

Petrovska, Magdalena; Krstevska, Aneta; Naumovski, Nikola

## Article

# Forecasting Macedonian Business Cycle Turning Points Using Qual Var Model

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**Magdalena Petrovska**\*  
**Aneta Krstevska**\*\*  
**Nikola Naumovski**\*\*\*

\* National Bank of the Republic  
of Macedonia

E-mail:  
PetrovskaM@nbrm.mk

## Forecasting Macedonian Business Cycle Turning Points Using Qual Var Model<sup>1</sup>

\*\* National Bank of the Republic  
of Macedonia

E-mail:  
KrstevskaA@nbrm.mk

\*\*\* National Bank of the Republic  
of Macedonia

E-mail:  
NaumovskiN@nbrm.mk

**Abstract:** This paper aims at assessing the usefulness of leading indicators in business cycle research and forecast. Initially we test the predictive power of the economic sentiment indicator (ESI) within a static probit model as a leading indicator, commonly perceived to be able to provide a reliable summary of the current economic conditions. We further proceed analyzing how well an extended set of indicators performs in forecasting turning points of the Macedonian business cycle by employing the Qual VAR approach of Dueker (2005). In continuation, we evaluate the quality of the selected indicators in pseudo-out-of-sample context. The results show that the use of survey-based indicators as a complement to macroeconomic data work satisfactory well in capturing the business cycle developments in Macedonia.

**JEL classifications:** F42, C25, C22

**Keywords:** Forecasting, Business cycle turning points, Qual VAR, MCMC, Latent variable

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<sup>1</sup> The responsibility for this paper lies solely with the individual authors. The views expressed herein do not necessarily represent those of the National Bank of the Republic of Macedonia.

## 1. Introduction

Economic analysts have been making great efforts to derive a mix of macroeconomic indicators that could summarize and predict business cycle patterns. Moreover, the prediction of business cycle phases is very challenging given that fluctuations in macroeconomic conditions are never directly observable. A good comprehension of business cycle facts is essential to macroeconomic decision-making, especially in monetary and fiscal policies. The GDP cycle was extracted using a double Hodrick-Prescott (HP) filter. This particular approach works towards achieving greater turning points signal stability. Furthermore, given that business cycle forecasting is the creation of postulates about how a business cycle will evolve in the future, analysts use a variety of economic indicators to form the predictions. For instance, the so called leading indicators are variables that have a tendency to change ahead of the economy as a whole, so they are frequently used in business cycle forecasting. Following this practice, we considered employing the European Commission's Economic sentiment indicator (ESI) for Macedonia in our analysis. Namely, the ESI as a single variable reflecting economic agents' sentiment integrates most of the information embedded in multiple indicators. We examined the leading property of the ESI relative to GDP firstly by using a static probit model. In this regard, we find that the cyclical movement of the ESI is helpful in monitoring and predicting the turning points of GDP.

A large and growing body of research (like for instance, on the case of U.S. recessions, the work by Kauppi and Saikkonen (2008), Nyberg (2010), and Ng (2012), among others), has demonstrated that including dynamic elements (e.g., lags of the binary response variable) in the probit models can produce more precise forecasts of recessions than standard probit regressions. Consequently, we focus on the Qual VAR method of Dueker (2005). One improvement that Dueker contributes to business cycle turning points forecasting literature is that this author's method includes a latent variable underlying the recession periods along with other indicators in a VAR setting. To this end, good forecasting indicators should closely match the volatile economic development.

Our Qual VAR model showed that both growth rates of real GDP, as most natural choice, and the ESI alone are good candidate indicators, however, they do not quite well reflect the recent Macedonian business cycle history. When it comes to the ESI for the Macedonian economy, we would like to point out that it is quite newly publicly available indicator and, to this end, we believe that this paper could contribute towards enlightening its forecasting power in business cycle analysis. Therefore, we proceeded with additional experiments that combine different financial and macroeconomic activity variables with the above selection

of data. After great many such simulations, we concluded that ESI along with the real GDP and the capacity utilization rate in manufacturing (which typically climbs when the economy is vibrant and falls when demand softens), can actually smoothly predict the Macedonian business cycle fluctuations. In addition, to our knowledge, this work is between the first papers on this subject for the Macedonian economy (aside from business cycle synchronization analysis).

This paper is organized as follows. The next chapter provides literature overview, while chapter 3 evaluates the ESI usefulness in assessing the current state of the Macedonian economy. Chapter 4 explains the Qual VAR approach that is used and chapter 5 provides the results, followed by the concluding part.

## 2. Literature review

The complicated nature of business cycle modelling has caused many difficulties in modern macroeconomics. During the last decades, researchers have kept on searching for the most accurate and reliable economic models to reflect in a best way the future economic behaviours. Most recession forecasting models use mathematical techniques originated from the vector autoregression method. However, a number of recent studies combine traditional probit models and vector autoregression models to develop more comprehensive dynamic probit VAR approaches.

