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FORECASTING BUSINESS ACTIVITY IN POLAND WITH LEADING INDICATORS

Repartition of business indicators between coincident, lagging and leading ones has a long history which started in the 1930's in the National Bureau of Economic Research by Burns and Mitchell. Some of them are important for economic forecasts, mainly because opinions and behaviour of consumers and entrepreneurs lead the real business realisations [Moore 1961, Lahiri, Moore 1991].

Two main questions are essential for researchers using leading business indicators: are the leading indicators useful for forecasting economic activity, and are there statistical methods of building up an optimal leading indicator [Auerbach 1982].

There are several methods of forecasting business cycles and their turning points, using simple and composite leading indicators. One of them is a method of successive signals. Another, sometimes very efficient method is a rule of the two consecutive months (quarters) of leading indicator decrease [Stekler, Schepsman 1973]. More complicated methods in forecasting turning points are dealing with probability distribution [Neftei 1979, 1982] or changes of the composite indicator's slope [Andersson 2001].

The empirical researches using leading indicators for business forecasting are different in their nature. Differences concern the principles in constructing indicators as well as the nature of interdependencies between the leading and reference (e.g. forecasted) series. There are also different techniques applied for checking statistically essential leads. Despite these differences many researches on business cycles prove the usefulness of leading indicators for short and medium term forecasting. [Shiskin 1967, Morris 1969, Stekler, Schepsman 1973, Neftei 1979, Auerbach 1982, Artis, Bladen 1995, Yeend 1996, Vieweg 1996, Burki 1996, Goldrian 1996, Rekowski 1997, Matkowski 1999, Marty 1999, Diebold, Rudebusch 1999, Camba-Mendez, Kapetanis, Weale, Smith 2002, Drodowicz-Bieć 2002, Stanek 2002].

Radical changes of the social-economic system in Poland after 1990 contributed to increasing presence of market mechanisms in the processes of makieng economic decisions.The essential symptom of these processes is cyclical developmnet of the Polish economy. Using many foreign and Polish methodology experiences

and also results of empirical ex post and ex ante research of economic cycles an attempted was made to separate statistically significant leading indicators in the course of the economic cycles in Poland over the period 1992-2002 and then their application for short term forecasting[1].

The analysis covers industrial production activity, construction industry and foreign trade, using business survey data and official statistical series. Reference economic cycles were calculated as industrial production cycles, construction production cycles and Gross Domestic Product (GDP) cycles. Fluctuations of the reference cycles, which were also subject of forecasting, are expressed in current and fixed prices (1995=100). In research, a uniform methodology was accepted. Statistical series were adjusted for seasonal and random fluctuations by means of the Census method II/X-11. Then cyclical fluctuations were separated in the form of emeprical data deviations in relation to the tendency, which was calculated by means of the Hodrick-Prescott method. Selections of leads among the quantitive and business survey indicators was based on two methods – the Pearson's correlation coefficient method and Granger's test. The selected leading indicators were used to build regression models, from which the models with the best adjustment to the real values were accepted. Explanation variables assumed in regression models were at the same time used as input variables to neural networks. Forecasting of the economic cycle was based on extrapolation of regression models and on using neural networks. Efectiveness of the forecasts was estimated on the basis of the RMSE and on comparsions to the prediction of a naive method. Forecasts of the industrial production or GDP are of a short term character.

In the analysis of the manufacturing industry cycles [Gaweł 2003] and the construction industry only business survey indicators were used which come from a business test of GUS – Central Statistical Office in Warsaw. In terms of industry six models were taken into account, where the reference variables are changes of the industrial production sold in fixed and current prices as well as changes of the production in the food and furniture industries.

Estimated parameters of the regression equations are the following:

$$IP_{cn} = 100.11 + 0.38\ DF_{t-2} + 0.14\ P_{t-4}$$

$$R^2 = 0.68\ F(2, 100) = 104.79$$

$$IP_{cr} = 100 + 0.44GS_{t-1} + 0.40\ DFC_{t-8} + 0.27FR_{t-12}$$

$$R^2 = 0.83\ F(3, 99) = 156.62$$

where:

IP_{cn} – industrial production at constant prices,

IP_{cr} – industrial production at current prices,

DF – foreign demand indicator (balance),

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P – production sold indicator (balance),
GS – general situation indicator (balance),
DFC – foreign demand climate,
FR – financial liabilities regulation (balance).

