is noteworthy that job finding and losing rates in Croatia as very similar to the ones in the EU area even though it has joined the EU only recently. Job finding rate in Croatia shares the cyclical dynamics in the EU by being procyclical whereas job losing rate is acyclical.

Structural unemployment in Croatia is observed using the methodology developed by De Nederlandsche Bank (2013). For details on the methodology for setting up mismatch indicator see DNBulletin (2013). Mismatch indicator for Croatia was developed on the basis of the DNB methodology (*Figure 3*).
Figure 3 shows the dynamics of labour market mismatch from 1994 to 2014 using the indices developed by DNB (2013). Figure 1 indicates that the mismatch between labour demand and supply continuously dropped from 2002 until the crisis of 2008. Worsening economic conditions resulted in increased mismatch in the labour market with strong seasonal impact on the mismatch caused by seasonal employment in the tourism sector. Increased labour mismatch after 2008 is a consequence of job lost due to termination of temporary contracts with the temporary employed, who find it hard to find new temporary jobs. However, the mismatch between labour demand and supply cannot account for a large share in the unemployment. Although it was more pronounced after the onset of crisis in 2008, high unemployment rate in Croatia is only a partial consequence of the inefficiencies in the labour market caused by labour mismatch. In fact, labour market mismatch accounts for about 5% of the total variance in the unemployment dynamics, but since it fails the Monte Carlo red noise test, we do not consider its impact on the unemployment different from background noise in the series.

3.3 Hysteresis in Unemployment

Hysteresis of unemployment, with unemployment exhibiting random walk as in Blanchard and Summers (1986), is a real issue for unemployment data in Croatia.

To estimate the fractional differencing parameter (d), this study uses the most common and standard non-parametric procedures on the basis of Geweke and Porter-Hudak (1983), Geweke and Porter-Hudak and modified in Phillips (2007), Moulines and Soulier (1999), and Robinson (1995a; 1995b). Geweke/Porter-Hudak test estimates fractional parameter d = 1.026, Moulines-Soulier test d = 0.9198 and Robinson test d = 0.9530. For differenced unemployment series Geweke/Porter-Hudak’s d = 0.6424, Moulines-Soulier’s test d = 0.2868 and Robinson’s (Whittle) d = 0.8352. Test results on the unemployment series in level show series to be non-stationary (Furuoka, 2014) but possibly mean-reverting, rejecting the hysteresis hypothesis for Croatia. Differenced unemployment series support the test results for the unemployment in levels proving unemployment data to be non-stationary and mean-reverting. Thus unemployment in Croatia does not follow random walk (no unit root in the series), but fractional integration instead. This means that while unemployment is not following a random walk, negative effects of unemployment are persistent in the long run.
Although negative effects of unemployment are not permanent, high persistence (long memory) in the unemployment in Croatia is a big issue, since policy actions (monetary and fiscal) are needed to deal with this issue. MSSA test results of this study confirm the hypothesis of fractional integration showing no true hysteresis in the unemployment, but ‘partial Hysteresis’ instead with negative effects of unemployment lasting over 250 months. ‘Partial hysteresis’ in Croatia is causing large problems to the economy, and although its effects are not permanent, they are cumulative and damaging in the long run. Further studies on the negative impact of ‘partial hysteresis’ in relation to ‘hysteresis’ in the unemployment (not just in Croatia) should be promoted.

Natural rate of unemployment in Croatia (Figure 4) over the observed period shows cyclical properties and large fluctuations. Natural rate of unemployment is driven by job finding and job losing rate and is calculated following Hall (1979), Brauer (2007) and Mankiw (2006).

![Figure 4: Measured Natural Unemployment Rate in Croatia, 1994-2013 (%)](image)

Source: own calculations.

The dynamics of natural unemployment rate over the observed period was mostly led by job finding and job losing rate and labour turnover rate. Over the last two decades, natural unemployment rate in Croatia has been rising steadily, reaching new equilibrium level. Worsening in the natural rate of unemployment registered after 2008 shifted the rate to the new, higher level. In 2011, natural rate of unemployment reached the highest level since 1994. Structural and frictional factors (rigidities of the labour market) are behind the increasing natural rate of unemployment registered after the onset of crisis in 2008. A large unemployment gap between the actual unemployment rate and the measured natural rate evidence that structural components behind rising unemployment in Croatia during the crisis account only for a smaller part of the total increase. A larger part of the increase in the unemployment in Croatia after the onset of crisis in 2008 is attributed not to the structural unemployment components but rather to fluctuations in aggregate demand and associated negative impacts.

