Coincident, leading and recession indexes for the Lithuanian economy

Agnė Reklaitė*

Abstract

In this paper coincident and leading economic indicators are analysed and used to construct coincident, leading and recession indexes for the Lithuanian economy by applying Stock and Watson (1989) methodology. Coincident and leading indexes describe the dynamics of the Lithuanian economy fairly well. The recession index accurately predicts periods of economic contraction.

Keywords: Recession, Coincident and Leading Indicators, Stock and Watson method, Kalman Filter

JEL classification: C43, E32, C10

Introduction

Analysis of coincident and leading economic indicators began with the works of Mitchell and Burns (1946). They started to analyse economic time series to determine if their cyclical turning points lagged, coincided or lead with the business cycle of the economy. According to this division these time series were combined into coincident, leading and lagging indexes by NBER (National Bureau of Economic Research) economists Shiskin and Moore (1968). Methods for constructing economic indexes were based on the weighted averaging of selected series. These indexes are capable of providing additional information on the direction of the business cycle. Attention to this field of research grew among economics practitioners and, as a result, all the developed countries (e.g. OECD countries) and some major developing economies have institutions and departments responsible for calculating and publishing these indexes as economic indicators used to summarise and forecast macroeconomic activity.

Traditional methods for leading economic index construction were developed by the U.S. Department of Commerce and are based on averaging the growth rates of selected series of the leading indicators, and variable selection relies heavily on economic insight rather than econometric models. Another weak spot in Department of Commerce methodology is lack of a dynamic component and constant need of revisions, which was pointed out by Chauvet (1998). Auerbach (1982) develops a more advanced method for variable selection

*Vilnius University, Faculty of Mathematics and Informatics, Address: Naugarduko St. 24, LT-03225 Vilnius, Lithuania, E-mail: agne.reklaite@gmail.com
and computation of weights, but the basic principle of weighted summing is left unchanged. Linear combination of coincident series is also applied by Issler and Vahid (2003) and NBER methodology is heavily relied on in their paper. The means of selecting leading indicators in index construction is extensively described in the paper by Fritsche and Stephan (2000).

Stock and Watson (1989) suggested a new methodology for estimating coincident and leading economic indexes. They used a dynamic single factor model to evaluate the “unobserved state of the economy”, and applied the Kalman filter to estimate its parameters. Their method of building a leading economic index was based on a non-traditional approach: the leading economic index was constructed as a forecast of the coincident index using leading indicators. This method has all the advantages of econometric methods to check if the model is adequate and the variables used are statistically significant. Stock and Watson also proposed a new recession index which is interpreted as a probability that the economy will be in recession six months hence. Other methods for predicting recession are based on prediction of turning points, such as Hymans (1973). Hymans’ method provided interesting results; however his method did not take into account the magnitude of change in economic indicators, which might have caused a relatively high false signals rate.

Diebold and Rudebusch (1996) suggested a dynamic factor model with regime switching which was proved to perform very similarly to the Department of Commerce methods or Stock and Watson methods. Moreover it did bring the upside of regime switching methods: improved forecast performance and ability to track switches in optimal decision rules (e.g. in consumption or investment) which may occur with regime change. Unfortunately our data did not cover much of the period before the 1998 recession, so identification of regime change could not be feasible at the present time but it is definitely worth addressing in the future.

An alternative method for evaluating the dynamic single-factor model (other than Kalman filtering) is the Bayesian approach applied by Otrok and Whiteman (1996). The advantage of this method is the possibility to extract not only the mean, but the whole distribution of latent factor. However, accurate assumptions about prior distributions are needed in order to obtain suitable posteriors.

