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CHAPTER 4

BUSINESS CYCLE IN CROATIA: BY THE DYNAMIC SYNCHRONIZATION TECHNIQUE

1. Introduction

The theme of turning points dating and research into the synchronisation of business cycles, co-movements of the two cycles by the method of indexes and calculation of correlation coefficients in the manner the authors conducted in this study on the case of Croatia, is a widely exploited research field in the modern analysis of business cycles. Methodologically, our study leans on the research program of concordance index calculations by the authors hereafter.

Various aspects of economic complexity today in Croatia deal with different but dependent economic parts such as, for example: the tourism, labour, monetary and

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production ingredients which will be presented and examined in this paper. It should also be noted that understanding of the cyclical characteristics in Croatia's economic activities in a systematic way could be important for the purposes of planning, coordination and resource allocation in the sustainable economic development of Croatia.

This paper applies the nonparametric procedure to estimate the concordance index for the assumed variable, and to study its cyclical features in relation to the reference variable. Our working assumption, broadly speaking, is that the findings should lead us to some important stylized facts about business cycle dynamics in Croatia.

The motivation for researching the main problem in this paper, i.e. researching the synchronization quality of business cycles in Croatia in comparison with the EU industrial cycle, lies in the authors' professional curiosity to penetrate into the secrets of the current deep recession, which is turning into an economic depression, which, certainly, drags the "cumulative causality" from earlier times. The novelty of this paper is that it will reveal the strength of synchronization of specific segments of economic life, both within Croatia and in relation to the EU economic fluctuations. The presumed contribution of this paper is reflected in the identification of the economic reality segments, which crucially contributes to the decline in economic activity in Croatia.

The paper is organized into 6 sections. After the *Introduction, in Section 2,* we select 17 variables stretching from tourism and labour issues to production and monetary flows in Croatia as well as information about industrial production in the EU. Variables concerning Croatia were selected for two reasons. Firstly, such a wide scope of variables corresponds to the goals of this research and is associated with a study of a wider spectrum of economic trends. Secondly, it is for a practical reason: all variables are on a highly frequent basis (monthly level), thus being ideal for regressing (of course,

following the conducted preparation procedure). The only variable concerning the EU (the industrial production index), included among selected variables, we should specially stress, is there for comparative reasons. Section 3 as a main part of this paper studies the business and growth cycle characteristics of the paired variables, e.g. their synchronisation based on their concordance indexes. These include the conventional Harding and Pagan nonparametric approach analysed by Bry-Boschan algorithm. The relationship between cycles in the assumed sector and those in the particular part of the economy are also explored by correlation coefficient obtained as a regression parameter. Section 6 summarises the main conclusion of this paper.

2. Literature review

Since Clement Juglar (1862) in the nineteenth century economists have been familiar with a cyclic description of economic activity over time, whereby periods of expansion in economic activity are followed by periods of contraction in what has become known as the business cycle. Burns and Mitchell (1946) formalised this nomenclature and derived a dating method whereby peaks and troughs would separate the phases of the business cycle; and the latter could be analysed statistically in terms of duration, amplitude and so on. The dating committee of the National Bureau of Economic Research in the USA still follows their lead in defining the turning points of business cycles for that country.

Twenty three years ago Blanchard and Fischer (1989) observed that "most macroeconomists (...) have abandoned the Burns-Mitchell methodology. Blanchard and Fischer (1989) explained this shift in the method by arguing that the Burns-Mitchell approach did not generate statistics with "well-defined statistical properties."

Harding and Pagan (2001) have stimulated renewed interest in the Burns Mitchell method with a series of articles in which they demonstrated that the statistical foundations of a dating algorithm can be described formally, and that such algorithms may be attractively robust and practically easy tools for identifying the phases of the cycle.

Harding and Pagan (2002) distinguished between parametric and non-parametric methods for identifying the turning points of macro-economic time series. Amongst the parametric approaches Markov switching models have achieved prominence and were in the past applied to the South African case by Moolman (2004).

Zhang and Zhuang (2002) in their paper construct leading indicator systems for the Malaysian and Philippine economies using economic and financial data, with an attempt to predict the turning points of growth cycles in the two countries.

Biscarri and Pérez de Gracia (2002) find that cycles in European countries have become substantially more concordant in recent years, a result that was to be expected given the increased integration of the European financial markets, but that the degree of concordance is not high.

The study conducted by Lahiri et al. (2003), underscores the importance of transportation indicators in monitoring cyclical movements in the aggregate economy. Benczúr and Rátfai (2005), carry out a detailed analysis of quarterly frequency dynamics in macroeconomic aggregates in twelve countries of Central and Eastern Europe; the facts they study include the variability and persistence in and the co-movement among output, and other major real and nominal variables. The paper written by Avouyi-Dovi et al (2006) provides an analysis of co-movements between real and financial variables in three new EU member countries (the Czech Republic, Hungary and Poland) and the euro area. Den Reijer (2007) in his paper focused on the deviation

cycles in manufacturing industries of nine-OECD countries, and the international linkage between the cyclic motions in the manufacturing industry of two countries measured by the degree of the synchronization. Pusnik and Tajnikar (2010), investigated how 'efficient' were the transformations of one of the waves of entrepreneurship determinants to another in Slovenia and Croatia and in other countries. Marinheiro (2011) concludes that the evidence on the relative performance of the European Commission's (EC) growth forecast is rather mixed, with considerable variation at the country level. As far as we know, according to available literature of the domestic academic community of economists, empirical studies on the topic of business cycle synchronization in Croatia are still missing. However, as a pioneering involvement, work on similar, yet different idea constructs, should be included, i.e. the NBER leading indicators method (also known as the barometric method), which was applied for the first time in the second half of the 90's by Ahec-Šonje (Ahec-Šonje, 1995; Ahec-Šonje, 1997). Similarly, Bačić and Vizek (2006) worked on the development and the performance of the composite leading indicator of the Croatian economy – CROLEI, whose purpose in their paper was to forecast classical business and growth cycles.