3.4 Croatian Disease and Seasonal Unemployment

For the discussion on Croatian disease and for the reference on the term ‘Croatian disease’ see Filipic (2012), even though in this study the same term is used in completely different meaning. Dealing with ‘Croatian disease’, the impact of employment and structural
shifts from the industry sector (manufacturing) on the service sector (tourism) is studied. Although this could imply some similar effects to the ones investigated by Filipic (foreign debt impact on the economy) as tourism also implies large foreign currency inflow, here we monitor Croatian disease through the lens of unemployment. Proxy for Croatian disease in this study is the share of tourism employment in the total employment. The logic behind the term ‘Croatian disease’ used in this study is as follows.

Due to large-scale deindustrialisation and declining importance of manufacturing in the economy, the importance of tourism sector has been growing strongly. In fact, this is clearly visible from tourism share in GDP in 2003, which is 26.7%, and share in total employment of 32.3% if compared to the same figures in 2013 (27.7% share in GDP, 29.8% share in employment) according to the data from the World Travel and Tourism sector. With one third of the economic activity and one third in employment dynamics, swings (cyclical activity) that are embedded in the tourism sector (seasonality) become embedded in the economic activity at the national level. As a consequence, economy starts operating in swings as well. For example, termination of temporary contracts has been the major source of growing unemployment dynamics since 2008. Tourism sector is able to generate substantial income to the economy (value added) but has a threshold level when it comes to generating new employment (new jobs). When this threshold of employment is reached, the economy starts loosing grip with cyclic shocks spreading from the tourism sector to other sectors of the economy. Such spreading of cyclic shocks from the tourism sector have an immediate and large impact on total employment, including unemployment dynamics in Croatia. Other main economic sectors, such as manufacturing sector and construction sector have low production capacity, being oriented only to doing business in the short run, not investing in capital goods and under tight internal accumulation funds. Following the logic of Copeland (1991), the impact of tourism on economy is complex, having both positive and negative externalities for the economy. It can be beneficial if high unemployment exists on the labour market by inhibiting part of the total number of unemployed people in the tourism sector. However, as observed by Copeland (1991), this is probably not the best policy action to fight high level of unemployment. In this study, we do not address the impact of the possible ‘Croatian disease, i.e. negative impact of the large share of tourism sector on the economy’, on de-industrialisation in Croatia. The impact of Croatian disease on the unemployment is analysed offering evidence that seasonal (by nature cyclical) employment in the tourism sector in Croatia contributes to the oscillations in the unemployment dynamics. MSSA model results used in the present study validate this hypothesis with Croatian disease being one of statistically important oscillations in the unemployment trajectory. Further research on the possible positive/negative impact of the “Croatian disease” on the economy should be motivated since this study offers evidence on the direct link in the Granger sense between ‘Croatian disease’ and unemployment dynamics.

4. Spectral Decomposition of Unemployment – Empirical Results

This section explains the results of the univariate SSA and multivariate MSSA spectral decomposition of unemployment in Croatia over the period from 1990 to 2013. As expected, the time series of unemployment show high level of persistence and long memory in the Granger and Hatanaka (1964), Elsner and Tsonis (1996), Granger (1966) sense. Trend component in the series is strong (Hodrick, Prescott, 1997), with four SSA components explaining almost 92% of the variance in the unemployment series. Trend component clearly identified by SSA 1-4 is visible in Figure 5.
Error bands (95% confidence level) are estimated from surrogate series (1000) following Allen and Smith (1996) against the null hypothesis (red noise). The identified spectral components fall into the error band with the SSA 1-4 at the 90% confidence level. Dots (representing evaluated eigenvalues) falling into 5th and 95th red noise percentile are not statistically significant from the red noise. Possible oscillatory components (signal) SSA 8-9 close above error band could be statistically significant but account for only a small part (2%) of the total variance in the unemployment series. Trend spectrum (using maximum entropy method) characterised by the long memory (persistence) in the unemployment is displayed in Figure 6.