Dueker (2005) presented a new Qual VAR model by incorporating information from qualitative and/or discrete variables in vector autoregressions. With a Qual VAR, it is possible to create dynamic forecasts of the qualitative variable using standard VAR forecasts. Previous forecasting methods for qualitative variables, in contrast, only produce static forecasts. Dueker applied the Qual VAR to forecasting the 2001 US business recession. Out of sample, the model predicted the timing of the 2001 recession quite well relative to the recession probabilities put forth at the time by professional forecasters. Most importantly, unlike traditional approaches in recession modelling, Dueker included a binary indicator for each recession as a dynamic component in the Qual VAR model. As an augmented VAR, the Qual VAR, which includes information about the qualitative variable in the form of a truncated normal latent variable, can also enhance the quality of density forecasts of other variables in the system, such as output growth, relative to the VAR without the qualitative variable.

Chen (2014) applied the Qual VAR method developed by Dueker (2005) to search for the macroeconomic indicators that fully fit the in-sample movements of busi-

ness cycle fluctuations and accurately predict the out-of-sample recession probability in Canada. This study examined the performance of several leading indicators in predicting future Canadian recessions using the sample from 1959 to 2012. Consistent with the findings from Estrella and Mishkin (1998), this paper finds that the slope of the yield curve provides the most reliable in-sample fitness of economic turning points in recent Canadian history. Besides, the US-Canada noon-spotted exchange rate also presents some in-sample forecasting power. However, none of the single variables included in this study provided significant out-of-sample forecasting power. Combining the exchange rate and the term spread provided the most accurate short-term signal of upcoming recessions in Canada. The addition of the growth rate of real chain-weighted GDP to the exchange rate and the term spread produced the most trustable forecasting model in the long run. Besides the advantages, one cannot ignore the fact that Qual VAR model may still suffer from the potential overfitting problem, thus careful choice of the appropriate forecasting indicators is crucial.

Moon and Lee (2012) evaluated the forecasting performance of the Korean ESI with respect to GDP growth and cycle. They found out that the constructed ESI (based on business survey index and consumer survey index) had a good tracking performance as a leading indicator of GDP. Using the Granger causality tests, they showed that the ESI precedes GDP growth, implying the former contains useful information in predicting GDP growth. Also, using a probit model, the authors confirmed that the ESI is helpful in monitoring and predicting the turning points of GDP.

### 3. Tracking the leading features of ESI with respect to GDP cycle

This Chapter aims to assess the extent to which the Macedonian cyclical development is affected by changes in consumer and producer business cycle evaluations, as summarized by the Economic sentiment indicator of the European Commission. Sentiment survey data are usually assumed to be leading variables relative to business cycles. The span of lead time, however, is less certain and subject to empirical verification. The amount of lead time may change over time as well. In this section, patterns of both the Macedonian business cycle and the economic sentiment cycle are analysed.

We initiated the procedure of mapping the peaks and troughs in the Macedonian economic downturns by first adopting a multivariate case of Chow and Lin (1971) as a temporal disaggregation method to estimate monthly from quarterly figures of the official GDP. For the economic cycle indicator, the industrial pro-

duction and retail trade were embedded as high frequency external information that is believed to satisfactorily represent the dynamics of the target variable<sup>2</sup>. The GDP cycle was extracted by applying a double Hodrick-Prescott (HP) filter to the previously obtained monthly figures. The HP filter is run twice to achieve a smoothed de-trended cycle (removing a long-term trend from the seasonally adjusted GDP and then smoothing this de-trended series). Namely, setting  $\lambda = 133,107.94$  in the first step and then imposing  $\lambda = 13.93$  in the second step of the filtering procedure allows us to remove the cyclical components that have a cycle length longer than 120 months and those that have a cycle length shorter than 12 months.<sup>3</sup>

The ESI is composed of the industrial, services, consumer, construction and retail trade confidence indicators. The economic sentiment indicator is compiled as an index with mean value of 100 and standard deviation of ten over a fixed sample period. Values of the economic sentiment indicator above (below) 100 indicate above-average (below-average) economic sentiment. For the purposes of the econometric analysis we generated a smoothed-curve representation of ESI. The adjustment of the sensitivity of the trend to short-term fluctuations is achieved by setting the value of the multiplier  $\lambda$  of the HP filter to 13.93.

European Commission publishes ESI for Macedonian economy (and several other candidate countries) on monthly basis, seasonally adjusted. The surveys used to construct this indicator for Macedonia were launched for the first time in May 2008<sup>4</sup>. The data set managed in this paper spans over the period from May 2008 to December 2014, reflecting this particular limitation.

