IMECONF
5th International Conference On Research In
MANAGEMENT AND ECONOMICS
17-19 December 2021
Berlin, Germany

"Winter Is Coming": Can Financial and Macroeconomic Variables Predict Crises?

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Abstract.

This paper focuses on the analysis of business cycles in a group of 11 Emerging European economies. The objective of this paper is twofold. First, we aim to test which macro-financial indicators provide the earliest warning signals of impending recessions for the selected group of countries using the signal method. We also test whether financial or macroeconomic group of indicators are able to catch the recession signals earlier using the Mann Whitney U Test. Second, to correctly identify the predicting indicators that emit early signals of incoming recessions, we aim to precisely identify the points in time when the business cycles entered the phase of recession, i.e. to pinpoint the turning points of business cycles in Emerging European economies. We thus implement the Bry-Boschan algorithm, adjusted for the quarterly GDP time series, to identify the dates of recessions in a selected group of countries more precisely, thus offering a methodological contribution to the literature. Our results indicate that the conventional and the BBQ method of identifying recessions correspond to a large extent, but not entirely, thus justifying the use of more sophisticated methods of determining turning points of business cycles. Our analysis shows that financial indicators offer earlier warning signals of impending recessions than macroeconomic indicators. We find that the most precise indicators for early signaling of impending recessions contain five financial and two macroeconomic indicators. Namely, the slope of the yield curve on euro bonds and on treasury bonds, the current account balance to GDP ratio, the real estate price index, yield on 2-year treasury bonds, the coefficient of self-financing of commercial banks and TED interest spread.

Keywords: Bry-Boschan algorithm, business cycles, predicting recessions, turning points

1. Introduction

This paper focuses on the analysis of business cycles in a group of Emerging European economies. The contribution of this paper is twofold. First, we aim to test which macro-financial indicators provide the earliest warning signals of impending recessions for the selected group of countries. Early warning indicators for recessions can be divided into various groups, depending on the type of variables used. In this paper the indicators will be divided into two main groups: financial and macroeconomic indicators. We will test whether one group sends earlier signals of incoming recessions than the other. The answer to this question is an important input for policy makers given that a timely counter-cyclical monetary and fiscal policy response depends on the correct detection and interpretation of signals emitted from the financial and real spheres of the economy. If the analysis shows that one group of indicators emits earlier signals than the other, the possible absence of signals from the former group of indicators may imply a low probability for the emergence of future recession episodes, regardless of the existence of signal from the latter group.

However, to correctly identify the predicting indicators that emit early signals of incoming recessions, we need to precisely identify the points in time when the business cycles entered the phase of recession, i.e. to pinpoint the turning points of business cycles. Although the conventional way of identifying recessions is to wait for the country to enter two consecutive quarters of negative GDP growth, recent macroeconomic research has shown that other, more sophisticated methods can be more precise in determining the precise turning points of business cycles (Krznar, 2011). To that end, our second contribution and objective is to implement the Bry-Boschan algorithm, adjusted for the quarterly GDP time series, to identify the dates of recessions in a group of 11 Emerging European economies more precisely, thus offering a methodological contribution to the literature.

With the emergence of various financial crises and recessions in emerging economies at the turn of the millennium, international financial institutions have started to develop early warning systems to identify weaknesses in economies in a timely fashion and to predict adverse economic and financial developments (Bussiere & Fratzscher, 2006). Caggiano et al. (2014) defined the early warning systems as models that serve to warn of the risk of recessions or financial crises by employing specific theoretical and empirical analyses.

Early warning indicators have a particular importance for the policy makers as they facilitate identification of weaknesses in an economy and implementation of preventive measures to avoid a recession (Bussiere & Fratzscher, 2006). Period of signalization is important as well since early identification of weaknesses ensures more time to implement preventive measures (Bucevska, 2011). Implementing any type of preventive measures represents a cost for policy makers, so they may be prone to creating a less sensitive model. On the other hand, failure to recognize an incoming recession in time may lead to much larger costs for policy makers and the economy as a whole (Bussiere & Fratzscher 2006).

2. Selection of indicators to forecast recessions

Early warning indicators of recessions are most often sorted into specific groups based on the data used for their calculation. Edison (2003) proposed a division of indicators based on the current account, capital account, sectoral and financial indicators. Similar groupings have been made by Andreou et al. (2009), based on monetary, current account, capital account,

banking and sectoral indicators. Abiad (2003) divided them into macroeconomic, capital flow and financial fragility indicators.

Some authors proposed much more detailed groupings. Babecky et al. (2012) and Frankel & Saravelos (2012) grouped the indicators into monetary conditions, interest rates, banking sector conditions, capital market conditions, money and credit, debt and savings, foreign debt, real estate prices, real economy, fiscal conditions, external balance, global variables, etc.