MEM graph shows the constraints of identifying noise in the unemployment series in the presence of trend, thus using SSA trend filtering technique unemployment series is detrended. Trend is dominating unemployment dynamics within the period of 2-14 years. The result of Kendall’s nonparametric test for the presence of trend (trend identification) following Kendall et al. (1994) shows the presence of trend in the unemployment series. Using SSA, the components of the unemployment series were identified as trend, thus we proceed with the trend extraction using the procedure of SSA time domain reconstruction by Burg (1968).
Reconstructed unemployment trend (SSA reconstructed trend) together with the original unemployment series are visible in Figure 7.

Source: own calculations.

Figure 7. Original Unemployment Series and SSA Trend Reconstructed Unemployment Series

4.1 Univariate (SSA) Model of Unemployment

To develop a SSA model of unemployment in Croatia, a seasonally adjusted and detrended unemployment series is used. For the spectral decomposition of the series, we use retained SSA components after trend SSA components were removed using nonlinear trend filtering techniques. SSA spectral decomposition together with Monte Carlo SSA test on the detrended unemployment series is visible in Figure 8.

Source: own calculations.

Figure 8. SSA Eigen Spectrum and Monte Carlo SSA Test for Detrended Unemployment Series
Possible statistically significant SSA eigenvalues are located over the 95% confidence interval (derived from 1000 surrogate series, red noise realisations for the Monte-Carlo test). It is evident from Figure 8 that eigenvalues 1-2 and 3-4 lie outside the red noise confidence interval and are superimposed on each other at the frequencies of 0.01 and 0.08 cycle/month. Since the identified oscillatory components (eigenvalue pairs) pass the Monte Carlo test, FFT test for oscillatory SSA components and frequency test for SSA pairs EOF’s pair 1-2 and 3-4 are identified as oscillatory components in the unemployment series. The figure above confirms the importance of the identified oscillatory pairs with EOF’s pairs being in phase quadrature shifted in time (T/4). Maximum entropy decomposition identifies three clear spikes in the signal at frequencies 0.005, 0.01 and 0.08 cycle/month. Testing against white and pure red noise using Monte Carlo SSA, however, shows only 0.01 and 0.08 cycle oscillations to be statistically significant (using multi-taper method). Statistically significant oscillations correspond to 12 and 20 month cycles in the unemployment series. This as well as the previous results showing seasonal and cyclical shocks has a significant impact on the unemployment dynamics.