The index of foreign demand 2 months ahead and the index of the production sold 4 months ahead are the statistically best business survey variables for the industrial production in fixed prices. The estimated parameters of both variables are 0.34 and 0.14 respectively, whereas determination coefficient equals 0.67. Both variables are pro-cyclical. For the production sold in current prices we assumed as explanatory variables the climate of foreign demand 8 months ahead, general economic condition 1 month ahead and the indicator of the settlement of financial liabilities 12 months ahead. The determination coefficient equals 0.82 and estimated parameters of variables are 0.40, 0.44 and 0.27 respectively. All the leading indicators behave pro-cyclically.

The forecasts of industrial production in fixed prices for the subsequent two months made by means of the regression equation and neural network which use at input the same survey variables, also gave good and correct results. The forecasts of industrial production in current prices for 1 month appeared incorrect and worse than the naive "no change" forecast.

Survey leading indicators are also useful for the analysis of the changes of economic activities at the branch level. For the production of the food industry in fixed prices the following survey indicators proved to be significant: foreign demand (5 months ahead), value of production sold (1 month ahead). All the indexes behave pro-cyclically and in 77% explain variability of the food industry production. Other business survey variables which are essential for explaining production of the food industry in current prices are: stocks of finished goods (1 month ahead) and the ability to settle financial liabilities (7 months ahead). Determination coefficient equals 0.76. Forecasts for 1 month horizon, calculated by means of regression models and neural networks, are worse than the results of the naive method.

In the case of the furniture industry, the production sold in fixed prices is best explained by the production forecasts index (10 months ahead), general business climate (1 month ahead). However, the explanatory capability of these variables is relatively low. For the production of the furniture industry in current prices, three survey indicators explain its variability in 83% – they are: the level of production sold (11 months ahead), domestic and foreign demand (6 months ahead) and employment forecast (1 month ahead). A short term – 1 month forecasts of furniture industry production were incorrect.

The results of research for the manufacturing industry allow the formulation of several important conclusions:

- Business survey indicators can be used to forecast industrial activity, however statistically essential leads are short, between 3-4 months.

- Explanatory value of survey indicators in regression models is higher for industrial production in current than in fixed prices.
- Types and importance of leading indicators depend on whether the reference cycle is expressed in fixed or current prices and also whether it concerns industry in general or a branch level.
- We obtained better adjustment of models to variations of reference values (higher correlation coefficients) when the same leading indicators were applied to neural network in comparison with regression procedure.
- Prognostic values obtained by means of regression models and neural network are similar, but for the assumed forecast horizon of 1-2 months we did not obtain satisfactory results of industrial production forecasts. Especially for the forecasts of 1 month, the naive method was better.

Another domain of the economy where we use survey leading indicators is the construction industry [Jankiewicz 2003]. The reference variables are construction and industrial production in fixed and current prices over the period from July 1993 till March 2002.

Estimated parameters of the regression equations for construction industry are the following:

$$CP_{cr} = 90.98 + E_{t-23} + 0.26\ OR_{t-11}$$
$$R^2 = 0.66\ F(3, 77) = 75.2$$

$$CP_{cn} = 94.78 + 0.14E_{t-23} + 0.17OR_{t-11} + 0.71PR_{t-12}$$
$$R^2 = 0.61\ F(3, 74) = 41$$

where:

CP_{cr} – construction production at current prices,
CP_{cn} – construction production at constant prices,
E – index of employment forecast in construction,
OR – index of order book's forecast,
PR – index of construction prcies forecast.

In regression equations of construction production in current prices the most essential are indexes of employment forecast in construction 23 months ahead and the forecast of the order books 11 months ahead. In explaining the changes in construction production in fixed prices the additional variable is the forecast of construction prices 12 months ahead.

The last year evaluation of the order books have the most important influence on variations in construction production. Regression models allow to explain 66% of variations in construction production in current prices and 61% in fixed prices. To a significantly smaller degree, which is 44%, leading indicators of construction activity explain the variations of industrial production, both in fixed and current prices.

The forecast of the construction and industrial production for the following months were made by means of regression models and neural network models, in-

troducing at input selected leading indicators. In relation to the construction production, the forecasts of regression models and neural networks are better (smaller forecast errors) than the forecasts of the naive method. In case of industrial production in fixed prices, the forecasts of neural networks are characterized by a definitely better quality, whereas for industrial production in current prices the regression method has more advantages.

The most important conclusions from the researches of survey leading indicators in construction industry are:

- Business survey indicators in the construction industry explain the ex post and ex ante fluctuations of construction production in a good way. The indexes of the order books lead changes in construction activity by 12 months.
- The forecasts of the variations of the construction and industrial production for the 3 month period, made on the basis of regression models and neural networks are in accordance with the directions of changes and are characterized by smaller errors than the forecasts of the naive method. The forecasts of neural networks are distinguished by better quality.
- Business survey indicators in the form of deviations from the trend significantly decrease the strength of their relations with the predicted variables. Statistical indicators of the economic situation in the construction industry, cleared only from seasonal and random fluctuations, have better prognostic qualities.

