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Methodological summary on the breaks in time series exercise

The basis for identifying breaks in the time series exercise of the Croatian Labour Force Survey was twofold.

First, we resorted to experimental approach and ran the pilot data collection using the IESS Framework Regulation in parallel with the regular LFS. The period initially chosen for estimation the impact of the breaks was a parallel first wave LFS data collection during Q1/2020. Due to the fact that the Eurostat expressed concern that the first quarter may not be the most appropriate one, the planned pilot data collection was switched to the Q2/2020. However, the emergence of COVID-19 pandemic and related labour market and data collection disruptions in Q2/2020 led to implementation of pilot being delayed to Q3/2020, as epidemiologic circumstances partially normalized. Due to modest statistical power of such inquiry, and strongly seasonal patterns of the Croatian labour market in Q3, the parallel survey was extended with first wave of Q4/2020 LFS, making for more robust pilot sample, twice the stipulated minimal size. The pilot survey was sampled in fashion to mirror the regular LFS collection for first waves in Q3 and Q4/2020, being executed by the same staff during the same weeks in the same PSUs as regular LFS, for total of 4 366 respondents in regular waves and 4 482 in pilot.

This pilot exercise failed to identify major disruptions to estimates of employment or unemployment indicators with introduction of IESS FR methodology. Inquiry focusing on 14 main indicators/groups did not identify differences in employment or unemployment for any of the required groups, apart from men 65+ in one specification. This finding proved robust in pairwise comparisons and multivariate models, whether observing gross or net difference (where pre IESS-FR data was transcoded according to the guidelines provided by Eurostat), weighted or not. For indicators pertaining to youth and senior population, in particular unemployment, due to modest sample size the confidence interval was very broad indicating low reliability of estimates. This pilot exercise, large as it was, was not sensitive enough to account for minor departures due to change in wording, items and ordering in a reliable fashion.

Second, due to the reasons listed above, additional counterfactual evidence was collected using entirely different approach via econometric series model utilizing both survey and administrative data for 12 out of 14 indicators[1]. In order to capture the time series nature of the LFS data we use a panel approach (a comparison of the measurements over a given period of time). For this purpose, we utilise alternative administrative sources of labour force data. The administrative data of the Croatian Pension Insurance Institute (CPII) are used in the case of employed persons, and the data of Croatian Employment Service (CES) were used in the case of unemployed persons. The key assumption in the analysis is that the administrative time series data do not have breaks in the observed time period (Q1/2007 to Q1/2021), since in that period there was no methodology change for administrative time series. Our approach was to model the data for the time span when the old LFS methodology was used (Q1/2007 to Q2/2020) and then

[1] Legal framework does not allow for persons 65+ to apply as unemployed, so administrative unemployment rates for this group cannot be estimated.

forecast from the model the period (Q3/2020, Q4/2020 and Q1/2021) for which we have the pilot data collected by the new LFS methodology. We will conclude that there are no breaks in the time series if both the measurements from the old survey as well as the measurements from the new survey can be interpreted as realisations of the same model. Due to the observed significant trend of decrease of the general population in the referent time period instead of analysing absolute numbers for the indicators we have modelled employment and unemployment rates instead.

Modelling was performed in several steps. First, we compared the time series of LFS data obtained by the old methodology with the time series of administrative LF data. Two time series cointegrate if they have the same stochastic trend and this trend can be removed by making the series stationary after taking a difference of a linear combination of the two time series. We test this stationarity using the Dickey-Fuller unit root test. The whole procedure, which determines the coefficients of the linear combination and then takes the difference and tests for its stationarity is called Engle-Granger Augmented Dickey-Fuller test. After having established that these two time series cointegrate, we have repeated the analysis on the whole time span (combining measurements collected both using old as well as the new methodology). In this way we have shown that the LFS time series can be represented as a linear transformation of the corresponding administrative time series (which is completely known, and does not have breaks) plus the corresponding (stationary) residual time series.

The residual series is further analysed using the classical ARMA time series models which then allows us to calculate the confidence intervals (CIs). In order to be complete, we note that ARMA models are a special case of seasonal ARIMA models. These models are described by seven parameters organized in two groups *(p,d,q)* and $(P,D,Q)_r$. The first three parameters describe the non-seasonal (trend) part of the model, i.e. order of the autoregressive part; the order of the differencing and order of the moving average part with lag one. The parameters *P, D, Q* and *r* describe the same type of components for the seasonal part of the model but with lag *r* (frequency) instead of lag one. The lag parameter *r* is set a priori (prior to algorithmically determining other six parameters) and for our analysis of quarterly data we choose *r=4*. This choice of the lag parameter has further been confirmed using Ollech and Webel's combined seasonality test. Note that models for which $p \geq 2$ and lag *r* effect is not present (e.g. *P=Q=D=0*) can also be used to model seasonality. The parameters of the model are determined by the Hyndman-Khandakar algorithm based on the combination of Akaike and Bayesian information criteria. The confidence intervals are then determined using standard approach for SARIMA series.

This procedure which we employed was divided into three steps:

1. In the first step, linear relation (co-integration nature) between recorded LFS data obtained by the old methodology and administrative LF data obtained from CPII and CES, with a stationary time series of residuals of the two observed time series is analysed.
2. In the second step, the best ARMA model for the corresponding residuals of the linear relation between the LFS data and administrative LF data obtained from CPII and CES is determined.
3. In the last step, 95% confidence intervals for the predicted future behaviour of the estimated LFS time series of the observed indicator (linear transformation of the CPII/CES series with determined additive ARMA series of residuals) were determined. Note that each confidence intervals covers 95% of realizations of the future behaviour (at Q3/2020, Q4/2020 and Q1/2021) of the estimated LFS time series of the observed indicator. For most of the indicators the measured data for (Q3/2020, Q4/2020 and Q1/2021) fell into the 95 % confidence intervals as determined by the model. For four indicators which did not satisfy this claim we have performed an additional more robust analysis.

a) We first determine the most suitable SARIMA model with *r=4* for the LFS data, and then we compute 95% CIs for future behaviour of this model observed at Q3/2020, Q4/2020 and Q1/2021.

b) All the pilot value data for (Q3/2020, Q4/2020 and Q1/2021) fell into the corresponding CIs, except for Ind1 at Q1/2021. However, it is shown that this value falls into the 99% CI.

Therefore, using comprehensive panel approach described above, this study has confirmed that there are no breaks in the LFS time series for the time period from Q3/2020 to Q1/2021, where the LFS data were collected according to the new LFS methodology.

Both methods applied indicate that the implementation of IESS HR did not lead to notable or consistent break in series with regard to employment and unemployment indicators. While both experimental and quasi-experimental approach suffer from low reliability (and broad confidence intervals) of estimates due to small samples or short series, none provides evidence of series breaks that would merit introducing correction factors for any or all indicators with any degree of confidence that those would improve comparability.