4.2 Spectral Impulse Response Analysis of Unemployment

Spectral impulse response analysis in this section shows how shocks in the oscillatory series (multivariate series considered in our MSSA model) impact unemployment dynamics. Spectral impulse response analysis is performed for all series recognised as statistically significant and stable limit cycles under our MSSA model. A remarkable fact can be noticed in the empirical results of the spectral impulse response analysis. One distinctive fixed point (stable equilibria) is found in the unemployment time series for Croatia. This identified stable equilibrium point fits natural unemployment rate measured in this study extremely well. A stable equilibrium point in the unemployment trajectory thus corresponds to the measured natural unemployment rate of 9% (horizontal line on the impulse response graphs). The unemployment trajectory tends to oscillate around this fixed point, i.e. trying to reverse to the natural unemployment rate of 9%. The measured natural unemployment rate of 9% and fixed point in the phase space correspond to the economic conditions in Croatia observed in this study (1998-2013). Obviously, as the dynamics of job destruction and job creation together with the considered multivariate series in the MSSA model change (see Groth, Gill, 2011), the natural unemployment rate and stable equilibrium change as well. The identified limit cycles (multivariate series) attract unemployment towards this fixed point (9% natural unemployment rate) unless there are shocks or fluctuations in the system. The empirical results obtained executing spectral impulse response analysis on the considered multivariate series demonstrate how shocks or fluctuations in the system drive unemployment away from fixed point and stable equilibrium in the phase space, i.e. natural unemployment rate. For example, in all derived spectral impulse response functions, two distinctive ghost fixed points can be traced (Figure 9).
First ghost fixed point occurs in the interval of 60-65 months and the second after 110-125 months. Because of the shocks in the directions of the identified oscillatory series, fixed point turns to the ghost fixed point, i.e. becomes unstable as system suffers from severe fluctuations in the phase space. For unemployment this means moving away from what we measured as natural unemployment rate in Croatia. First ghost point is less vulnerable to the shocks in the limit cycles. The second ghost point shows a completely opposite situation. At the interval of 120 months, shocks in the limit cycles cause unemployment trajectory to be significantly less attracted to the limit cycles captured by the MSSA model components. This phenomena is observed for all MSSA components with a shock in the MSSA component (one standard deviation shock) resulting in large unemployment deviations. Shocks and forces behind system fluctuations are much more limited in strength when the second ghost limit cycle is over. With effects of the shocks in the limit cycles dying out within the period of 30 months (from 120 to 150 months, unemployment returns near the fixed point (stable trajectory) path. Even after that point, we can observe two more ghost fixed points and ghost limit cycles that are not so pronounced. Following Kimoto and Ghil (1993), it can be observed that unemployment floats around this ghost limit cycle and ghost fixed point over a long time period (100 months). The path of unemployment trajectory in Croatia is steadily affected by shocks in monetary, fiscal and foreign limit cycles. Fluctuations in aggregate demand caused by CNB (Croatian National Bank) interventions and inflation targeting policy cause complex dynamics in the attractors. Such intervention and active monetary policies distort the dynamics of limit cycles and unemployment attempts to return to the natural rate of unemployment level. Fiscal policy through expansionary/contractionary dynamics contributed to the oscillations in the stable trajectory path of unemployment in a similar way to monetary policy. Spectral impulse response analysis reveals large cyclical movements in the unemployment. Two distinct peaks at 5 (cycle/years) and 10 (cycle/years) dominate the unemployment trajectory. The first peak (cycle) is caused by large oscillations in the limit cycles of industrial production (energy), Croatian disease proxy, core inflation, CNB discount rate, loans to business share in total loans, foreign shocks (EU industrial production index proxy). This means that unemployment dynamics in Croatia over a 5-year cycle period is dominated by movement (changes) in monetary policy, sectoral shifts and foreign shocks. The largest impact so far has been registered for the Croatian disease proxy series. Increasing focus on the tourism sector development in the last decade had a cumulative impact on the
unemployment dynamics in Croatia caused by seasonal unemployment shocks. Seasonal dynamics is now tightly embedded in the path of unemployment trajectory. The seasonal effect of tourism industry on unemployment is much larger in the first cycle in relation to the second cycle. The impact in the second cycle is still present and significant but not so pronounced. This is probably due to the lagging multiplicative effects of the tourism industry on the economy and consequently total unemployment. Croatian disease causes large oscillations in the unemployment resulting in ghost limit cycles. This is proved by MSSA analysis on unemployment for the period of 1990-1998 in Croatia (empirical results not presented here). The impact of Croatian disease on the unemployment dynamics during this period was significantly lower with seasonal effects triggering ghost cycles of limited strength and persistence.

Shocks (oscillations) in the time series we use in our MSSA unemployment model have a permanent (long lasting) and substantial impact on the unemployment dynamics. The first ghost limit cycle is caused by oscillations in the Croatian disease proxy series and monetary policy (inflation and exchange rate targeting). The second ghost limit cycle is more pronounced and is caused by oscillations in all modelled time series but with a particular attention to aggregate demand and fiscal policy. Fiscal policy imbalances (public debt and non-sustainable public expenditure level) put pressure on aggregate demand. The implementation of fiscal austerity policy drags aggregate demand down having a large effect on unemployment generating sizable ghost limit cycle (second peak in the spectral impulse response analysis). Fluctuations in multivariate series that were considered in the MSSA model of unemployment cause large oscillation and generate profound ghost limit cycles (points) with quite persistence. Effects of these fluctuations last over 250 months (almost 21 years) before unemployment (system) closes orbit and returns to the previous fixed point, i.e. stable equilibrium which in the case of unemployment is the natural rate of unemployment.