We followed Harding and Pagan (2002) in this paper and applied their dating algorithm, improved by Bry and Boschan (1971), to identify the turning points of the heterogeneous set of macro-economic variables and to, in a broader way, try to determine business cycles in the Croatian economy.

3. Conceptual background

Bry and Boschan's algorithm proposed by Pagan and Harding (2002a) is an example of nonparametric (as opposed to parametric as we state before in the Literature previews)

dating method and it is the method used in our paper. The selected method and associated regression tests, which will be, step by step, explained in further presentation, were chosen for the following reasons: it concerns a relatively simple, extensively used, method in recent economic literature which deals with the problem of business cycle synchronization, providing sufficiently robust results and analytical implications.

A crucial part of the business cycle tracing system is the computation of the cycles. We select one of the most frequently used cycle extraction methods, or filters: the Hodrick –Prescott filter since Hodrick and Prescott (1997) argued that business cycle facts should be defined as deviations of observed time series from a flexible trend.

a. Cycle extraction method

We should smooth our time series. We use the Hodrick-Prescott filter again for trend cycle decompositions. The filter contains only one parameter, which controls the smoothness of the filtered series.

Hodrick and Prescott (1981) use the following model:

$$yt = \mu t + ct, \quad (1)$$

According to this model the series contains only a trend and a cycle. The ratio of the variances of *ct* and μt is assumed to be equal to the chosen parameter λ. For a larger λ, a smoother trend will be obtained. As a measure of the smoothness of the trend, Hodrick and Prescott (1981) take the sum of squares of the second order differences.

Furthermore, they pose that the cycle is the deviation from the trend, and its long-term average should be zero. This results in the following minimization problem:

$$\min_{(\mu_t)}\left\{\sum_{t=1}^{T} c_t^2 + \lambda\sum_{t=1}^{T}[(\mu_t - \mu_{t-1}) - (\mu_{t-1} - \mu_{t-2})]^2\right\} \quad (2)$$

According to the literature (Hodrick and Prescott (1997), the optimal values are λ =1600 and λ =14400 for quarterly and monthly data respectively. In our computations, we employ λ =1600 although we are dealing with monthly data frequencies, as we have stressed before. Namely, there two reasons for it: first, λ=14400 implicates too smooth a trend line, where it is more difficult to identify the turning points, and second, the time series which are analysed are, in fact, annual growth rates at a monthly level.

We present the non-linear trends obtained from the application of the HP filter, with λ = 1600, to the monthly growth rate of included time series in Croatia.

Year-on-year growth rates (or alternatively year-over-year growth rates, year-to-year growth rate, rate of change from the previous year, or 12-month rate of change are rates of change) expressed over the corresponding period (month or quarter in relation to the frequency of the data) of the previous year.

Therefore, all time series are given as year-on-year growth rates (YoY) in this paper. This rate is calculated by dividing the figure Y(i,t) for a given period t (a month in relation to the frequency of the data i) by the value of the corresponding period in the previous year Y(i,t-12).

For monthly data:

$$YoY(i,t)=\{[Y(i,t)/Y(i,t-12)]-1\}*100 \quad (3)$$

The same result is obtained by difference of logged original series.

$$YoY(i,t)= \Delta y\ (i,t)=\ln (Yi,t)-\ln(Yi, t-12) \quad (4)$$

The non-linear trends highlight the cyclical nature of the series, enabling the identification of peaks and troughs for each case.

b. Dating method

The dating algorithm used here is by Bry and Boschan (1971) as suggested by Harding and Pagan (2001) in various recent papers. This algorithm identifies local minima (troughs) and local maxima (peaks) in a single time series, or $\{\Delta yt\}$ after a log transformation. Peaks are found where Δys is larger than k values of $\{\Delta yt\}$ in both directions [t-k, t+k] and troughs where Δys is smaller than k values of $\{\Delta yt\}$ in both directions. So, k value stands for the minimal duration of a phase given in the number of months.

The size of k is set by the censoring rule of the algorithm. There is no optimal size for k, but Bry and Boschan (1971) suggested a value of 5 at a monthly frequency. A censoring rule is also required to ensure that the cycle (and each of its phases) is of a minimum duration. Again we followed Harding and Pagan (2001) and set the minimum duration for a single phase at 9 months and the minimum duration for a complete cycle

(from peak-to-peak or trough-to-trough) at 24 months. The Bry-Boschan algorithm therefore identifies turning points according to the requirements in equation 3 and 4, subject to the above mentioned censoring rules.

Peak at t if

$$\{(\Delta y_{t-9}, \Delta y_{t-8}, \ldots \Delta y_{t-2}, \Delta y_{t-1}) < \Delta y_t > \Delta y_{t+1}, \Delta y_{t+2}, \ldots, \Delta y_{t+8}, \Delta y_{t+9})\} \tag{5}$$

Trough at t if

$$\{(\Delta y_{t-9}, \Delta y_{t-8}, \ldots, \Delta y_{t-2}, \Delta y_{t-1}) > \Delta y_t > \Delta y_{t+1}, \Delta y_{t+2}, \ldots, \Delta y_{t+8}, \Delta y_{t+9})\} \tag{6}$$

Once the turning points of the cycle have been identified it is possible to describe the characteristics of the cycle in terms of duration, amplitude, steepness, non-linearity, and synchronisation among the two assumed cycles.