Another alternative to evaluate the coincident index is the method by Mariano and Kurosawa (2002) which has a certain appeal as their coincident index has a strong relation to latent monthly real GDP and is therefore easier of interpretation. However this method was not acceptable due to insufficient monthly data for the Lithuanian economy. Another method that we had to decline because of data specifics (lack of financial information), was a suggestion by McGuckin et al. (2001), which required incorporating financial information and forecasts of real variables into construction. The same reason was used for rejecting the method of Estrella and Mishkin (1998). As far as recession predictions are concerned, there are alternatives to the logit model by Gaudreault et al. (2003) or Birchenhall et al. (1999). One of them is Markov-switching models: Ralf Arens (1999) used them with interest rate spreads, another
– the probit model by Wright (2006), where the yield curve was used as a leading indicator. Markov-switching models are more data greedy than logit or probit models; they require quite a large number of historical “switches” in order to obtain accurate predictions. There are many more methods\(^1\) for economic index evaluation, but most of them are based on Stock and Watson methodology or its modifications.

Since coincident, leading and recession indexes have not previously been calculated for the Lithuanian economy, the main objective of this work is to apply Stock and Watson methodology for evaluation of these indexes for the Lithuanian economy.

This paper demonstrates that the Stock-Watson dynamic single factor model is suitable for evaluating the “unobserved state” of the Lithuanian economy. The constructed coincident economic index closely tracks the dynamics of the economy. We built an adequate linear model for evaluating the leading economic index as a six month forecast of the coincident economic index. The evaluated leading index fairly well describes the growth rates of the coincident economic index. It can be inferred from the leading index that the Lithuanian economy will fall rapidly in the 2\(^{nd}\) and 3\(^{rd}\) quarters of 2009. The logit model is developed to identify periods of recession. The Lithuanian recession index is built and provides high recession probabilities for quarters with negative GDP growth. It also gives very high recession probabilities for the 2\(^{nd}\) and 3\(^{rd}\) quarters of 2009. As an additional validating step, out of sample analysis is performed, which shows that our logit model provides high recession probabilities for actual recession periods and could be used as an early warning system.

This paper is organized as follows. The first two sections explain how the coincident and leading economic indexes are built and their statistical relationship with the Lithuanian economy is examined. The third section presents a recession index and its modelling as well as model testing. The third section is followed by the main conclusions of this study. As far as software is concerned, the dynamic single-factor model was evaluated using \textit{Eviews} software, seasonal adjustment was performed with \textit{gretl}, the rest of the computations were done using \textit{R}.

\section{Coincident index}

\subsection{Definition}

According to Stock and Watson, the coincident economic index (or CEI) reflects the “unobserved state of the economy” and is coincident with the business cycle, which consists of expansions and contractions occurring at the same time in many economic activities and commonly refers to co-movements in different forms of economic activity. The coincident

\footnote{\(^1\)Most of them are reviewed in: “Leading Economic Indicators: New Approaches and Forecasting Records”, Cambridge: Cambridge University Press.}
economic index is suitable for describing the state of the economy. Contrary to GDP, its absolute value does not show the size of the economy. It reflects GDP dynamics and could be used to identify whether the economy is in expansion or recession but is not suitable for forecasting GDP.

1.2 Potential coincident variables

We considered variables on the subject of output, employment and retail to include in the dynamic single-factor model. Variables of those subjects are commonly used by many methodologies for construction of the coincident index (e.g. Stock and Watson, NBER methodology). As far as the Lithuanian economy is concerned not all the series were of the needed length. In order to obtain a proper estimate of the coincident index for the latest period (2008-2009) it was necessary to acquire the time series starting at least in 1998 since Lithuania was in recession at that time.

The initial list of variables that we considered including in the Stock-Watson dynamic single factor model consists of employee hours in non-agricultural establishments, wholesale-retail, income from manufacturing, index of employment in the construction sector. Several variables were considered to take from each category (i.e. output, employment and retail). Selection was based on availability and their relationship to the business cycle. Since employment seemed to be lagging behind the business cycle, it was left out the model. Another variable that we decided to include in the list is the index of real estate prices. Our motivation for doing this is that the Lithuanian economy was severely affected by the real estate bubble and rapid growth of the construction sector, which is fairly well described by housing prices.