Figure 1 displays the trajectory of both ESI cycle and GDP cycle, with monthly frequency. ESI cycle serves as a proxy of consumers' and producers' set of opinions about the general state of the economy. On the other hand, GDP cycle de-

<sup>2</sup> We also considered monthly data for construction works, but due to high volatility they were not included in the interpolation procedure.

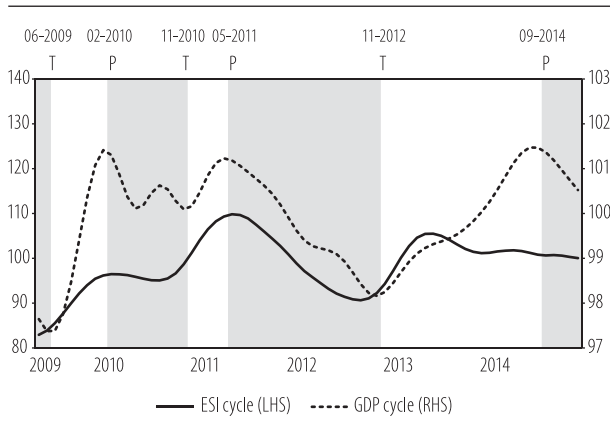
<sup>3</sup> Going from frequencies to  $\lambda$  parameter is achieved by substituting into the formula:  $\lambda = [4(1 - \cos(\omega_0))^2]^{-1}$  whereas  $\omega_0$  is the frequency expressed in radians, and  $\tau$  denotes the number of periods it takes to complete a full cycle. The two parameters are related through  $\omega_0 = 2\pi/\tau$ . So the  $\lambda$  values above correspond to  $\tau = 120$  months and  $\tau = 12$  months (Source: OECD, <http://www.oecd.org/std/compositeleadingindicatorsclifrequentlyaskedquestionsfaqs.htm#12>).

<sup>4</sup> However, the data on confidence indicator for consumers are published since May 2012. According to the User guide by EC, (March 2014), the ESI summarizes the confidence indicators in five areas of the economy, according to the following weights: industry (40%), services (30%), consumers (20%), construction (5%) and retail trade (5%).

scribes the economic conditions from the perspective of production and supply, as well from consumption and demand standing point.

The leading feature of the cyclical movement of ESI with respect to that of GDP, observed in Figure 1, is also fully-confirmed by the cross-correlation analysis

**Figure 1: Cyclical components of ESI and GDP**



To this end, Table 1 suggests patterns of small leads and lags between these variables, a factuality which will be picked up later by the Qual VAR model, given its dynamic structure. The maximum cross-correlation is 0.71 and 0.68, when the cyclical component of ESI is 0 and 1 month ahead of GDP, respectively, as shown in Table 1.

**Table 1: Cross-correlation of the cycles of the ESI and GDP**

Leading (-1) or Lagging (+1) months												
-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
0.06	0.22	0.38	0.51	0.61	<b>0.68</b>	<b>0.71</b>	0.61	0.48	0.34	0.21	0.08	-0.02

The detected relation between the cross-tabulated variables leads us to a static probit model aiming at further examining the leading property of the cyclical component of ESI with respect to that of GDP. To this end, our approach is exactly analogous to that of Moon and Lee (2012). Additionally, in continuation in this Chapter we provide an evaluation of the forecast performance of the ESI cycle in identifying the business cycle turning points in both in-sample and pseudo out-of-sample context.

Following Moon and Lee (2012), we define a binary dependent variable,  $Y_t$  which takes on only values of one and zero as follows:

$$Y_t = \begin{cases} 1, & \text{if the economy is in deceleration period} \\ 0, & \text{otherwise} \end{cases}$$

Then the estimated probability of being in the deceleration period is of the form

$$P(Y_t = 1|x, \beta) = F(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k)$$

where  $x_1, \dots, x_k$  are  $k$  explanatory variables,  $\beta_1, \dots, \beta_k$ , are the corresponding regression coefficients and  $F$  is the cumulative distribution function (cdf) of a standard normal distribution, i.e.,

$$F(a) = \Phi(a) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^a e^{-t^2/2} dt$$

Here the deceleration period is defined based on the peak and trough points of the GDP cycle. The contemporaneous and lagged values of the cyclical component of the ESI are introduced as explanatory variables in the probit model from above. Moreover, Table 2 shows that both of them are statistically significant. Note that the sign of estimated coefficient of ESI\_CYC(-1) is positive, implying that ESI\_CYC(-1) and the contemporaneous GDP cycle tend to co-move.

We also carried out the LM test for heteroscedasticity using the artificial regression method described by Davidson and MacKinnon (1993, section 15.4). We tested the null hypothesis of homoscedasticity against the alternative of heteroscedasticity. So to this end, the null was accepted. We also performed the Hosmer–Lemeshow goodness-of-fit test. The test results confirmed that the model is correctly specified.