In practice, the Bry-Boschan algorithm is supplemented by censoring procedures to distinguish the real peaks and troughs from spurious ones, *e.g.*, a movement from a peak to a trough (phase) cannot be shorter than 9 months and a complete cycle must be at least 24 months long. The resulting turning points define a “specific cycle” of each component series.

c. Turning point determination in relevant cycles

The classical approach defines the business cycle directly by analysing the change in the level of a variable, characterising the cycle as a succession of expansions and recessions. Formally, an expansion is defined as the period of time separating a trough from a peak; conversely, a recession is the period between a peak and a trough. What is crucial in this approach, then, is to precisely define and identify the turning points, i.e. the peaks and troughs. Using these turning points, a recession (expansion) is defined as the time separating a peak (trough) from a trough (peak).

d. Synchronization and concordance index in growth cycles

Though it fell out of fashion after the 1970's, this view of the cycle has recently been the subject of several papers, which proposed a simple method for analysing the concordance between two series, i.e. the simultaneous presence of the two series in the same recessionary or expansionary phase of the cycle. Before compiling the concordance index, we first have to define a function to indicate the phases of increase (or decline), Sy, t=1 of a variable, *y* for example, which we will use to calculate the index: Sy,t=1 *if y* increases at *t* , and 0 otherwise. We use a statistic developed by Harding and Pagan as the concordance index (cf. Canova: 2007).

The concordance index for *x*, written *cxy*, is defined as the average number of periods in which two variables *x* and *y* coincide at the same phase of the cycle, i.e.:

$$C_{x,y} = \frac{1}{T} = \sum_{t=1}^{T} \left[S_{x,t} S_{y,t} + (1 - S_{x,t})(1 - S_{y,t}) \right] \quad (7)$$

The index has a value of 1 if *x* and *y* are always in the same phase, i.e. the two series are in perfect concordance, with expansions and contractions perfectly juxtaposed. If the index reads 0, *x* and *y* are always in opposite phases, i.e. the two series are in perfect discordance, with either a pronounced lag or a total contrast in phase.

e. Synchronization of cycles test

In general, the distributional properties of *Cx,y is* unknown. To calculate the significance levels for these indices, we use the method suggested by Harding and Pagan (2001), which we detail below. Let $\mu_{s,i}$ and $\sigma_{s,i}$, *i* = (*x,y*) denote the empirical mean and the empirical standard deviation of $S_{i,t}$ respectively. If ρ_s denotes the empirical correlation between *Sx,t* , and *Sy, t* , it can be shown that the concordance index is equal to:

$$C_{x,y} = 1 + 2\rho_s \sigma_{s_x} \sigma_{s_y} - \mu_{s_x} - \mu_{s_y} \quad (8)$$

According to this equation, *Cxy* and *ρs* are linked in such a way that either of these two statistics can be studied to the same effect. To estimate *ρs*, Harding and Pagan suggest estimating the linear relationship:

$$\frac{S_{y,t}}{\sigma_{S_y}} = const + \rho_s(\frac{S_{x,t}}{\sigma_{S_x}}) + \varepsilon_t \tag{9}$$

where *const* is a constant and *εt* a residual. The estimation procedure for the equation (9) must be robust to serial correlation in the residuals, because *εt* inherits the serial correlation properties of *Sy,t* , under the null hypothesis *ρs*=0.

We should test if synchronization of cycles is significant between indicators and the reference cycle. A simple way to do so is the t-test for *H0: ρs*=0.

Standard *t*-statistics is based on OLS regression. We use Newey-West heteroskedasticity and autocorrelation consistent (HAC) standard errors (lag truncation = 5) to account for possible serial correlation and heteroskedasticity in errors *et*. The methodology to compute what are often termed heteroskedasticity and autocorrelation consistent (HAC) standard errors was developed by Newey and West; thus they are often referred to as Newey-West heteroskedasticity and autocorrelation consistent (HAC)

The synchronisation of cycles among our chosen variables can be measured and tested based on the index of concordance between two paired specific cycles.

How many concordance indexes can we obtain? We have a total of 17 different cyclic variables (see the following chapter about the empirical data), which need to be paired provided they can be repeated, according to the equation from the combination theory as permutation with repetition:

Number of matches = (n+r-1)! / r! (n-1)! (10)

Where:

n = 17 cycle variables

r = 2 chosen numbers

Inclusion of the values in the equation gives 136 possible pairs which result in the concordance indexes *Cxy,* and the correlation coefficients ρ.

4. Empirical data and analysis

The data on 17 time series which appear in the analysis relates to the time period between the years (and months) 1991m1 and 2010m3. Some time series are somewhat shorter and they start in 1992 or later, ending in 2010m4 (see Table 1 – in the Appendix), so, while calculating concordance indexes of the two time series, the work technique was adjusted to the shorter time series. The data linked to Croatia was taken from the Monthly Database on Central, East and Southeast Europe, which can be found on the following website: http://mdb.wiiw.ac.at/. On the other hand, the data referring to the industrial production index in the EU area is obtained from the section Statistical data of European Central Bank. http://sdw.ecb.europa.eu/.

We use a uniquely comprehensive sample of monthly frequency data. Our data sets considered in this paper are monthly seasonally unadjusted data generated by the Croatian economy.

The variables we study are: unemployment rate (UR); vacancy rate (VR); tourism arrivals (ARR); tourism overnight stays (ON); real NB discount rate (RDR);

construction production index (CI); nominal narrow money (M1); retail consumer price index (RPCI); industry production index (IND); productivity in industry index (PROD); nominal total import in Euro (IMP); nominal total export in Euro (EXP); nominal wage (WAGE); real wage (RW); real exchange rate (RE); nominal exchange rate (HRK). The variable Industrial Production Index, Total Industry (excluding construction) (EUI) is also included in this study, providing information about the industrial production movements within the Euro area 17.