The final list of the variables we selected for the dynamic single factor model is:

- **IM** - Income from manufacturing (thousands of LTL)
- **NT** - Real estate price index
- **retd** - Wholesale-retail (index corresponding to quarters of 2005)
- **IP** - Index of production in comparable 2005 prices (thousands of LTL)

These series are quarterly seasonally adjusted data covering the period from 1998 1\(^{st}\) quarter to 2010 2\(^{nd}\) quarter. Since the **NT** series started in the 4\(^{th}\) quarter of 1998, the values of the first three quarters were extrapolated using the Holt-Winters procedure. The initial data analysis showed that these four series are \(I(1)\) processes, but they are not cointegrated (the Dickey-Fuller test failed to reject the null hypothesis about unit root existence and the Johansen
test did not provide evidence about cointegration). Therefore further analysis uses the first differences of these series logarithms.

1.3 Evaluation procedure

We follow the Stock-Watson dynamic single factor model. The coincident economic index is a transformation of the estimate of a single factor – “the unobserved state of the economy”. The structure of the model that we used in this study is:

\[
\Delta X_t = \beta + \gamma(B)\Delta F_t + \mu_t, \quad (1)
\]
\[
D(B)\mu_t = \varepsilon_t, \quad (2)
\]
\[
\phi(B)\Delta F_t = \delta + \eta_t, \quad (3)
\]
\[
\Delta C_t = a + b\Delta F_t. \quad (4)
\]

Here \( X \) is a vector of logarithms of coincident variables \( IM, NT, retd \) and \( IP \). \( F_t \) is a factor, describing the unobserved state of the economy at time \( t \). The functions \( \phi(B), \gamma(B) \)
and $D(B)$ are respectively scalar, vector and matrix lag polynomials. The error term $\mu_t$ is serially correlated and its dynamics are described in equation (2). $C_t$ is the coincident economic index. Error terms $(\varepsilon_t, \eta_t)$ are assumed to be serially uncorrelated with the zero mean and diagonal variance matrix $\Sigma$. Since $\Delta F_t$ has zero mean and unit variance (step 3 in evaluation algorithm), $a$ and $b$ are the de-normalization parameters.

Equations (1), (2) and (3) form a state-space model and its parameters and the “unobserved state of the economy” are evaluated using the Kalman filter (for more details see Hamilton (1994)).

The evaluation is performed in this order:

1. Each economic variable from vector $X$ is first-differenced: $\Delta X_t = X_t - X_{t-1}$.
2. Each series of differences $\Delta X_t$ is normalized by subtracting its mean and dividing by its standard deviation. Since $\Delta X_t$ has a zero mean there is no need to evaluate parameters $\beta$ (in equation (1)) and $\delta$ (in equation (3)) as they are equal to 0.
3. After evaluating the parameters of the state-space model with the Kalman filter, a new time series $\Delta F_t$ is acquired. This has a zero mean and unit variance, because $\Delta X_t$ is normalized.
4. $\Delta F_t$ is de-normalized (equation (4)) and the coincident economic index $C_t$ is constructed:

$$C_t = \begin{cases} 
c, & t = 0; 
c + \sum_{i=1}^{t} \Delta C_i, & t = 1,2,\ldots,T.
\end{cases}$$ (5)

Green and Beckman (1993) evaluated parameters $a$ (the trend parameter) and $b$ (the variance around that trend) as a weighted average of the trends of the coincident series, selected into the model, with weights proportional to the contributions of the indicators in the Kalman filter. An alternate method of Crone and Clayton-Matthews (2005) sets $a$ to be equal to the GDP growth trend, and the $b$ parameter is evaluated in the same way as Green and Beckman (1993). Since neither of these methods provided desirable results for the Lithuanian economy, we had to come up with a new method. This is based on minimizing the sum of squares: $\sum_{t=1}^{T}(C_t - GDP_t)^2$ (the OLS method was selected expecting to get the same periods of expansion and contraction for the coincident index and Lithuanian real GDP). This procedure can be shown combining equations (4) and (5):

$$C_t = \sum_{i=1}^{t} \Delta C_i + c = \sum_{i=1}^{t} (a + b\Delta F_i) + c = ta + b \sum_{i=1}^{t} \Delta F_i + c.$$  

This kind of equation can be rewritten in the form of a linear regression which is estimated using OLS:

$$GDP_t = at + b \sum_{i=1}^{t} \Delta F_i + c + \varepsilon_t.$$
It is worth mentioning that CEI is not an estimate of GDP (although it might look like one). CEI as well as GDP are both indicators of macroeconomic activity each of them having their own peculiarities.