Our empirical results from the MSSA model explain the factors behind rising natural rate of unemployment in Croatia and deviations of actual unemployment from the natural rate. Spectral impulse response analysis of ghost limit cycle and points here addresses and explains the causes of shocks in unemployment in Croatia. However, our MSSA model of unemployment in Croatia only partially answers the question if the rising natural rate of unemployment in Croatia is transitory or permanent. In other words, the question is whether the current level of unemployment is a consequence of cyclical or of structural components. In order to answer this question, we must analyse the relationship between permanent and transitory movement in the unemployment and explain the observed fluctuations.

4.3 The Relationship between Permanent and Transitory Movements in Unemployment and Related Series

To analyse fluctuations in unemployment, spectral decomposition is used to decompose unemployment and other series considered in the MSSA model of unemployment. Spectral multivariate models decompose bivariate series in trend and cycle components. Following Golyandina et al. (2010) and Alexandrov et al. (2012), we use MSSA decomposition on the identified oscillatory multivariate series. Using bivariate series for MSSA reconstruction, having each of the series paired to the unemployment series, we get 21 reconstructed series. Running bivariate MSSA on previously identified SVD (singular value decomposition) components separately, trend reconstruction from bivariate relationship between unemployment and each of 21 observed individual series is applied. Trend is
extracted following the methodology of Alexandrov et al. (2012) developed for trend extraction in the SSA.

Cross series correlations for unobserved components detected using bivariate MSSA to filter permanent and transitory components from the series are presented in Table 1.

Table 1. Estimates of cross correlation between permanent and transitory components MSSA UN - X

<table>
<thead>
<tr>
<th>Cross series</th>
<th>Correlations</th>
<th>Cross series</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent UN / Transitory UN</td>
<td>0.0786</td>
<td>Permanent UN / Permanent (BP)</td>
<td>0.7599</td>
</tr>
<tr>
<td>Permanent UN / Permanent (AE)</td>
<td>0.9165</td>
<td>Permanent UN / Permanent (BB)</td>
<td>0.8735</td>
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Source: own calculations.

Table 1 shows a statistically significant nonlinear relationship between a permanent/transitory unemployment component and permanent/transitory component for each of the series considered in the MSSA model and used in the bivariate model. In the bivariate
spectral unobserved component model, we did not include the impact of switching regimes on the relationship between the series. Switching regimes could explain how and why some components move together and others move apart during expansion/recession regimes. Since statistical relationship both in trend and cycle is considered to be important, it can be concluded that both structural and cyclical factors affect the unemployment dynamics in Croatia. Impact of the permanent component of the series on permanent unemployment is still greater in relation to the shock of the transition component to unemployment. In designing active labour market policy for fighting unemployment in Croatia both structural and cyclical component should be addressed. Cross correlation coefficient obtained from the spectral unobserved component model validates the results of both Granger causality and spectral impulse response analysis. The combined results show that shocks have long persistence to the unemployment series causing complex behaviour of the unemployment series in phase space. Results also show that increased natural rate of unemployment in Croatia is in fact both transitory and permanent in nature.

4.4 Unemployment Limit Cycles and Forecasting Unemployment Using MSSA Model

In this section, the unemployment dynamics in Croatia over the period from 1998 to 2013 is reconstructed using the results of the MSSA model (identified oscillatory components) (Figure 10). Limit cycles in the phase space that were found in our MSSA model (55-month cycle) explain the unemployment dynamic behaviour with an exceptional fit. One must take into consideration that shocks and fluctuations from 2008 are also included in the unemployment trajectory and shocks are always hard to fit.

*Figure 10. Unemployment and Reconstruction with MSSA Oscillatory Components*

*Source: own calculations.*
Source: own calculations.

Figure 1. One year ahead forecasting of unemployment using MSSA model

Figure 1 shows one year ahead forecasting of the unemployment series capturing variance of the series quite well. The comparison of the forecasted and original data on unemployment shows that spectral forecasting techniques fit the series very well. The forecasting results of the MSSA model used in this paper appear to be superior to similar empirical studies on unemployment in Croatia. Superiority of the spectral technique over standard time series methods is expected for countries in transition such as Croatia. It is due to statistical bias in the data, multiple series breaks, transitional shocks, structural adjustments, macroeconomic stabilisation, unit root and stationarity issue in official macroeconomic data (see Mariano, Diebold, 1995).