While longer data sets are usually preferred for studies of data synchronisation turning points, estimating only over the given period will be less susceptible to charges of regime change. Namely, when it comes to our data, synchronisation processes of the business cycles mainly coincide with the process of economic transition and they start with the majority of large structural changes in the economy, politics and environment in the first half of the 90's.

Applying the dating rule described above with a minimum duration of the cycle of 9 months, to the selected annualised growth rate time series for the various time span periods within January 1990 – March 2010, the statistics contained in Table 1 are obtained. Expansion phases are under the heading TP (or PT in case of unemployment) and recession phases under the heading PT.

Table 1 (in Appendix) presents the dating chronology and different turning points for the relevant time series annualised growth rate variable and its annualised growth rate cycles based on this procedure.

Figures 1-4 (in Appendix) illustrate filtered year on year growth of industrial production and construction index rate and their cycles graphically, showing their growth rate expansion and recession phases according to trended components. Because of limited

space in this paper we show only four figures and not the rest of the 26 graphs that refer to the remaining 13 time series variable.

On average, expansion in unemployment rates (or contraction in economic activity) is shorter and much weaker than expansion phases in vacancy rates. Also, unemployment displays a much stronger change in expansion than other variables but a shorter average duration measured by conjectural phases and relatively long contraction phases. In general, asymmetries over cyclical phases are presented in all series.

We do not intend to further quote Table 1 interpretation of remaining introduced variables, but will, in further text, concentrate on the synchronisation aspect of the Croatian business cycles.

We have tabulated the concordance measures and the test statistics in Table 2. In the first A part of the Table 2, the concordance statistics *Cxy*s are reported above the diagonal while the correlation coefficients ρs are reported below the diagonal, and μ *S* and σ *S* are given at the bottom.

In the second part B of the Table 2, standard *t*s are reported below the diagonal while the robust *t*s are reported above it. Some of these statistics significantly reject *H0*. The large t-values (approximately above value of 2) also suggest the existence of co-movement of the cycle and the reference cycle.

Our *ad hoc* criteria by the rule of the thumb for grading the synchronisation strength between the two cycles of the paired variables, according to the concordance index, are:

- 0-0.25 very weak synchronisation,
- 0.26-0.5 weak synchronisation,
- 0.51-0.75 moderately strong,
- 0.76-1 very strong.

Clearly, synchronisation is only present in the case of a significant correlation coefficient, whose sign determines the direction of the mutual cycle movement of the two variables. In principle, in a weak or a very weak synchronisation of the two cycles, the correlation coefficient is not significant even in the standard form.

5. Results and discussion

In our result analysis discussion, we will refer mainly to the strong synchronisation phenomenon as the paired cycles, in that domain, have significant correlation coefficients according to the regressional equation (9) and the t-value.

Judging by the height of the concordance index from the aspect of unemployment, as a referent variable, it appears that the highest degree of cycle synchronisation exists between the cyclic growth in unemployment and the cyclic decline in industrial production. The latter concordance index equals 0.75, however, the associated correlation coefficient, which equals approximately 0.44 and which, although significant with application of both the t-statistics and the robust t-statistics, only gives the indication of an incomplete inter-temporal interdependency in movement. Towards the top of the moderately strong synchronisation, there are movements between tourist arrivals and unemployment rates. This is not surprising as Croatia is, however, a tourist country with an abundance of employment potential for “non-voluntarily unemployed persons”. Similarly, the result of the pairing of the areas of the unemployment rate and a real discount rate should also be added here. It appears that the instrument of the discounting of interest rates is, (albeit in an interplay with the domestic inflation trends) one with which the Croatian National Bank intervenes in the economy, be it facilitating

or aggravating the inflow of new loan funds for the economy, moderately strongly synchronised with the unemployment corpus.

A moderately strong degree of synchronisation exists between unemployment and movement of the real HRK/EUR exchange rate (as opposed to the nominal rate, where synchronisation is of a weak intensity). In fact, a strong degree of coincidence exists between unemployment cyclic growth and appreciation of the real HRK/EUR exchange rate. Although the correlation coefficient is not high (it equals 0.28), this positive correlation is, however, significant, according to both concepts of measuring of the t-values.

A very strong degree of synchronisation of two paired cycles we see in the movement of the growth of the vacancy rate i.e. the growth rate of tourist arrivals, as well as the growth rate of the vacancy rate and the growth rate of exports. In both cases, the concordance index is 0.8, and the associated correlation coefficient is significant. It is clear that the rate of filling of vacant work positions grows in the same direction as the growth in tourist arrivals (in Croatia otherwise chronically problematic) goods export. A moderately strong degree of synchronisation also exists between the vacancy rate and the rate of the construction sector (the concordance index is 0.7); this is not surprising as the expansion of the construction sector is, in fact, closely associated with the expansion of employment, thus the growth of construction is a pro-cyclical variable. It should be noted that the bubble bursting in the property market and the decline in the demand for flats during the last two years directly facilitated the decline in the employment rate. This result clearly shows the unsustainable development of events in the construction sector because its supply didn't meet effective demand and the production collapsed. The unsold resident flat houses inventory remain very high,

The correlation coefficient, calculated as the regressional coefficient, points to the mutual movement of the said variables, with a high significance of the correlation coefficient estimate.