1.4 Results

The following measurement equations were evaluated:

\[ \Delta I_M = \lambda_{I_M} \Delta F_t + \varepsilon_{I_M}^M, \]  
\[ \Delta N_T = \lambda_{N_T} \Delta F_t + \mu_{N_T}^T, \]  
\[ \Delta retd = \lambda_{retd} \Delta F_t + \varepsilon_{retd}^d, \]  
\[ \Delta I_P = \lambda_{I_P} \Delta F_t + \mu_{I_P}^P. \]  

The maximum likelihood estimates of these equations are listed in the table 1.

**Table 1: Maximum likelihood estimates of equations (6), (7), (8), (9) parameters**

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>St. error</th>
<th>z-statistics</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda_{I_M} )</td>
<td>0.578407</td>
<td>0.167040</td>
<td>3.462689</td>
<td>0.0005</td>
</tr>
<tr>
<td>( \lambda_{N_T} )</td>
<td>0.552367</td>
<td>0.215221</td>
<td>2.566513</td>
<td>0.0103</td>
</tr>
<tr>
<td>( \lambda_{retd} )</td>
<td>0.611800</td>
<td>0.172612</td>
<td>3.544375</td>
<td>0.0004</td>
</tr>
<tr>
<td>( \lambda_{I_P} )</td>
<td>0.408776</td>
<td>0.198672</td>
<td>2.057539</td>
<td>0.0396</td>
</tr>
</tbody>
</table>

The maximum likelihood estimates of the following transition equations (10), (11), (12) are listed in the table 2.

\[ F_t = \phi F_{t-1} + \varepsilon_{I_M}, \]  
\[ \mu_{I_P}^T = d_{I_P} \mu_{I_P}^{T-1} + \varepsilon_{I_P}^T, \]  
\[ \mu_{N_T}^T = d_{N_T} \mu_{N_T}^{T-1} + \mu_{N_T}^{T-2} + \varepsilon_{N_T}^T, \]  

The intercept in equation (10) turned out to be statistically insignificant and was eliminated.

The variances \( \sigma_1^2, \sigma_2^2 \) are of error terms \( \varepsilon_{I_M} \) and of \( \varepsilon_{retd} \) respectively. \( \sigma_3^2 \) is common variance for error terms \( \varepsilon_{I_P} \) and \( \varepsilon_{N_T} \). All estimates of those variances are listed in the table 2.

The constructed coincident economic index for the Lithuanian economy is plotted in figure 2. Real GDP is also plotted in that graph (index of real log GDP, 2005 Q1 = 100). As can

\footnote{Variances of \( \varepsilon_{I_P} \) and \( \varepsilon_{N_T} \) were restricted to be the same after running a Wald test on those coefficients.}
**Table 2:** Maximum likelihood estimates of equations (10), (11), (12) parameters and error variances $\sigma_1^2, \sigma_2^2, \sigma_3^2$