**Table 2: Probit model estimation**

Variable	Coefficient	Std. Error	z-Statistic	Probability
C	9.1340	3.0781	2.9674	0.0030
ESI_CYC	-0.8864	0.1829	-4.8453	0.0000
ESI_CYC(-1)	0.7965	0.1650	4.8263	0.0000
McFaddenR-squared	0.3953			

Hosmer-Lemeshow chi2(8) = 3.5217

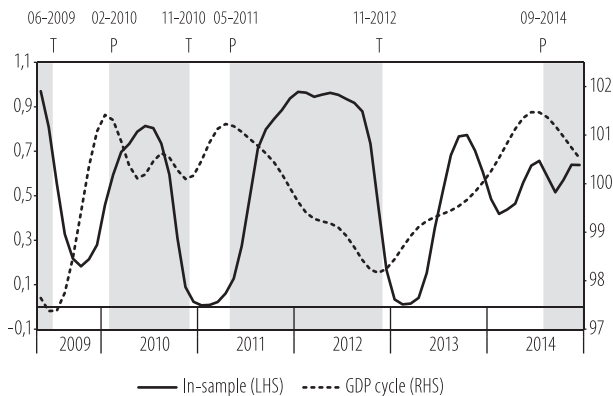
Prob > chi2 = 0.8975

Heteroscedasticity L-M test = 2.8737

Probability = 0.2377

From the estimated probit regression, the probability of being in the deceleration period can be computed for each data point, which is called in-sample forecast. The probabilities from the in-sample forecast are graphed together with the GDP cycle in Figure 2.



**Figure 2: Estimated probabilities and the GDP cycle**

Note: P-peak, T-trough.

The estimated probabilities are shown to be high in the shaded areas which represent Macedonian business cycle recessions. In particular, they are close to 1 during the deceleration phase spanning from mid-2008 to mid-2009, reflecting the new global reality i.e. the global downturn and mid-2011 to end-2012 reflecting the second wave of the crisis (Greek debt crisis).

In addition, recursive 1-step ahead out-of-sample forecasts were run over the period from May 2011 to December 2014. The predictive accuracy of these forecasts is evaluated by comparing a percentage of correct classification based on the pre-specified cutoff value, which is procedure analogous to that described in Moon and Lee (2012). So, there are two types of correct classifications. One is that the predicted probability is greater than the cutoff and the observed  $Y_t=1$ , and another is that the predicted probability is less than or equal to the cutoff and the observed  $Y_t=0$ .<sup>5</sup> The portion of  $Y_t=1$  observations that are correctly predicted is called sensitivity, while the fraction of  $Y_t=0$  observations that are correctly classified is called specificity. In this particular empirical implementation, the sensitivity is calculated for the deceleration phase and the specificity for the acceleration phase. Moreover, a percentage of correct classification among total observations is calculated.

<sup>5</sup> Recessions / expansions are defined by the binary code 1 / 0. For example, with cutoff value of 0.6, all results of the probit model for recession with probability equal or higher than 0.6 will be plausible.

**Table 3: Percent of correct classification 1-step ahead**

Cutoff value	Phase	Percent of correct classification 1-step ahead
0.4	Deceleration	100
	Acceleration	75
	Total	66
0.5	Deceleration	96
	Acceleration	60
	Total	70
0.6	Deceleration	83
	Acceleration	50
	Total	68

Table 3 summarizes the reliability of the recursive 1-step ahead out-of-sample forecasts based on three cutoff values of 0.4, 0.5, and 0.6. Percentage of correct classification depends on the choice of the cutoff. In the deceleration period it is highest when the cutoff value is 0.4 since the smaller cutoff value implies declaring deceleration more easily. Evidently the total forecast power tends to decrease as the cutoff value gets bigger. When it comes to correct classification of the acceleration periods, Table 3 highlights that the model's forecasting performance weakens to some extent. Still, our estimated probit model seems to identify the business cycle turning points satisfactorily well.

## 4. Predicting business cycle turning points using Qual VAR approach

### 4.1. A brief note on the usefulness of the Qual VAR

As we have already stated, a large and growing body of literature (like for example, on the case of U.S. recessions, the work by Kauppi and Saikkonen (2008), Nyberg (2010), and Ng (2012), among others), has found evidence that including dynamic elements (e.g., lags of the binary response variable) in the probit models can yield more accurate forecasts of recessions than standard probit regressions. Therefore, this Chapter adapts the Qual VAR model from Dueker (2005). Intuitively speaking, Qual VAR is a combination of standard VAR and a probit-type approach to predict business cycle turning points, which per se is our key interest. So, one distinctive actuality about the Qual VAR of Dueker (2005) is that it adds to the information set a so called latent index of nearness to a turning point. An increase in this index indicates that the business cycle conditions are improving - either moving closer to exiting a recession or to stronger expansion. On

the other hand, a decline in the index suggests that business cycle conditions are worsening - either moving closer to entering a recession or to a deeper recession. Moreover, for the in-sample period, the index is by construction negative during recessions and positive during expansions.