Conclusions

Unemployment is a complex phenomenon thoroughly studied in the literature on economics. Unemployment is significant with regard to economy due to the fact that unemployment is in the same time policy goal and instruments. The issue of unemployment is particularly important for transitional economies such as Croatia facing high long-term unemployment rates. Understanding the empirical dynamics of unemployment is thus important for designing efficient economic policies to fight long-term unemployment. However, disentangling empirical relationships inherent in the unemployment data is quite a difficult task. Statistical data for transitional economies usually show large statistical biases due to inefficient statistical framework at local and national levels. Transitional and structural shocks cause large biases in the time series data posing stationarity and nonlinearity issues for researches trying to build empirical unemployment models. This is the reason why standard time series models studying unemployment dynamics in transitional economies do not perform well. To study unemployment under such difficult data constraints, a spectral analysis technique is used in this paper. The choice of spectral analysis is related to the fact that spectral methods are much less vulnerable to the stationarity, unit root, structural breaks and nonlinearity in the time series data. Superiority of the spectral methods over standard time series models of unemployment is substantiated in this study. Spectral methods provide better forecasting fit for the unemployment series. Permanent and transitory components in the unemployment series are extracted more precisely being more robust in relation to time series extraction techniques. This gives the possibility to researchers to carefully identify cycles in
the unemployment, natural unemployment rates and possible hysteresis in the unemployment dynamics. This study shows that using advanced spectral analysis methods, complex unemployment phenomena can be studied in greater enabling the researchers to identify complex empirical relationships behind the phenomena. This paper is our humble contribution to the study of the most important unemployment determinants under significant data constraints in the presence of the structural breaks, stationarity and nonlinearity issues.

References


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Management and Business Administration: Multidisciplinary Perspective