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>St. error</th>
<th>z-statistics</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>0.513014</td>
<td>0.237326</td>
<td>2.161641</td>
<td>0.0306</td>
</tr>
<tr>
<td>$d_{IP}$</td>
<td>-0.385661</td>
<td>0.150547</td>
<td>-2.561731</td>
<td>0.0104</td>
</tr>
<tr>
<td>$d_{NT1}$</td>
<td>-0.076715</td>
<td>0.198289</td>
<td>-0.386883</td>
<td>0.6988</td>
</tr>
<tr>
<td>$d_{NT2}$</td>
<td>-0.311772</td>
<td>0.197049</td>
<td>-1.582210</td>
<td>0.1136</td>
</tr>
<tr>
<td>$\sigma_1^2$</td>
<td>0.526997</td>
<td>0.035233</td>
<td>14.957653</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\sigma_2^2$</td>
<td>0.473253</td>
<td>0.031783</td>
<td>14.890232</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\sigma_3^2$</td>
<td>0.585036</td>
<td>0.020417</td>
<td>28.654065</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Figure 2:** Coincident index for Lithuanian economy and its comparison to GDP
be seen from figure 2 CEI accurately describes contractions and expansions of the Lithuanian economy and GDP dynamics is rapidly mirrored in the dynamics of the coincident economic index. Its correlation with real GDP is 0.995.

2. Leading index

2.1 Definition

The leading economic index is an indicator describing future economic dynamics. Stock and Watson (1989) constructed the leading economic index (LEI) using a significantly different method from traditional NBER methodology. Rather than combining time series of leading indicators into a composite index based on weighted average like NBER economists, they used past changes of the coincident economic index as well as leading indicators to construct the leading index as a forecast of the coincident index.

2.2 Potential leading variables

We considered 39 potential leading variables from different sectors of the Lithuanian economy (e.g. consumption, residential and non-residential sectors, employment, the foreign market and exchange rates). We selected the subset of these variables for further analysis following this procedure:

1. We examine if turning points (the points where the sign of quarter on quarter growth rates change) of leading variables have a relationship with the turning points of the coincident economic index.

2. We inspect the simple correlation between CEI and lagged potential leading variables. A potential leading variable should have a greater correlation with CEI at lags greater than one.

3. Every potential leading variable is tested to Granger cause coincident economic index.

4. We run a regression for each potential leading variable $Y_i$:

$$C_t = \beta_0 + \beta_1 Y_{i,t-l} + \varepsilon_t,$$

and obtain $R^2_l$ of those models $\forall i$. If $R^2_l$ is largest with $l = 2$ for variable $Y_i$, it is selected for construction of LEI. Here $t = 3, ..., T, l = 0,1,2, \varepsilon_t$ is an error term.

4These 39 variables were selected based only on time series length, availability and economic sense.

5Priority is set to the variables which have leading turning points corresponding to GDP for the year 2008.

6Formally, a lead of one is already good. However, if we want to catch economic growth patterns for future periods, a lead of two quarters is better since there is a delay with data publishing (usually about 2 months).
2.3 Evaluation and results

We follow a slight modification of Stock and Watson methodology offered by Gaudreault et al (2003).

The coincident economic index $C_t$ is transformed to be stationary

$$\Delta C_{t+2} = 100 \times \left( \frac{C_{t+2}}{C_t} - 1 \right), \quad t = 1, \ldots, T - 2. \tag{14}$$

Next, the differences $\Delta Y_t = Y_t - Y_{t-1}$ of leading variables are calculated for each $i$ (time series are already logged and seasonally adjusted). After that, we run a regression of $\Delta C_{t+2}$ on all differenced leading variables $\Delta Y_t$.

After eliminating insignificant variables we obtain a final list of leading indicators\(^7\):

- $st$ - Own-account construction work carried out within the country (thousands of LTL)
- $pid$ - A profitable share out of the total number of enterprises
- $Tbills$ - Average treasury bills yield.

Figure 3: Variables used in leading index construction

The quarterly data that we used cover the period from 1998 1\textsuperscript{st} quarter to 2010 2\textsuperscript{nd} quarter.