Our Qual VAR model had been inferred based on its historical efficiency in recognizing the most recent business cycle trends. In line with this actuality, a lag length of 1 month was selected. This also corroborates with Chauvet and Hamilton (2005) who recommend simpler specifications that perform well historically in the dating of the future business cycle turning points of unknown character.

## 4.2. Estimation of a Qual VAR

This section discusses the formal algorithm that we exploited to forecast future business cycle fluctuations using Dueker's (2005) multivariate dynamic probit model, also referred to as a Qual VAR. An intuitive derivation along with a detailed description of this algorithm is provided by Meinus and Tillmann (2014). This section is practically an adaptation of these authors' work.

So, intuitively, the Qual VAR model augments a standard VAR with a probit-equation for the probability of a recession. Due to this non-linear equation, estimating the model involves evaluating an integral numerically, which is implemented by Markov Chain Monte Carlo (MCMC) techniques. As in simple probit models, one can assume that a continuous latent variable,  $Y_t^*$ , lies behind the binary dependent variable, i.e. a 0/1 variable that denotes expansions and recessions, with switches at business cycle turning points.

The factuality that the latent variable,  $Y_t^*$ , is an autoregressive process makes the dynamic probit a proper equation for a VAR system. The law of motion of the latent variable  $Y_t^*$  is shown in equation (1). In the application to forecasting of the business cycle developments, the latent variable  $Y_t^*$  can be called an index of nearness to a turning point, because its distance from zero indicates how many standard deviations the economy is from a business cycle turning point. It is defined as an autoregressive process of order  $\rho$  depending on a constant  $\delta$ , its own lagged values and a set of lagged explanatory variables  $x_{t-p}$ ;  $\phi$  and  $\beta$  are vectors of the coefficients;  $\epsilon_t$  is a random error term following standard normal distribution and  $t=1, \dots, T$  is the time index.

$$y_t^* = \delta + \sum_{l=1}^{\rho} \phi_l y_{t-l}^* + \sum_{l=1}^{\rho} \beta_l X_{t-l} + \epsilon_t, \quad \epsilon_t \sim \mathcal{N}(0,1) \quad (1)$$

We associate the value of one to a binary variable  $y_t$  if business cycle downturn occur in period  $t$  and zero otherwise. The value of the binary variable  $y_t$  takes the form

$$y_t = \begin{cases} 0 & \text{if } y_t^* > 0 \\ 1 & \text{if } y_t^* \leq 0 \end{cases} \quad (2)$$

The VAR ( $\rho$ ) process for the dynamics of  $k$  regressors is given by

$$Y_t = \mu + \sum_{l=1}^{\rho} \phi^{(l)} Y_{t-l} + v_t, \quad (3)$$

$$v_t \sim \mathcal{N}(0, \Sigma)$$

with a  $k \times 1$  vector  $Y_t = (x_t, y_t^*)'$  where  $x_t$  incorporates  $k-1$  time series of observed macroeconomic data and  $y_t^*$  constitutes a vector of the latent variable. The set of VAR coefficients is described by

$$\Phi^{(l)} = \begin{bmatrix} \Phi_{XX}^{(l)} & \Phi_{Xy^*}^{(l)} \\ \Phi_{y^*X}^{(l)} & \Phi_{y^*y^*}^{(l)} \end{bmatrix}, \quad (4)$$

$\mu$  is a  $k \times 1$  vector of constants and  $v_t$  constitutes the  $k \times 1$  error vector. The covariance matrix of the errors is  $\Sigma$ .

Dueker (2005) shows that the model (3) can be estimated by MCMC class of algorithms for sampling from a probability distribution, in particular via Gibbs Sampler. A Gibbs Sampling strategy allows joint estimation of the VAR coefficients  $\phi$ , the covariance matrix of the VAR residuals  $\Sigma$  and the latent variable  $y_t^*$ .