The cycles of tourist overnights, as a referent variable, were not paired with any other cycle in the way of a very strong mutual synchronistic cycle. Towards the top of the moderate synchronisation, judging by the concordance indexes of these tourist cycles are industrial production variables (0.7) and the variables of the construction industry (0.65). We presume that the strong degree of synchronisation of the given phase of the tourist overnights and industry cycles, in the inter-temporal sense, is a consequence of a greater realisation of the food and crude oil industries within a tourist season, but also of the expansion of construction investment, although the latter may only be a pure chance in coincidence. Moderately strong synchronisation exists between the cyclical phases of tourism (both from the aspect of overnights and total arrivals) and the cyclic phases of imports. As the correlation coefficient is not significant from the point of view of the robust t-value, it is inopportune to make conclusions on simultaneous movement of imported goods due to the great import dependency of the Croatian tourist economy. So, the tourism in Croatia's recent economic structure contributes to much more goods import intensity than before 1990 (in the depreciated ex -Yugo dinar exchange rate era). The Republic of Croatia has been facing chronic trade deficit for almost two decades, which has, therefore, been unsustainable ever since. A high degree of the moderately strong synchronisation also exists between the probability that a certain cyclic phase of tourist arrivals will coincide with the cyclic phase of goods export. The correlation coefficient is, in this case, significant. We do not have either a rational answer, or a theory which would explain this puzzle. Is this a question of a coincidence, an increased delivery of built ships during the summer months, or something else?

The cyclic phase of the real discount rate's inclining trend is in the largest measure synchronised with the acceleration of inflatory phases measured according to the RCPI. The high concordance index (0.75), as a result of the pairing of these two areas, should not be surprising. The real discount rate is, in fact, a result of the nominal discount rate, reduced by the inflation percentage; apart from this, it is logical that in the inflation episodes, by the instrument of discount rate operation, thus influencing the business banks' loan potential, the Croatian National Bank increases the loan price by increasing the discount rate, in order to reduce inflation pressures. It is clear that the Croatian National Bank uses very successfully this credit and monetary instrument for the purposes of anti-inflation politics, but it is also clear that it is done in a predictable way, as the correlation coefficient is relatively high and highly significant among real discount rates and RCPI cycles. It seems that cycles of labour productivity, too, are rather strongly synchronised with the cycles of real discount rates. Labour productivity in the circumstances of, say, more expensive money, is perhaps synchronised with the discount rate growth, due to the illusion of higher wages and the so-called wealth effect, labour entropy measured by absenteeism degrees thereby being reduced. In the latter case also, the regression parameter, which measures the correlation coefficient, is highly significant. It is interesting that the construction sector is, to a very large degree, synchronised with external trade trends, in a larger measure with the import (concordance index 0.9) than with the export (concordance index 0.74). This is why it is not surprising that the import in 2009 and 2010 has been slowed down also as a consequence of the fall in conjuncture in the construction industry. According to the Official Statistics Department of Croatia the GDP in 2009 decreased about 5.8%, and in current 2010 the fall will be about 2%. Given that the construction sector is procyclically directed compared to the GDP trends, the revival of the construction sector will signify the exit from nowadays very serious recession but also the revival of

external trade flows, a larger fiscal income due to larger custom income, etc. The construction sector is moderately strongly synchronised also with the cyclical inflation fluctuations. It appears that the increase of prices in the construction sector present in the observed period (bubble price in the construction sector in pre-recession years before 2008) stimulates the strengthening of offer in the flat construction sector, this further being reflected on the inflation of retail prices. Cyclic fluctuations of the construction sector are moderately strongly synchronised both with the movements of productivity and the industrial production movements. It should be emphasised that in all the noted cases the correlation coefficients are high.

The cyclical movement of the monetary aggregate M1 is, as expected, considerably synchronised with the cycles of nominal exchange rate of the HRK; this evidence is well in line with the monetary theory of exchange rates. The basic idea of this theory is that the exchange rate depends on the relative rate of growth of the money supply of two countries (Frenkel, 1976; Mussa, 1976; Bilson, 1978). Namely, the cyclical growth of M1 causes cyclical depreciation impulses in the HRK. In the exercise of determination of the synchronisation index RCPI, as a referential variable, the cyclical movement of retail prices is closely synchronised with the cyclical movement of labour productivity, import (both correlation coefficients are significant, i.e. different from zero). Industrial production is much synchronised with the fluctuation of the import movements; in this case, too, the correlation coefficient is significant. The cyclical movement of productivity is, in a considerable measure, synchronised with the movement of import and nominal wages. As import represents an important input in the economy due to the high import dependency of the Croatian economy, the import in Croatia can act proactively from the aspect of productivity strengthening, but also from the aspect of nominal wages growth, provided the productivity also grows. In Croatia, import is, in a considerable measure, synchronised strictly with export movements, probably due to

the domination of the re-export business, but also due to the import dependency of the export business.

Finally, it remains to conclude that the complex of nominal and real wages, together with the HRK exchange rate is a highly inter-synchronised area of cyclic movement; although the correlation coefficients are highly significant also when it comes to the robust testing of the t-values, these findings are of a trivial character and they are of no surprise to us.

In the case of the variable of industrial production index in the Euro zone, it is interesting to emphasize that only four paired variables (unemployment, tourist overnights, prices and nominal wages) from Croatia are in a medium strong synchronization relation with the industrial fluctuation in Europe. It therefore appears that, in the majority of cases, the cyclic phase of industrial production contractions in the EU coincides with the cyclic phase of unemployment expansion in Croatia. The correlation coefficient in the form of regression coefficient is not high (it equals approximately 0.16), but, on a significant level, it is different from zero. It is obvious that the industrial fall in production in the Euro zone implies negative external impacts in Croatia in the form of increased dismissal of workers, bankruptcy of Croatian companies, conditioning the fall in employment. Also, our empirical results confirm an obvious synchronization link between cyclic phases of tourist overnights and cyclic phases of industrial fluctuations in the Euro zone. In this case, too, the correlation coefficient is, like in the previous example, relatively low, but on a significant level different from zero. It is interesting to mention that cyclic fluctuations on the plan of nominal wages and the retail price index in Croatia are also very synchronized in time dynamics with the fluctuations in the Euro zone industrial production. It seems that the inflation of retail prices and nominal wages in Croatia is followed by the phase of industrial growth in the Euro zone,

while the phase of disinflation in Croatia is synchronized with contraction episodes in the Euro zone.