The model (eq. (15)) was constructed. The estimates of $\beta$ parameters are in the table 3.

$$\Delta C_{t+2} = \beta_0 + \beta_{st}\Delta st_t + \beta_{pid}\Delta pid_t + \beta_{Tbills}\Delta Tbills_t + \varepsilon_t, \tag{15}$$

\(^7\)The series $st$ and $pid$ were acquired from Statistics Lithuania and seasonally adjusted using Tramo seats. The source of $Tbills$ series is the Bank of Lithuania. $Tbills$ was aggregated to form a quarterly time series.
Table 3: Estimates of equation (15) parameters

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>0.3365</td>
<td>0.0554</td>
<td>6.073</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\beta_{st}$</td>
<td>2.3381</td>
<td>0.6637</td>
<td>3.523</td>
<td>0.0010</td>
</tr>
<tr>
<td>$\beta_{pid}$</td>
<td>6.6364</td>
<td>1.9177</td>
<td>3.461</td>
<td>0.0012</td>
</tr>
<tr>
<td>$\beta_{Tbills}$</td>
<td>-0.7273</td>
<td>0.3608</td>
<td>-2.016</td>
<td>0.0501</td>
</tr>
</tbody>
</table>

The adjusted $R^2$ of model (eq. 15) is 0.524. The fit and 2-steps ahead forecast are in the figure 4.

Figure 4: The changes in Lithuanian coincident economic index $\Delta C_t$ and constructed leading index LEI

As can be seen from the figure 4, the leading economic index fairly well describes the coincident index and their dynamics are similar. It also indicates that the Lithuanian economy will grow quite rapidly in the 3rd and 4th quarters of 2010.
3. Recession index

A recession is usually defined as a period of at least 2 consecutive quarters of negative GDP growth. A recession index was constructed by Stock and Watson (1989) as a probability that the economy would be in recession six months hence. Their approach is based on the idea, that recession and expansion are states of distinct economic behaviour, each of them having their individual peculiarities.

The probabilities are evaluated using historical recession periods, which were the 4th quarter of 1998, the 1st, 3rd and 4th quarters of 1999 and an interval from 2008 4th quarter to 2009 4th quarter.

The recession index construction was based on the following way, proposed by Gaudreault et al (2003):

1. We construct a binary time series \( s_t \), where \( s_t = 0 \), if the economy is in expansion and \( s_t = 1 \) if it is in recession at time \( t \). We use real GDP growth to identify the recession periods.

2. The logit model is constructed using series \( s_{t+k} \) as a dependent variable and leading indicators as predictors. In our case \( k = 2 \), which means that the recession index is a probability of recession occurring in the following 6 months. Model specification is achieved by selecting leading variables:
   - At first we regress \( s_{t+k} \) on each of the leading variables individually. Then we select the model with the lowest AIC (Akaike’s information criterion).
   - Next, each of the rest of the leading variables is separately included in the model selected the step before, and the model with the lowest AIC is selected.
   - The procedure is done again with two pre-selected variables from the steps above. The third variable is included individually from the rest of the leading variables. The process is repeated until AIC is no longer improved.

3. After selecting variables and evaluating the parameters of the logit model, we construct the recession index \( R_t \).

The model with the lowest AIC had one regressor: \( pid \). The other two models that were considered (with two regressors: \( pid \) and \( st \), and with all leading indicators) provided practically the same predictions, and the regressors \( T\) bills and \( st \) were statistically insignificant. The fact, that the ratio of profitable enterprises is useful in predicting future recessions is not surprising and makes sense from the economic point of view since this variable reflects dynamics in customer purchasing power, labour productivity and efficiency in management and

\[ ^8 \text{In this work the same definition of recession index is applied.} \]
those 3 factors are definite to have an impact on future output. The estimates of logit model parameters are in the table 4.

**Table 4: Estimates of logit model parameters**

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-3.706</td>
<td>1.118</td>
<td>-3.314</td>
<td>0.00092</td>
</tr>
<tr>
<td><em>pid</em></td>
<td>-94.436</td>
<td>29.258</td>
<td>-3.228</td>
<td>0.00125</td>
</tr>
</tbody>
</table>

**Figure 5: Recession index for Lithuanian economy**

The constructed recession index $R_t$ is depicted in the figure 5. The graph shows high recession probabilities for historical recessions. The recession probabilities for 2009 are also very high. The model provides surprisingly low probabilities for the end of 2010.