With a sufficient number of iterations  $i$ , the obtained draws make up the true joint posterior distribution. Thus, Gibbs Sampling only requires knowledge of the full conditional posterior distribution of the VAR coefficients  $\phi$ , the covariance matrix  $\Sigma$  and the latent variable  $y_t^*$ .<sup>6</sup>

With each iteration we generate a draw for the latent variable by first establishing a state space model. The state equation is defined as:

<sup>6</sup> The conditional posterior for the VAR coefficients under the Jeffrey's prior is multivariate Normal and the conditional posterior of the variance is Wishart distributed. In each period a single observation of the latent variable is truncated Normal with truncation limits imposed by the observable binary variable  $y_t$ .

$$\begin{bmatrix} y_t^* \\ y_{t-1}^* \\ y_{t-2}^* \\ \vdots \\ y_{t-\rho+1}^* \end{bmatrix} = \begin{bmatrix} c_{y^*} \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} \begin{bmatrix} \Phi_{y^*y^*}^{(1)} & \Phi_{y^*y^*}^{(2)} & \Phi_{y^*y^*}^{(3)} & \dots & \Phi_{y^*y^*}^{(\rho)} \\ 1 & 0 & 0 & \dots & 0 \\ 0 & 1 & 0 & \dots & 0 \\ \vdots & \vdots & \ddots & & 0 \\ 0 & 0 & \dots & 1 & 0 \end{bmatrix} \begin{bmatrix} y_{t-1}^* \\ y_{t-2}^* \\ y_{t-3}^* \\ \vdots \\ y_{t-\rho}^* \end{bmatrix} + \begin{bmatrix} \Phi_{y^*X}^{(1)} & \dots & \Phi_{y^*X}^{(\rho)} \\ 0 & \dots & 0 \\ 0 & \dots & 0 \\ \vdots & \vdots & \vdots \\ 0 & \dots & 0 \end{bmatrix} \begin{bmatrix} X_{t-1} \\ X_{t-2} \\ X_{t-3} \\ \vdots \\ X_{t-\rho} \end{bmatrix} + \begin{bmatrix} \epsilon_{y^*,t} \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} \quad (5)$$

With the following measurement equation:

$$y_t^* = [1 \quad 0 \quad 0 \quad \dots \quad 0] \begin{bmatrix} y_t^* \\ y_{t-1}^* \\ y_{t-2}^* \\ \vdots \\ y_{t-\rho}^* \end{bmatrix} \quad (6)$$

So, we set up a state-space model, and smooth the data with a measurement equation that leaves out only one data point. The Kalman smoother<sup>7</sup> gives the mean and variance of the state variable, i.e.  $y_t^*$  given all the other  $y_t^*$  plus the rest of the model. Suitable initial values for the Smoother can be obtained from the binary data for the latent variable and from OLS estimates for the coefficients given the binary data. Contingent on the first two moments we then sample from the truncated Normal for  $y_t^*$ . We start the Kalman Smoother in period  $\rho-1$ , and generate conditional draws for the VAR coefficients from a multivariate Normal.

For the VAR, everything except the lag coefficients on the  $y_t^*$  end up in the “X” component of the state space model, the state equation only needs the dynamics involving the  $y_t^*$ . The MCMC sampler was set up to do 30,000 iterations. The first 5,000 iterations were discarded not only to allow the sampling process to converge to the posterior distribution but also to be less dependent on the initial values. Draws of the VAR coefficients from the OLS distribution that were not

<sup>7</sup> The Kalman filter uses past and current observations to predict the current state, (i.e.,  $\{S_t|Y_t\}$  for each,  $t$  where  $S_t$  is state variable, i.e. unobserved variable, and  $Y_t$  is observed variable). While this is sufficient for computing the likelihood of the system, this is suboptimal for estimating the sequence of states. The econometrician should use all available data to estimate the sequence of states  $\{S_t|Y_T\}$  (for each  $t$ ), which is the advantage when using Kalman smoother which uses current, past and future available observations.

stationary were rejected and re-sampled. From the resulting sample, we calculate the mean of the latent variable, the VAR coefficients and the variance.

### 4.3. The data set

The first part of this section provides a basic argument for each variable selected in the model building process, while the second part elaborates upon the data transformation techniques.

As a first step, as we already mentioned, the business cycle is extracted from the monthly real GDP data series using a double Hodrick-Prescott (HP) filter. Furthermore, a binary dependent variable is created to take value 1 if the economy is in deceleration period and value 0 otherwise. The finally selected indicators beyond this dummy variable can be classified as survey data and macroeconomic data. A joint feature that lies behind these variables is their strong link with the GDP cycle.

Our Qual VAR model put together the following indicators: real GDP (interpolated GDP, with monthly frequency), as the most comprehensive measure of the state of the economy, the ESI, as well as the capacity utilization rate in one of the main productive sectors, i.e. manufacturing.

As a survey-based indicator, the ESI aims to get insight into the mindsets of economic agents, both from the supply and the demand side of the economy. If consumers and manufacturers are optimistic about the current and future economic situation, they might increase their consumption and production, respectively.

The capacity utilization rate in manufacturing is also a well-recognized indicator of economic slack at a point in the business cycle. The information it provides is about the extent of spare or used production capacity, so it therefore measures the “output gap”, whether positive or negative. Intuitively, if growth were gaining momentum, capacity utilization ought to be increasing. The opposite is true if utilization levels are decreasing, signalling a deceleration in the economy.