6. Conclusions

In order to understand the link between various business cycles, which include various segments of the Croatian economy, as, for example the question of labour and unemployment, formation of aggregate demand from the export and import aspects, added value through industry and construction, or tourism, instruments of foreign currency and monetary politics (narrow money, real discount rate, exchange rate), as well as the industrial cycle in the Euro area, we offer the following conclusive remarks.

The number of included cycles and the interaction of each particular variable, the complexity of the researched links through as many as 136 regression exercises and the calculation of the concordance indexes, offer an opportunity to identify the stylised facts about the dynamics of the Croatian business cycles. The hypotheses of this paper, that the results should lead us to some important stylized facts about business cycles dynamics in Croatia, have been proved.

Our regression exercise allowed us to identify significant correlation coefficients and concordance between the following business cycles in Croatia: first, stark co-movement exists between the unemployment cycles and industrial production cycles (both in Croatia and somehow less in the Euro area). Namely, that results show that there is a high level of probability that the dismissal of employees in the Croatian economy will coincide with the contraction phase in the Croatian and EU industries. This is the first stylised fact of the Croatian business cycles. This result is a trivial novelty on its own

but could be a substantial contribution to Croatia's economic literature due to formal testing deductions.

The high concordance index, accompanied by the significant correlation coefficient between the cycle phase of expansion, vacancy rate and export, indicates that the cyclic phase of growth of new job position openings coincides, in a large measure, with the cyclic phase of growth of export, construction, but also with tourist arrivals. The latter finding, as a novel and scientific contribution, is the second stylised fact of the Croatian business cycles. It is clear that creation of new job positions, as a phenomenon in the labour market, neglects the impulses coming from industry and it is much more attracted by those coming from the service economy.

The third stylised fact and its contribution to economics literature, reads: there is an almost perfect synchronisation between the cyclic phases of the construction industry and import and somewhat a lesser one concerning export. Thus the picture of the general economic recession adequately corresponds to that finding. Namely, it is very well known from the empirical findings that the construction sector, as the bearer of the so-called price bubble, works pronouncedly pro-cyclically in the growth phases, but also vice versa. In our case, this is additionally aggravated by the decline in external trade exchange, which occurs in synchronisation with the construction contraction.

Did the import sector as a whole transmit a recession or expansion phase on industry or its productivity? Very probably, in our opinion, due to the concordance index result, it did. It is clear that import is an important segment of value added creation in industry, due to its import dependency.

Intuitively, price stabilising monetary policies ought to move against the business cycle due to coordination failure problems, and this is precisely what we found for Croatia where real discount rates moved in the same direction as in the case of price cycle

movements after peaks and troughs in those segments of economic activity. The real discount interest rates moved pro-cyclically with unemployment and productivity as reference variables, too.

As an important final conclusion, spill over of the negative industrial cycle in the Euro zone onto the descending phase of tourist overnights should be emphasised. Also, given the cyclic fluctuations of industrial production in the EU, a high degree of synchronization of this, in fact external and autonomous sector, with fluctuation of Croatian retail prices and nominal wages should be noted. It appears that some future inflation theory in Croatia, or simply an empirical check of one of the models of Phillips curve of Croatia (due to a pronounced link with the unemployment sector) should also include the industrial production of the EU zone as a variable.

The estimation of the turning points from relatively short time series despite the monthly or high frequency intensity was a major constraint in our research. Statistical data on the monthly basis of our time series is missing in the longer time span in Croatia.

In our opinion, it may be useful to further investigate the dichotomy between the lag and lead terms of two opposite cycles in calculating the concordance index or using an approach based on different filter data, or synchronisation methodology.

One step to improve and justify the success of our research in the light of its results should be a more proactive anti-recession policy, both on the real side (construction building sector, as well as tourism and industry) and financial part of the economy (fuelling more money into economy by dropping the interest rates).

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Appendix

Table 1. Cyclical phases of variables

Variables/ Estimation period	Turning Point (month)	Duration (months)		Amplitude (percentage)	
Unemployment 1991m1-2010m3	T P 1995m6 1999m9 2004m2 2005m4 2007m5	39	32.5	-10.056	8.568
Vacancy rate 1991m1-2010m3	P T 1993m4 1996m8 2000m1 2003m1 2007m5	38	46.5	-17.270	18.662
Tourism Arrivals 1991m1-2010m3	P T 1995m3 1997m2 1998m5 2003m5 2007m1	41.5	29.5	-30.255	5.926
Overnight stays 1991m1-2010m3	P T 1993m6 1994m11 1997m6 1999m11 2001m10 2004m8 2007m8	26.6	30	-2.271	2.253
Real Discount Rate 1993m1-2010m3	T P 1995m6 1999m7 2003m9 2007m9	50	48.5	-2.484	1.298

Construction 1992m1-2010m1	P T 1992m8 1998m6 2001m6 2004m4 2006m8	52	32	-1.562	0.975
M1 1992m12-2010m2	T P 1997m10 2002m2 2005m2 2006m11	36	36.5	-18.197	20.262
RCPI 1993m1-2010m3	T P 1994m7 1998m7 2002m1 2005m5 2006m5 2007m5	27	33.3	-0.25	2.563
Industry 1993m1-2010m3	P T 1996m11 1999m9 2002m12 2004m3 2006m3	24.5	31.5	-1.928	1.883
Productivity 1994m1-2010m2	P T 1995m6 1999m1 2001m6 2004m10 2007m2 2008m1	31.3	28.5	-3.146	2.509
Import 1994m1-2010m3	P T 1994m10 1999m1 2001m6 2004m2 2006m4	41.5	27.5	-20.7	7.257
Export	P T	32.5	37.5	-8.439	7.241