4. **Model testing**

One may wonder if this model would have provided good results in a real-time environment. In this section we perform out of sample analysis and show that our model predicts recession in advance.
In the figure 6 the 1-step (i.e. quarter) ahead and 2-step ahead forecasts are graphed. The horizontal axis represents the latest data used in model evaluation. For each period two forecasts of recession probability are graphed.

**Figure 6:** 1-step and 2-step ahead forecasts of recession probabilities

5. Conclusion

Stock and Watson (1988, 1989) offered a methodology for estimating coincident, leading indexes, and proposed a new recession index. In this paper quarterly coincident, leading and recession indexes are built using this methodology. The main conclusions of this study are the following:

- The dynamic single factor model is suitable for evaluating the “unobserved state” of the Lithuanian economy since the evaluated state has mostly the same periods for economic expansions and contractions as real GDP and tracks it very closely. Its estimate i.e. the Lithuanian coincident index, evaluated by the Kalman filter well describes the Lithuanian economy’s dynamics and its correlation with real GDP is 0.995.

- Application of OLS is proposed for evaluating de-normalization parameters of the unobserved state of the economy. The advantage of this method is that there is no need
for rescaling the index.

- The leading index was evaluated by applying linear regression as a six month forecast of the coincident economic index. A model is built where leading variables were used as regressors, its $R^2$ is 0.524. The evaluated leading index fairly well describes the growth rates of the coincident economic index. It can be indicated from the leading index that Lithuanian the economy will grow quite rapidly in the 3rd and 4th quarters of 2010.

- The Lithuanian recession index is built, and it provides high recession probabilities for actual recession periods. It also gives very low recession probabilities for the 3rd and 4th quarters of the year 2010.

- After performing out of sample analysis, it can be stated that this model has good performance in a real-time environment and could be used as an early warning system.

Acknowledgements

I would like to thank Vaidotas Zemlys and RasaBložytė for valuable discussions and support. I am also grateful to an anonymous referee, who helped to put this study in order.

References


Appendix A

Statistics Lithuania data sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>M2010108</td>
<td>Seasonally adjusted GDP</td>
</tr>
<tr>
<td>pid</td>
<td>M4032205</td>
<td>A profitable share out of the total number of enterprises 1998-2008</td>
</tr>
<tr>
<td>pid</td>
<td>M4032211</td>
<td>A profitable share out of the total number of enterprises 2009-2010</td>
</tr>
<tr>
<td>gi</td>
<td>M4032206</td>
<td>Costs of production 1998-2008</td>
</tr>
<tr>
<td>gi</td>
<td>M4032210</td>
<td>Costs of production 2009-2010</td>
</tr>
<tr>
<td>IP</td>
<td>M4050207</td>
<td>Index of production</td>
</tr>
<tr>
<td>vtvds</td>
<td>M4050207</td>
<td>The index of average number of persons employed in intermediate goods sector</td>
</tr>
<tr>
<td>retd</td>
<td>M4070202</td>
<td>Wholesale retail</td>
</tr>
<tr>
<td>IM</td>
<td>M4032209</td>
<td>Income of manufacturing 2005-2010</td>
</tr>
<tr>
<td>IM</td>
<td>M4032204</td>
<td>Income of manufacturing 1998-2008</td>
</tr>
<tr>
<td>tk</td>
<td>M7020201</td>
<td>Transportation of loads by rail (thousands of kilometres)</td>
</tr>
<tr>
<td>st</td>
<td>M4060107</td>
<td>Own-account construction work carried out within the country</td>
</tr>
</tbody>
</table>

---

IM data for 2009-2010 were constructed taking the source data and multiplying them by a certain ratio. Modification was needed because the levels for 2005-2008 differed significantly from those in data source M4032204. The ratio was the average of $\frac{x_t}{y_t}$ where $x_t$ is M4032204 data and $y_t$ was M4032209, $t$ covered the period 2005-2008.