Following Berge (2015), in this paper we divide the indicators into two basic groups – financial and macroeconomic indicators. The following 23 financial and 23 macroeconomic indicators have been included in our analysis.

In the group of financial indicators, we included: stock market index, VIX index, bank deposits adjusted for CPI, bank deposits to GDP ratio (%), bank loans to deposits ratio (%), bank loans to GDP ratio (%), coefficient of self-financing of commercial banks, central bank assets to GDP ratio (%), international reserves to GDP ratio (%), monetary multiplier (M1/M0), M2 growth rate, M2 to international reserves ratio, foreign assets to M3 ratio, real interest rate on deposits, real interest rate on loans, money market interest rate, LIBOR, 2-year treasury bills yield, slope of the yield curve for treasury bills, interest rates on US treasury bills, slope of the yield curve on US treasury bills, slope of the yield curve on euro-denominated bonds, TED interest rate spread.

In the group of macroeconomic indicators, we included: export of goods, import of goods, foreign debt to exports ratio, foreign debt to international reserves ratio, current account balance to GDP ratio (%), budget balance to GDP ratio (%), gross national savings growth rate, gross national savings to GDP ratio, nominal effective exchange rate, market pressure index, unemployment rate, inflation rate, world oil prices growth rate, raw material price index, real estate price index, consumer confidence index, economic sentiment index (ESI), industrial production growth rate, GDP growth rate in OECD countries, global exports, copper to gold price ratio, political stability.

The data was acquired from the national statistical office databases, central bank databases and databases of international organizations like Eurostat, International Monetary Fund, OECD and specialized websites like Investing.com (2019). More details on the variable calculation is available from the authors upon request. To determine the recession periods, seasonally adjusted quarterly real GDP data (2010 prices) was used, acquired from Eurostat. The time period spans from 1995:Q1 to 2018:Q2.

3. Methodology**Identifying the Periods of Recessions and Business Cycle Turning Points**

To make the recession forecasting models as accurate and reliable as possible, precise identification of business cycle turning points is needed. The literature offers various methods do determine the phases of business cycles, among which are the so-called conventional method based on two consecutive quarters of GDP decline and the Bry-Boschan algorithm (Krznar, 2011).

The conventional method is most often used to identify periods of recessions (Lee et al., 2009). The idea behind the method is to avoid confusing a random statistical deviation or a one-off event with an actual recession (O'Donoghue, 2009). This method assumes that a certain quarter is the peak of a cycle if its GDP growth rate is positive, followed by two

quarters of negative GDP growth. Likewise, a quarter is considered as the cycle trough if the GDP growth rate is positive in quarter t+1, but negative in t and t-1. It is important to use the seasonally and calendar adjusted GDP growth rates to explain the movements in GDP in the best possible way (Krznar, 2011). The shortcomings of this method are that it identifies a recession solely using GDP, which is a relatively stern measure of economic welfare as it ignores other important factors like employment, income distribution, etc. (Harding & Pagan, 2002).

The Bry-Boschan method to determine business cycle turning points is included among the most frequently used non-parametric methods (Bry-Boschan Quarterly – BBQ). This method comprises six basic steps and several sub-steps, as detailed in Bry & Boschan (1971). Given that the BBQ method identifies the turning points based on movements around local maxima and minima, adding new observations rarely affects the previously identified turning points. Additional advantage of the method is that the importance of non-typical values is equally important as the values close to local maxima and minima. One needs to understand, however, that the BBQ method cannot identify the turning points at the beginning and the end of sample (first two and last two observations), given the lack of previous/following observations needed for identification (Krznar, 2011).

The countries included in the analysis are Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

3.2. Measuring the Accuracy in Predicting Recessions

To measure the accuracy of indicators used for predicting recessions, we will use the signal method and the Mann-Whitney U Test.

In the signal method, the signal period is set at 18 months and for each of the 18 months before the recession started we will identify situation A (signal generated) or situation C (signal missing). For months outside the signal periods we will identify situation B (false signal generated) or situation D (no signal). The sums of these situations will be used to calculate the share of correct signals, equal to A/(A+C), the share of false signals, equal to B/(B+D), and the measure of signal error (ω), equal to [B/(B+D)]/[A/(A+C)] for each country.

To determine the critical values, the measure of signal error of indicators will be minimized for each country. Thus, a measure of signal error will be calculated for the entire set of values for each country, and the centile of the set for which the signal error is the lowest will be selected. Implementation of this procedure for each country will identify a specific centile of the set which will represent the critical value at which the signal error is minimized. The comprehensive measure of signal error for a particular indicator is calculated as the average of signal errors for all analyzed countries.

To answer the question whether the financial or macroeconomic indicators emit earlier warning signs of recessions, we employ the one-tailed Mann - Whitney U Test. This test is one of the non-parametric tests without a pre-defined model structure, but rather it is determined based on the data. The test was independently developed by Mann & Whitney (1947) and Wilcoxon (1945).