1994m1- 2010m3	1994m4 1997m7 2000m7 2002m9 2005m12				
Nominal Wage 1995m1- 2010m3	T P 1997m3 1998m3 2001m9 2004m4 2005m6 2007m12	28	24.33	-4.375	1.274
Real Wage 1995m1- 2010m3	T P 1997m4 1998m3 2001m9 2002m12 2005m6 2008m1	36	19	-4.261	1.144
Real exchange rate 1994m2- 2010m3	P T 1996m4 1998m2 2000m2 2002m1 2004m3 2005m6 2007m6 2008m12	19.5	24.6	-0.42	0.50
HRK/USA $ 1995m1- 2010m4	P T 1997m8 1998m9 2000m2 2003m8 2005m12 2007m9 2009m5	25.33	21.66	-12.864	10.627

EUI	T P	48.6	26.6		

Source: calculated by authors, Note: T =Trough, P = Peak

Table 2. Measuring and testing of synchronization of cycles

A. Concordance indexes and correlations of cycles among time series variables													
	EUI	**UR**	**VR**	**ON**	**AR**	**INTR**	**CONI**	**M1**	**RCPI**	**IND**	**PROD**	**IMP**	**EXP**
EUI	**-**	**0.59**	**0.4**	**0.65**	**0.34**	**0.55**	**0.51**	**0.42**	**0.59**	**0.48**	**0.44**	**0.4**	**0.35**
UR	**0.16**	**-**	**0.52**	**0.65**	**0.66**	**0.7**	**0.54**	**0.41**	**0.54**	**0.75**	**0.62**	**0.62**	**0.5**
VR	**-0.27**	**0.02**	**-**	**0.59**	**0.75**	**0.16**	**0.7**	**0.37**	**0.34**	**0.34**	**0.42**	**0.58**	**0.8**
ON	**0.16**	**0.29**	**0.18**	**-**	**0.58**	**0.23**	**0.65**	**0.41**	**0.43**	**0.7**	**0.58**	**0.61**	**0.38**
AR	**-0.44**	**0.31**	**0.51**	**0.17**	**-**	**0.33**	**0.55**	**0.14**	**0.35**	**0.55**	**0.54**	**0.66**	**0.68**

WA	RE	EXP	IMP	PROD	IND	RCPI	M1	CONI	INTR
0.22	-0.16	-0.4	-0.28	-0.12	-0.05	0.19	-0.15	-0.04	0.11
-1.51	0.28	-0	0.26	0.23	0.44	0.1	-0.19	0.11	0.37
-0.28	0.09	0.59	0.15	-0.16	-3.2	-0.33	-0.27	0.37	-0.68
0.12	-0.21	-0.27	0.2	0.15	0.41	-0.14	-0.21	0.31	-0.27
-0.38	0.05	0.32	0.24	0.08	0.1	-0.29	0.05	0.07	-0.31
0.2	3.22	-0.29	0.02	0.36	0.25	0.49	0.13	-0.22	-
0.26	-0.1	0.42	0.73	0.4	0.21	0.27	-0.7	-	0.4
-0.04	-0.04	-0.27	-0.42	-0.26	-0.05	-0.42	-	0.16	0.57
0.26	-0.06	-0.11	0.41	0.47	0.02	-	0.35	0.68	0.75
0.21	-0.12	-0.04	0.51	0.11	-	0.52	0.48	0.59	0.62
0.35	0.11	-0.11	0.51	-	0.55	0.74	0.36	0.64	0.69
0.23	-0.1	0.33	-	0.75	0.74	0.65	0.28	0.9	0.52
-0.05	0.08	0.33	0.71	0.44	0.48	0.6	0.34	0.74	0.36

RW	0.04	-0.28	-0.11	-0.04	-0.26	0.16	0.14	0.12	0.12	0.06	0.18	0.17
HRK	-0.09	-0.43	0.14	0.04	0.029	-0.26	0.07	0.35	-0.09	0.07	0.04	0.15
Mean		0.571	0.523	0.512	0.466	0.518	0.328	0.645	0.531	0.531	0.518	0.33
STDEV		0.494	0.498	0.399	0.499	0.499	0.469	0.477	0.478	0.488	0.499	0.47

Note: Concordance indexes above the diagonal cells / correlations of cycles below the diagonal