Research of leading indicators coming from official series concentrates on the firm level and its economic-financial indicators [Kozłowska, Ka1inowski 2003]. It is assumed that many microeconomic decisions are made in advance in relation to globalindustrial production or Gross Domestic Product. The analysis covered 29 economic-financial indicators over the period from the first quarter of 1993 till the third quarter of 2002. Reference dimensions were the production sold in industry and GDP in current prices.

Because of the short-term character of the financial variables (with the exception of investment ones) when selecting leading indicators, we assumed that their maximum leads are up to 6 quarters. In total 180 time series of explanatory variables were analysed with the leads from 1 to 6 quarters. Basing on the analysis of correlation coefficients and Granger test we selected the leading indicators and introduced them to the regression equations. The functions of the regression were assumed in accordance with the best statistical results and economic justification of the relationships between variables justified by, among others, the signs of estimated parameters of variables.

In the explanation of the variations in the industrial production two economic indexes 1 quarter ahead are of the biggest significance: revenues from the sales of companies which change pro-cyclically and stocks of finished goods which behave contra-cyclically. The determination coefficient is 0,88. The financial indexes, such as profitability ratios or financial liquidity ratios, proved to be non essential. Their

usefulness in short term forecasting of the industria1 production is smaller than that of economic indexes, although their leads are contained within the range of 1-2 quarters.

The reference cycle of Gross Domestic Productis explained first of all by the stocks of finished goods 6 quarters in advance. Their variations are contra-cyclical mainly because of a long lead which displaces the phase of the cycle. The second important explaining factor is the cost of the sold products 1 quarter ahead. Financial indicators of profitability and quick index which 1eads the variations of GDP by 6 quarters have weaker, although significant influence. The indexes explain variations of GDP in 87%. The leads of economic-financial indexes in relation to variations of GDP are quite long and amount to 6 quarters on average.

In regression models of industrial production and GDP only leading indicators obtained on the basis of the Granger test were accepted which suggests that in order to forecast the economic situation this test is a better tool of selecting essential explanatory variables than the correlation method. In forecasting industrial production and GDP we used regression

models and neural networks of the MLP type. Forecasts one quarter ahead made by means of both methods are less biased than the naive forecasts. When comparing the predicted values to real values we calculated forecasting errors as deviations of the predicted figures from the real ones. Both in case of industrial production and GDP the forecasts of regression models in comparison with forecasts of neural networks have slightly smaller errors. The differences are still marginal.

The main conclusions from using leading economic-financial indexes of companies to forecast the changes of industrial production and GDP are the following:

- The microeconomic leading indicators assumed in the studies explain in 90% the fluctuations of industrial production and GDP in the period under analysis.
- Leads of the indexes in relation to industrial production are shorter and they account for about 1 quarter, whereas the leads of GDP reach on average 6 quarters. It results, among others, from the character of fluctuations of both aggregates. Industrial production reacts to the changes of the factors faster and more violently, whereas reactions of GDP, which is a bigger economic aggregate, are slower and smoother.
- In explaining the changes in industrial production, the leading indicators such as the revenues from sale and stocks of finished goods dominate. The importance of financial indexes is not significant. A bigger influence of financia1 indexes, especially of profitability indexes, is revealed in the variations of GDP. This is undoubtedly connected with the investment processes.
- Short term (l quarter) forecasts of industrial production and GDP made by means of regression models and neural networks are accurate and better than

naive forecasts. Forecasts of regression models have smaller errors in comparison with forecasts of neural networks, but the differences between them are inconsiderable.

The components which predict changes of the cycle of the Polish economy were also sought in the monetary area [Kruszka 2003]. Over the period of 1992-2001, 11 financial indicators were analysed. Monetary variables include: MO, M1, M2, DivisiaMl, DivisiaM2, net credits for the budget sector, average interest rates of 13 and 52 week treasury bonds, the rate of rediscount credit and rate of collateral loan.

The regression models were built from the selected monetary leading indicators. Monetary independent variables explain on average 70% of the changes in the industrial production and GDP. The changes of the amount of money M2 or DivisiaM2 3-4 quarters ahead have the most important influence on industrial production and on GDP, both in fixed and current prices. As regards the strength of influence, the changes of bank deposits, are a subsequent variable, whereas the changes of a rediscount rate have their strong influence on industrial production and GDP in fixed prices. The leads of both variables equal 3 quarters.