Mann - Whitney U Test compares how many times a variable from one sample has been ranked above the variable from another sample. Variables from both samples are grouped together, with rank 1 assigned to the lowest value, rank 2 to the next lowest, and so on. After the variables are ranked, the ranks are summed and divided by the total number of variables.

Variables with equal values are assigned the same rank. The test is done by calculating the U-statistics for each set, following:

$$U_x = n_x n_y + ((n_x(n_x + 1))/ 2) - R_x \quad (1)$$
$$U_y = n_x n_y + ((n_y(n_y + 1))/ 2) - R_y \quad (2)$$

where n_x is the number of observations in the first sample, n_y in the second sample, Rx is the sum of ranks assigned to the first sample, and Ry to the second. If n_x and n_y are larger than 8 (which is the case here), a normal approximation may be used (Mann & Whitney, 1947), where:

$$\mu_u = (U_x + U_y)/2 \quad (3)$$
$$\sigma_u = \sqrt{((n_x n_y)(N + 1))/12} \quad (4)$$

In case the groups obtain the same value, the formula for standard deviation becomes:

$$\sigma_u = \sqrt{\frac{n_x n_y}{N(N+1)} * \left[\frac{N^3 - N}{12} - \sum_{j=1}^{g} \frac{t_j^3 - t_j}{12}\right]} \quad (5)$$

where g is the number of equal values, and t_j is the number of equal ranks in group j.

The null hypothesis of the Mann - Whitney test is that two independent sets are homogenous and have identical distribution (Nachar, 2008), i.e. that there is an equal probability that a variable from the sample of financial indicators has a higher or equal rank than a variable from the sample of macroeconomic indicators. The alternative hypothesis is that the time of signal generation is stochastically longer (signals are generated earlier) for financial indicators. To reject the null and accept the alternative, the empirical z-score (z*) has to be higher than the critical value of z-score (z_α) at the 1% level of significance:

$$z = \left(\left|U - \frac{n_x n_y}{2}\right|\right) / \sigma_u \quad (6)$$

$$H_0: \quad p(x_i > y_i) = ½ \rightarrow z^* \leq z_\alpha \quad (7)$$
$$H_1: \quad p(x_i > y_i) > ½ \rightarrow z^* > z_\alpha$$

where x_i is a variable (the moment of first emitted signal) from the set of financial indicators, while y_i is a variable from the set of macroeconomic indicators.

4. ResultsComparison Between the Conventional and BBQ Method to Identify Business Cycles

Our analysis has shown that in 11 Emerging European economies there were combined 25 recession episodes in the analyzed period, with an average duration of 5.52 quarters. in some countries the recessions were only two quarters long, while the longest recession was observed in Croatia with the duration of 18 quarters. The analysis has also shown that, in the entire sample, recessions appeared in 13.8% of observed quarters.

The highest average GDP growth rates were recorded in Lithuania (1.01%), Estonia (0.98%), Slovakia (0.96%) and Latvia (0.95%), while the lowest average growth rates were in Croatia (0.47%). This can be explained by the fact that Croatia found itself in a recession for the highest number of quarters (23), which is especially concerning given that the time period for

analysis was the shortest for this country (from 2000 onwards). Recession periods have been identified using the conventional method and the Bry-Boschan algorithm (BBQ). The following findings can be emphasized:

- For Bulgaria, using the conventional method we identify four recession periods with the total duration of 19 quarters. BBQ method confirms this finding, but identifies that the 1998 recession started two quarters earlier than identified by the conventional method;
- There were three recessions in Czechia, with the total duration of 12 quarters, equally identified by the conventional and BBQ method;
- There were two recessions in Estonia, with the total duration of nine quarters, but BBQ method found that they both started two quarters earlier than indicated by the conventional method;
- Croatia recovered the longest from the 2008-09 global recession, with 23 quarters of local recession. Using the conventional method, two recession periods were identified, while the BBQ method joined them together in one large recession;
- Three recessions were identified for Latvia, with 20 quarters of total duration. BBQ method identifies the start of the 1995 recession one quarter earlier than the conventional method, while for the other recession it identifies that it ended two quarters earlier.
- Two recessions with total durations of 10 quarters are identified for Lithuania, equally identified using both methods;
- Hungary had three recessions of 13 quarters in total. BBQ method identified one additional recession that lasted through the entire 1995 and half of 1996;
- Poland had only one short two-quarter recession in 2001, confirmed by both methods;
- Using the conventional method, two recessions lasting 13 quarters in total have been identified for Romania. BBQ method identified one additional recession lasting through entire 1995;
- Similar to Poland, Slovakia experienced only one short four-quarter recession in 1999, confirmed by both methods;
- Slovenia had two recessions with the total duration of 13 quarters. BBQ method identified that the global recession ended in mid-2009, and not late-2009 as the conventional method suggested.