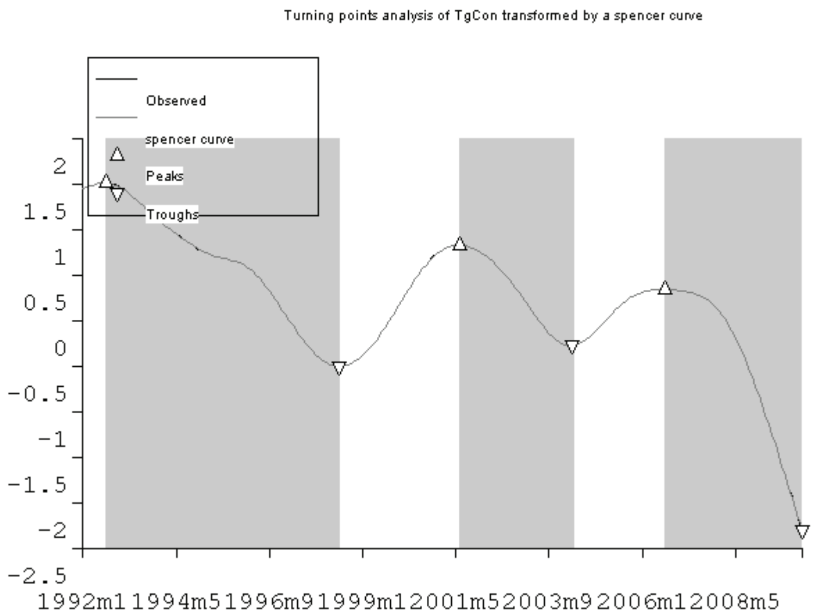
EXP	IMP	PROD	IND	RCPI	M1	CONI	INTR	AR	ON	VR	UR	EUI	5	B. Standa-rd and robust t-stati-stics for *H0*: ρ *S* = 0
-2.89	-2.01	-0.86	-0.36	1.31	-0.76	-0.21	0.61	-3.32	0.15	-2.04	0.15	-	EUI	
-0.06	1.59	1.51	3.44	0.14	-1.32	0.75	2.65	2.32	2.09	0.01	-	2.37	UR	
5.11	0.98	-1.1	-2.2	-2.67	-1.86	2.81	-6.66	4.16	1.23	-	0.22	-4.16	VR	
-1.82	1.3	1.02	3.06	-0.93	-1.37	2.86	-1.9	1.22	-	2.75	4.54	2.37	ON	
2.27	1.61	0.53	0.69	-2.02	0.33	0.48	-2.18	-	2.62	8.97	5.07	-6.6	AR	
-1.99	0.18	2.56	1.67	3.66	0.87	-1.3	-	-4.83	-4.77	-13.2	5.74	1.34	INTR	
2.98	7.06	3.04	1.56	2.02	-6.6	-	-2.8	1.08	4.65	5.91	1.6	-0.45	CON I	
-1.98	-2.8	-1.75	-0.42	-2.81	-	-13.22	1.97	0.74	-2.94	-4.08	-	-1.53	M1	
-0.71	2.16	3.32	0.19	-	-4.85	4.04	7.88	-4.21	-1.98	-5.18	0.56	2.65	RCPI	
-0.25	4.12	0.69	-	0.42	-0.84	3.3	3.54	1.5	6.38	-4.85	6.95	-0.75	IND	
-0.76	3.82	-	1.51	7.5	-3.64	5.43	5.45	1.08	2.13	-2.37	3.3	-1.74	PRO	
2.72	-	8.19	7.72	4.66	-6.4	14.8	0.4	3.64	2.78	2.14	3.52	-4.04	IMP	
-	5.73	-1.66	-0.66	-1.61	-4.08	6.46	-4.23	4.97	-3.9	9.92	- 0.11	-5.85	EXP	
1.18	-1.66	1.69	-1.8	-0.8	0.54	-1.36	4.6	0.78	-1.57	1.22	4.06	-2.32	RE	
-1.12	3.35	4.96	2.87	3.65	-0.65	3.76	2.87	-5.98	1.56	-4.05	- 6.12	3.13	WA	
1.97	2.67	2.44	0.97	0.83	1.45	1.99	2.23	-3.66	-0.4	-1.61	- 3.94	0.59	RW	
2.1	1.89	0.54	1.01	-1.24	3.64	0.95	-3.34	2.6	0.63	1.99	- 6.38	-0.98	HRK	

HRK	RW	WA	RE
-0.43	0.34	1.45	-1.12
-3.18	-1.9	-2.96	1.9
0.94	-0.76	-1.94	0.57
0.25	-0.2	0.78	-2.98
1.29	-1.66	-2.75	0.37
-1.43	1.1	1.32	2.22
0.45	0.98	1.82	-0.62
1.74	0.65	-0.31	0.26
-0.56	0.67	1.67	-0.37
0.47	0.52	1.39	-0.67
0.25	1.16	2.45	0.77
0.92	0.98	1.69	-0.7
0.87	0.95	-0.43	0.67
-0.67	-0.54	-1.4	-
2.8	6.98	-	-2.8
3.34	-	18.8	-1.05
-	6.57	5.52	-1.5

Source: calculated by authors

Note: Standard t-statistics above the diagonal cells/robust t-value below the diagonal

Figure 1-2. Turning points of trended growth rate on annual basis of Construction and Industrial production index



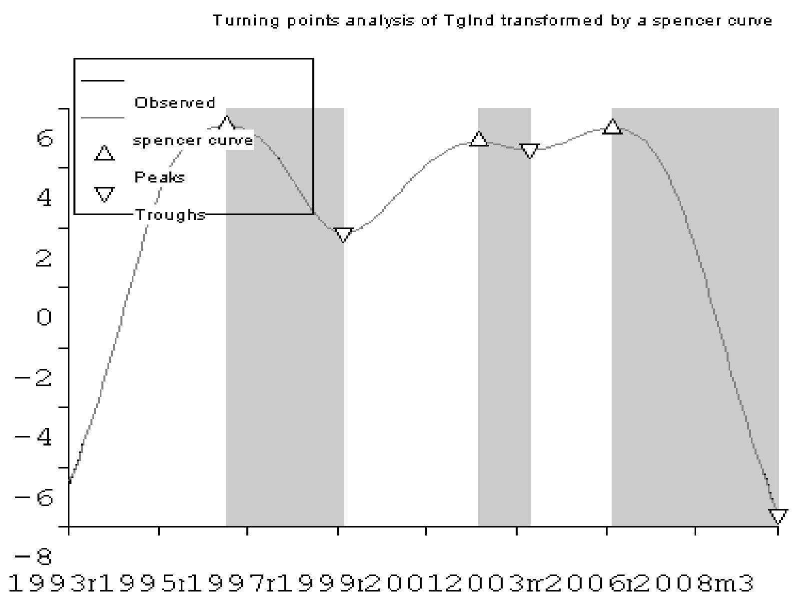


Figure 3-4. Trend and cycle of growth rate on annual basis of Construction and Industrial production index