Restricted by a non-availability of longer series for the ESI, the data set managed in this section covers the period starting from May 2008 and ending in December 2014. Regarding the final data transformations, we would like to stress that our Qual VAR employs the annualized monthly percentage change in real GDP (log approximation based on seasonally adjusted data); the year-on-year change in the ESI level as well as the year-on-year percentage point change in the capacity utilization rate in manufacturing. All of them come along with the binary

variable illustrated earlier in this paper. The ESI and capacity utilization level in manufacturing enter the model in year-on-year changes since their 12-month differences exhibit high correlation with their reference series (i.e. GDP cycle). Moreover, the usage of the 12-month change is a parsimonious way of allowing longer lags to enter the model (i.e. 1 parameter summarizes 12 lags). Another potential benefit in enabling longer lags to play a role lies in the fact that it permits smoother trajectory of the latent business cycle turning point index.<sup>8</sup> Additionally, this type of data formulation proved to deliver significant prediction accuracy gain around business cycle turning points (Section 5 addresses this turning point signal stability issue in greater detail).

When it comes to data selection process, we would like to acknowledge that a variety of VAR-specifications covering different real and financial variables were tested. To this end, we found that the monthly growth rates of both the real GDP and ESI alone serve as poor forecast indicators. The model extension with the inclusion of the monthly annualized inflation rate along with the monthly change in both, CB bill rate (main policy rate) and money supply M2 did not help as well in improving the model's predictive power.

## 5. Empirical results

The Qual VAR model that we propose tries to improve on the early detection of the business cycle turning points. With this regard, we argue that an adequate forecasting model should provide a reasonably good record of business cycles in pseudo out-of-sample context. Following this evaluation criteria, we found that our Qual VAR is satisfactorily successful in the accurate and timely assessment of near-term business cycle developments. The next section is an overview of the ability of our model to capture the most recent cyclical facts.

### 5.1. Pseudo out-of-sample simulation

At this point, we would like to accentuate that, the analysis of the model's forecasting performance is labelled as "pseudo" because the vintages are not obtained

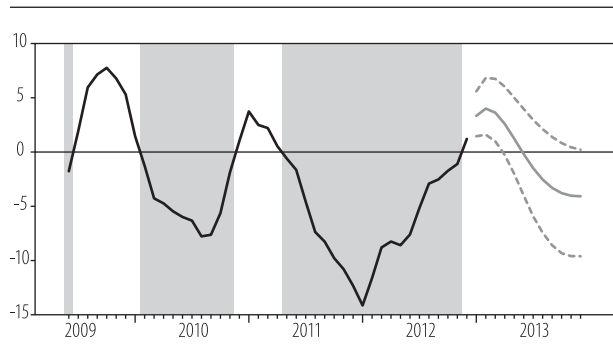
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<sup>8</sup> In the Qual VAR, the latent index (unobservable variable), driving an observable binary variable, and a number of other observables (jointly) follow a VAR process. Estimating a VAR process instead of a single state space specification using solely the Kalman smoother procedure, thereby exploiting more information, leads to efficiency gains in the identification of the latent variable.

in pure real time but from the latest available data set – a practice perceived as a natural framework to evaluate the value added in forecasting.

The Figure 3 plots the pseudo real-time prediction of the direction of the business cycle in 2013 from information set ending in December 2012. The ex post knowledge on the real direction of the GDP cycle in the corresponding period points out that the accuracy of the index is limited to only near-term business cycle developments (the first few months).

**Figure 3: Posterior mean of latent variable and its 12-months-ahead forecast (shaded areas indicate recession dates)**



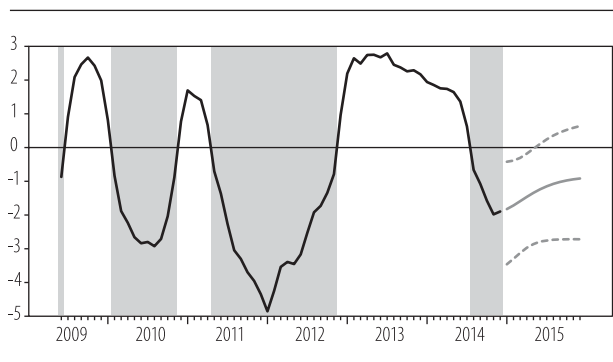
In order to achieve greater quality assurance, we performed an additional robustness check by repeating the above procedure on a data set ending in December 2010. This time, results comply with subsequent knowledge of the cyclical facts for the entire 2011. However, like in the previous case, the empirical findings are statistically significant only for a very short horizon.