We conclude that the conventional and the BBQ method match to a large extent, but not one-for-one, with deviations that confirm the justification for using more sophisticated methods to identify business cycle turning points.

4.2. Accuracy Comparison of Financial and Macroeconomic Indicators

Tab. 1 compares the level of accuracy for specific types of indicators, based on the signal method and the measure of signal error. It can be seen that the observed financial indicators are more precise than macroeconomic ones, given that they have a lower average value of signal error (0.442 compared to 0.600, respectively). In addition, with equal sample sizes, financial indicators contain 10 indicators with the signal error (ω) lower than 0.4 (which can be considered as very precise), while macroeconomic indicators have only two.

Table 1: *The comparison of accuracy of financial and macroeconomic indicators*

Type of indicator	No. of indicators	Min	Max	Average	Std deviation	Indicators with ω < 0,4
Financial	23	0.086755	0.718794	0.442442	0.165889	10
Macroeconomic	23	0.185062	0.926904	0.599894	0.203825	2

Source: authors' calculations

The spread of signal error measures is between 0.087 for the slope of the yield curve for euro-denominated bonds and 0.927 for the copper to gold price ratio. It is usually considered that an indicator is unreliable, i.e. not precise enough for early recognition of recessions, if its signal error is higher than 1 (Ahec-Šonje & Babić, 2002). As the most accurate indicators for early recognition of recessions in Emerging European economies using the criterion of minimizing the signal error, we identify seven indicators. Five of them are financial and two are macroeconomic: slope of the yield curve for euro-denominated bonds, slope of the yield curve for treasury bills, current account balance to GDP ratio (%), real estate price index, yield on two-year treasury bills, coefficient of self-financing of commercial banks, and TED interest rate spread.

To additionally test the relative accuracy of financial vis-à-vis the macroeconomic variables in predicting recessions, we employed the Mann Whitney U Test. Inserting data into formulae (1) – (6) we find that the empirical z-score (2.691) is larger than the theoretical critical z-value (2.326). This means that at the 1% confidence level, we can reject the null and accept the hypothesis that financial indicators have lower values of signal errors than macroeconomic indicators, thus sending more precise signals for incoming recessions in Emerging European economies. The empirical level of p-value reveals the probability of a type 1 error, i.e. the rejection of the correct null hypothesis. Given that the empirical p-value is 0.00356, which is lower than the theoretical significance value of 1% ($\alpha = 0.01$), the null hypothesis is rejected. Our findings confirm the findings of Alessi & Detken (2011), who found that financial indicators are likely to emit more information for predicting recessions than macroeconomic ones.

5. Conclusion

This paper had two objectives. First, to precisely identify the turning points of business cycles in 11 Emerging European economies using a more sophisticated Bry-Boschan method than the most commonly used conventional method. Second, we examined which macro-financial indicators provide the earliest warning signals of impending recessions for the selected group of countries using the signal method. We also tested whether financial or macroeconomic group of indicators are able to catch the recession signals earlier using the Mann Whitney U Test.

We found that the conventional and the Bry-Boschan method match to a large extent, but not one-for-one, with deviations that confirm the justification for using more sophisticated methods to identify business cycle turning points.

We then utilized 46 different indicators and divided them into two broad groups – financial and macroeconomic indicators. The signal method enabled us to measure how precise each of the 46 indicators is in recognizing incoming recessions. Using the one-tailed Mann - Whitney U Test we found that the indicators based on financial variables have lower measures of signal errors than the ones based on macroeconomic variables, implying they send more accurate signals of impending recessions. This also implies that the macroeconomic signals in

the data may be taken with caution if they are not accompanied by the financial signals as well. By doing so, it is recommended to monitor the signals of a larger number of financial and macroeconomic indicators, giving more emphasis on the indicators that proved more reliable in the past, given that no single macroeconomic indicator is completely reliable.

Based on this research, new opportunities for future research arise. This paper was focused on the Emerging European economies, characterized by a relatively high degree of democracy and financial and trade openness. A question arises as to what the findings would be in emerging economies with a different social and political setup in other geographical regions of the world. It would be insightful to compare the results obtained for Emerging European economies with the results of a more comprehensive study, including a larger group of emerging countries. Finally, future research could build upon this paper by using longer time series of data and more periods of recessions to analyze.

It may be concluded that the results of this research offer empirical evidence for better understanding the indicators for early warnings of recessions and give boost for the popularization of using such methods. To that sense, in addition to expanding the literature in the field, this paper contributes by offering new insight into utilizing the indicators for early signaling of recessions in business practice and policy making, especially for emerging economies.

Acknowledgment

This paper was supported by the Croatian Science Foundation under the project no. UIP-2017-05-6785.

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