The forecasts of industrial production and GDP were made at a horizon of 1 quarter. Forecasts based on the regression models accurately indicated the course of production and GDP changes in the predicted period, whereas GDP forecast was more precise. The use of neural networks gave better, that means less biased forecasts than extrapolations of the linear models. Relatively worse results of forecasts of neural networks concern GDP in current prices which shows deviations caused by inflationary phenomena. A high adjustment level of industrial production series and GDP to the ex post and ex ante values resulting from the models of neural networks suggests a non linear character of the relationships between the economic cycle and monetary factors.

The conclusions from the studies of the influence of leading monetary indexes on the cycle of the Polish economy are as follows:

- Monetary factors clearly explain fluctuations of the industrial production and GDP. Their leads in relation to the reference variables amount on average to 3-4 quarters.
- Changes of the amount of money M2, changes of bank deposits and rediscount rate have the biggest influence on fluctuations of the industrial production and GDP both in current and fixed prices.
- Short term forecasts of industrial production and GDP, made by means of regression models and neural networks using monetary leading indicators, were proper and better than the naive forecasts.
- Results of applying neural networks are better than the effects of the regression models, both in ex post and in ex ante analyses. This indicates non linear character of the connections between the economic cycle and changes in the monetary sphere.

Business cycle in Poland is under a growing influence of the variations in foreign economies. The main transmission channel is foreign trade. Analysing the influence of foreign economic conditions on the Polish economy [Stefański, Wojciechowski 2003] we took into account business survey and official indicators of the main foreign trade partners of Poland. Next we studied how and with what leads these indicators influence exports and imports, industrial production and GDP in 1992-2001. The survey data come from IFO – Institut fur Wirtschaftsforschung and from the European Commission, whereas the GUS, IMF and OECD are the source of the official statistics.

Among foreign survey indicators the best results were obtained in relation to the optimism indexes in industry in Great Britain, Germany, Italy and Holland, which are ahead of the Polish exports by 2-3 quarters. Optimism indexes in the industry in Germany and Great Britain 3 quarters ahead were introduced to the regression equation of exports. They explain the variations of exports in 75%. Quarterly forecast made on the basis of the regression model proved to be inaccurate and worse than the naive forecast. Also the forecast by means of a neural network had more errors than the naive one. Among survey indicators of IFO, the indexes of general economic situation in Great Britain and Russia 3 and 2 quarters ahead proved the strongest mutual correlations with the Polish exports. These indexes explain 84% of the variations of exports. However, quarterly forecasts proved to be inaccurate.

The highest correlation coefficients between Poland's imports and survey indicators were obtained for the private consumption of France and Germany and capital expenditures of Germany. The leads of indexes are contained between 1 and 3 quarters and are characterised by contra cyclical variations. This is also confirmed by negative signs of estimated parameters of these variables in regression equation. The assumed leading indicators explain 82% of the fluctuations of the Polish imports. The forecast for one quarter was good in terms of the direction of changes in imports but the error of the forecast was considerable.

The leading indicators of the Polish exports and imports were also sought among official statistical series characterising business conditions abroad. The selected leading indicators were introduced to the regression equations. The best adjustment proved to be the model in which the variables explaining fluctuations of the Polish exports are industrial production of Italy 2 quarters ahead, new orders in Italy 2 quarters ahead and the unemployment rate in Holland 2 quarters ahead. These variables explain exports variations up to 91%. The forecast for two quarters by means of the regression equation is accurate in terms of exports variations. The forecast error is big, however smaller than the error of the naive forecast. The forecast for 1 month by means of neural network proved to be inaccurate.

Mutual correlation between leading indicators of foreign economies and fluctuations of the Polish industrial production and GDP are weaker than in case of foreign trade. The short term forecasts however are worse than the naive ones.

Summarising the analyses we should point out the following results:

- Business survey indicators of foreign economies are leading the variations of the Polish exports by 2-3 quarters. The indexes of the general economic situation and indexes of optimism in industries of Great Britain and Germany have the biggest explanatory meaning. In terms of Polish imports survey indicators of private consumption and capital expenditures of Germany and France 1-3 quarters ahead are of the greatest importance.
- Forecasts of exports and imports for the period of 1 quarter made on the basis of the regression models and neural networks were not accurate or they showed considerable errors.
- Among the official statistical indexes of the foreign economic situation, the indexes of the economy in Italy (industrial production, foreign trade) and Great Britain 2 quar- ters ahead, have the biggest influence on the variations of the Polish exports and imports. The forecasts for the period of 1-2 quarters are in accordance with the directions of the variations of exports and imports, but they have big forecast errors.
- The relations between leading indicators of foreign economies and the cycle of the Polish industrial production and GDP are non essential in case of survey indicators or weak with reference to official ones.

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