ILGŲ NEDARBO LYGIO CIKLŲ IŠSKYRIMAS KROATIJOJE TAIKANT SPEKTRINĮ MODELIAVIMĄ

Marinko Škare, Dean Sinković

SANTRAUKA

Table 1A. List of time series (variables) used in modelling

<table>
<thead>
<tr>
<th>Series</th>
<th>Description</th>
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<tbody>
<tr>
<td>UN</td>
<td>Number of persons unemployed</td>
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<tr>
<td>AE</td>
<td>Industrial production index (energy) 2010=100</td>
</tr>
<tr>
<td>AES</td>
<td>Indices of stock (energy) 2010=100</td>
</tr>
<tr>
<td>AI</td>
<td>Industrial production index (intermediate goods) 2010=100</td>
</tr>
<tr>
<td>AIS</td>
<td>Indices of stock (intermediate goods) 2010=100</td>
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<tr>
<td>B</td>
<td>Budget surplus/deficit in millions of Kuna</td>
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<tr>
<td>BB</td>
<td>Industrial production index (capital goods) 2010=100</td>
</tr>
<tr>
<td>BBS</td>
<td>Indices of stock (capital goods) 2010=100</td>
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<tr>
<td>CBR</td>
<td>Central Bank reserves in millions of EUR</td>
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<tr>
<td>CD</td>
<td>Industrial production index (durable consumer goods) 2010=100</td>
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<tr>
<td>CDS</td>
<td>Indices of stock (durable consumer goods) 2010=100</td>
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<td>CD's</td>
<td>Proxy for Croatian disease (employment in tourism/total employment)</td>
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<tr>
<td>CIP</td>
<td>Core inflation 2010=100</td>
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<td>CN</td>
<td>Industrial production index (non-durable consumer goods) 2010=100</td>
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<td>CNS</td>
<td>Indices of stock (non-durable consumer goods) 2010=100</td>
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<td>CPI</td>
<td>Consumer price index 2010=100</td>
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<td>CTE</td>
<td>Loans to enterprises (share in total loans)</td>
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<td>CW</td>
<td>Construction work indices 2010=100</td>
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<td>DR</td>
<td>Croatian national bank discount rate</td>
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<td>Industrial production index EU area 2010=100</td>
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<td>Foreign trade deficit in millions of EUR</td>
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<td>HNB</td>
<td>Foreign exchange reserves in Central bank in millions of EUR</td>
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<td>IIP</td>
<td>Industrial production index (industry), seasonally adjusted Euro area 18 countries</td>
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<td>IP</td>
<td>Industrial production index 2010=100</td>
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<td>JCR</td>
<td>Job creation rate</td>
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<td>JDR</td>
<td>Job destruction rate</td>
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<td>JFR</td>
<td>Job finding rate</td>
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<td>JLR</td>
<td>Job losing rate</td>
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<td>LADDER</td>
<td>Ladder effect</td>
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<td>LCP</td>
<td>Unit labour costs</td>
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<td>M1</td>
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<td>M4</td>
<td>Monthly rates of growth in money supply (M4)</td>
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<td>MM</td>
<td>Labour mismatch index</td>
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<td>NEC</td>
<td>Net employment change</td>
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<td>NER</td>
<td>New entrants to the register (total)</td>
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<td>NER1</td>
<td>New entrants to the register (no schooling and uncompleted basic school)</td>
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<tr>
<td>NER2</td>
<td>New entrants to the register (basic school)</td>
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<tr>
<td>NER3</td>
<td>New entrants to the register (1–3 years vocational school)</td>
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<td>New entrants to the register (4 (or more)-year vocational secondary school and grammar school)</td>
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<td>New entrants to the register (non-university college)</td>
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<td>NER6</td>
<td>New entrants to the register (university and postgraduate degree)</td>
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<td>New entrant to the register by business closure</td>
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<td>New entrant to the register by reduction in demand</td>
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<td>New entrant to the register (first time job seeker)</td>
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<td>NERPE</td>
<td>New entrants to the register (previously employed)</td>
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<td>NERTC</td>
<td>New entrant to the register by end of temporary contracts</td>
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<td>NERXP</td>
<td>New entrants to the register (no working experience)</td>
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<td>NNW</td>
<td>Nominal net wage in Kuna</td>
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<td>NW</td>
<td>Nominal gross wage in Kuna</td>
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<td>PLR</td>
<td>Primary liquidity ratio (banking system)</td>
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<td>Producer price index (chain)</td>
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<td>RES</td>
<td>Weighted average Central Bank reserve requirements (in % of res. Base)</td>
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<tr>
<td>RW</td>
<td>Real gross wage</td>
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SEI – Total employed in tourism
TSHIFT – Employed in manufacturing (share) proxy for technological shift
UN1 - Unemployed persons no schooling and uncompleted basic school total
UN15 – Unemployed persons age 15–19 total
UN1W - Unemployed persons no schooling and uncompleted basic school woman
UN2 - Unemployed persons basic school total
UN20 - Unemployed persons age 20–24 total
UN25 - Unemployed persons age 25–29 total
UN2W - Unemployed persons basic school woman
UN3 - Unemployed persons 1–3 years vocational school total
UN30 - Unemployed persons age 30–34 total
UN35 - Unemployed persons age 35–39 total
UN3W - Unemployed persons 1–3 years vocational school woman
UN4 - Unemployed persons 4 (or more)-year vocational secondary school and grammar school total
UN40 - Unemployed persons age 40–45 total
UN45 - Unemployed persons age 40–45 total
UN4W - Unemployed persons 4 (or more)-year vocational secondary school and grammar school woman
UN5 - Unemployed persons non university total
UN50 - Unemployed persons age 50–55 total
UN55 - Unemployed persons age 55–60 total
UN5W - Unemployed persons 4 (or more)-year vocational secondary school and grammar school woman
UN6 - Unemployed persons university and postgraduate degree total
UN60 - Unemployed persons age 60 and more total
UN6W - Unemployed persons university and postgraduate degree total woman
UNB – Unemployment benefits recipients
UNW15 - Unemployed persons 15–19 age woman
UNW20 - Unemployed persons 20– 24 age woman
UNW25 - Unemployed persons 25–29 age woman
UNW30 - Unemployed persons 30–34 age woman
UNW35 - Unemployed persons 35–39 age woman
UNW40 - Unemployed persons 40–44 age woman
UNW45 - Unemployed persons 45–49 age woman
UNW50 - Unemployed persons 50–54 age woman
UNW55 - Unemployed persons 55–59 age woman
UNW60 - Unemployed persons 60 and more age woman