## 5.2. Pure out-of-sample results

Figure 4 displays the model simulated trajectory for the business cycle direction in 2015 from an information set ending in December 2014.

The predicted raise in the index indicates that the business cycle conditions are expected to improve in 2015, i.e. a recession is not foreseen that far

**Figure 4: Posterior mean of latent variable and its 12-months-ahead forecast (shaded areas indicate recession dates)**





ahead. But again, the statistically significant period spans only over the first few months of 2015.

All in all, the results suggest that our Qual VAR predicts the business cycle developments reasonably well on a near-term horizon, so that forecasts of it are perceived to be a useful addition to NBRM's existing framework aimed at GDP nowcasting.

## 6. Conclusion

The derivation of a mix of macroeconomic indicators that could summarize and predict business cycle patterns is usually a challenging task, given the fluctuations in macroeconomic conditions. A good understanding of business cycle facts is crucial to macroeconomic decision-making, especially in monetary and fiscal policies. This paper describes the procedure of mapping the peaks and troughs in the Macedonian economic cycle. A number of recent studies in this area combine traditional probit models and vector autoregression models to develop more comprehensive dynamic probit VAR approaches and that is also done in this paper in the case of Macedonian economy.

Sentiment survey data are commonly assumed to be leading variables relative to business cycles, therefore, we use the Economic sentiment indicator (ESI) published by the European Commission for the Macedonian economy. The detected relation between these two variables points us to a static probit model aiming at further examining the leading property of the ESI with respect to GDP. Additionally, we provide an evaluation of the forecast performance of the ESI cycle in identifying the business cycle turning points in both in-sample and pseudo out-of-sample context. The estimated probabilities within in-sample forecast are shown to be high during the deceleration phase of the Macedonian business cycle spanning from mid-2008 to mid-2009, reflecting the global economic downturn and from mid-2011 to end-2012 reflecting the second wave of the crisis (Greek debt crisis). The predictive accuracy of out-of-sample forecasts is evaluated by comparing a percentage of correct classification based on the pre-specified cutoff value, which is procedure analogous to that described in Moon and Lee (2012). The estimated probit model seems to identify the business cycle turning points satisfactorily well.

According to a large and growing body of literature, the inclusion of dynamic elements in the probit models can yield more accurate forecasts of recessions than standard probit regressions. Therefore, we adapt the Qual VAR model from

Dueker (2005). Our Qual VAR model put together the following indicators: real GDP (interpolated GDP, with monthly frequency), ESI and the capacity utilization rate in manufacturing. Considering its reasonably good track record in approximating the business cycle facts in pseudo out-of-sample context, we found that our Qual VAR is satisfactorily successful in the accurate and timely assessment of near-term business cycle developments. To this end, the forecasts of it are perceived to be a useful addition to the NBRM's existing framework aimed at GDP nowcasting.

## 7. References

1. Chauvet, M. and Hamilton, J. D. (2005). Dating Business Cycle Turning Points, NBER Working Paper No. 11422.
2. Chen, L. (2014). Forecasting Canadian Recession using Qual VAR Model, Master thesis, University of Ottawa, Department of Economics, ECO6999, August 2014.
3. Chow, G.C. and Lin, A. (1971). Best linear unbiased interpolation, distribution and extrapolation of time series by related series. *The Review of Economics and Statistics*, 53, 372-375.
4. Davidson, R. and MacKinnon, J.G. (1993). Estimation and Inference in Econometrics, New York: Oxford University Press.
5. Dueker, J. M. (2005). Dynamic Forecasts of Qualitative Variables: A Qual VAR Model of U.S. Recession, *Journal of Business & Economic Statistics*, 23, 96-104.
6. Estrella, A. and Mishkin F.S. (1998). Predicting U.S. Recessions: Financial Variables as Leading Indicators, *The Review of Economics and Statistics*, 80, 45-61.
7. European Commission (2014). *The joint harmonized EU programme of the business and consumer surveys, User guide*. Brussels: European Commission.
8. Kauppi, H. and Saikkonen, P. (2008). Predicting US recessions with dynamic binary response models, *The Review of Economics and Statistics*, 90, 777-791.
9. Meinus, A. and Tillmann, P. (2014). The Macroeconomic Impact of Unconventional Monetary Policy Shocks, MAGKS Papers on Economics 201426. Philipps-Universität Marburg, Faculty of Business Administration and Economics, Department of Economics.
10. Moon, H. and Lee, J. (2012). *Forecast Evaluation of Economic Sentiment Indicator for the Korean Economy*. Basel, IFC Conference, BIS.
11. Ng, E. (2012). Forecasting US recessions with various risk factors and dynamic probit models, *Journal of Macroeconomics*, 34, 112-125.
12. Nyberg, H. (2010). Dynamic probit models and financial variables in recession forecasting, *Journal of Forecasting*, 29, 215-230.