Zbigniew Matkowski*

COMPOSITE LEADING INDICATORS

1. Introduction

This paper refers to a broader research on composite indicators of economic activity for Poland, which was started in 1994 and has been continued in the Research Institute of Economic Development (RIED) at Warsaw School of Economics under five successive research projects headed by the author. The aim is to develop a system of composite indicators based on quantitative and qualitative data to be used in the analysis of cyclical changes in the economy as well as in forecasting. Three types of composite indicators have been developed to this purpose:

(a) general coincident indicator (GCI) – a monthly proxy to GDP, covering five major sectors of the economy: industry, construction, agriculture, and trade;
(b) composite leading indicators (CLI), based on quantitative and qualitative data, compiled according to OECD standards;
(c) economic sentiment indicators (ESI) vs. economic climate indicators (ECI) based on survey data.

The results have been published in RIED's 'Papers and Proceedings' (Matkowski, ed., 1997, 1998, 1999) as well as in economic journals. They have been also presented at several international conferences (e.g. CIRET Conferences in Budapest, Munich, Helsinki, Wellington and Taipei, and International Meetings on Economic Cycles in Ourense and Madrid). The new results are included in this book.

This paper presents the new edition of our composite leading indicators for Poland. The paper includes six parts. Section 1 is this introduction. Section 2 provides the background, including a review of all the CLIs developed by now for Poland. Section 3 describes the methods and procedures used in compiling CLIs. Section 4 presents the new edition of our CLIs for Poland, covering the period 1975-2002. Section 5 presents the CLIs for Poland for the period of transition. Section 6 brings some conclusions.

2. Background

Leading indicators are sensitive quantitative and qualitative indicators which can be used in forecasting the fluctuation in the aggregate economic activity.

The disputes on the virtue and predictive power of leading indicators have been continued since the earliest days of their application in business cycle analysis. Koopmans' criticism (1947) about the lack of theoretical foundation of leading indicators has been mitigated by the tremendous contribution brought to the knowledge

* Dr Zbigniew Matkowski is Senior Lecturer and Research Fellow at Chair of Economics II, Warsaw School of Economics.

of business cycles by the empirical research on coincident, leading and lagging indicators (see e.g. Moore and Cullity, 1994; Klein, 1996). In spite of some failures, the usefulness of this method in short-term economic forecasting is unquestionable. It is true that 'as a practical method of forecasting, the leading indicators cannot be used very effectively or accurately' (Evans, 1969, p. 460). However, the same applies as well to all other methods of business forecasting. After 60 or 70 years of continuous service, the leading indicator approach has not exhausted its potential as a method to predict cyclical swings in the economy (cf. Westlund, 1993).

Many books and papers have been directly or indirectly devoted to the subject (eg. Moore, 1983; Niemira and Klein, 1994; Nilsson, 1991; Zarnowitz, 1992). As early as in late 1970's the barometric method was also presented to the Polish readers (Matkowski, 1979).

The empirical research on composite leading indicators for the Polish economy began in early 1990's. Kudrycka and Nilsson developed the first CLI for Poland in 1993 and repeated the exercise in 1995 and 1996 (Kudrycka and Nilsson, 1993, 1995, 1996). Unfortunately, this research has been stopped in 1996.

At about the same time this author, under a research project located in the Research Institute of Economic Development (RIED) at the Warsaw School of Economics, started a systematic search for a composite leading indicator for Poland. The results obtained in the successive editions of our CLIs were presented at the CCET Workshop on Short-term Economic Indicators in Budapest, the OECD Meeting on Leading Indicators in Paris in 1996, 23th CIRET Conference in Helsinki in 1997, and I International Meeting on Economic Cycles in Ourense in 2000 (Matkowski, 1996, 1997a, 2000). The successive versions of our CLIs were also published in economic journals and books in Poland (Matkowski, 1997bc, 1998, 1999, 2000b).

Both the CLIs compiled by Kudrycka and Nilsson and by Matkowski were based on the OECD methodology (OECD, 1987).

In the early 2000's, the US Conference Board, under its international CLI program, made also some preparations to develop a CLI for Poland based on its own methods. Two contributed papers included in this book, by Bieć-Drozdowicz and Stolorz (2004), refer to the approach taken by TCB, though these papers are fully independent.

3. Methods and procedures

According to the CLI methodology adopted by the OECD (OECD, 1987, 1998), component series included in the CLI should meet the following criteria:

- *Economic significance* – component variable should be economically significant and play a causal role in the mechanism of fluctuations;
- *Cyclical behaviour* – component series should be well correlated with the reference indicator with a lead, there should be no missing or extra cycles, the lead at turning points should be more or less the same over the whole period;

- *Data quality* – component series should have a broad statistical coverage, they should be available on a monthly rather than quarterly basis, timely and easily available, with no breaks in time series and not too many data revisions.

A similar list of criteria for cyclical indicators compiled by The Conference Board (TCB, 2001), as a continuation of the research on cyclical indicators started by the NBER, includes the following requirements:

- *Conformity* – the series must conform well to the business cycle;
- *Consistence* – the series must exhibit a consistent timing pattern as a leading, coincident or lagging indicators;
- *Economic significance* – cyclical timing must be economically justified;
- *Statistical adequacy* – data must be collected and processed in a reliable way;
- *Smoothness* – month-to-month changes must not be very erratic;
- *Currency* – new data must be available reasonably quickly.

The real problem is that when these standards were strictly applied, very few or no time series could be accepted. This is because there is no ideal cyclical indicator. In practice, these requirements are not strictly observed and the matter of judgement is to decide which indicators can be accepted.

The criteria for the selection of leading indicators used by the OECD and TCB are similar. The basic difference consists in a different concept of the reference index and different way of data processing.

As regards the reference index, TCB (following the concept of business cycle analysis developed in the NBER) compiles a composite coincident index based on many variables representing various aspects of economic activity. The OECD applies a single series to represent the overall economic activity, based on the available statistics, usually industrial production index or GDP.

As regards data processing, the main difference is that TCB, following the classical concept of business cycle, uses undetrended time series while the OECD, focusing on growth cycles, works on detrended time series. There are also some differences in smoothing procedures, weighting system, standardisation and aggregation as well as in the way in which the results are presented.

Our CLIs for Poland are based on the OECD methodology. We use similar concepts, methods and procedures, the same data processing techniques and analogous ways of data analysis. Therefore, our CLIs are directly comparable with the OECD system of CLIs. However, when applied to the specific conditions of the Polish economy and the available set of statistical data, these methods have to be adapted or modified.

The most important methodological innovation applied in our work on CLIs is our own concept of the reference index GCI (*general coincident index*), which is a monthly proxy to GDP based on the statistical data on output or sales in five major sectors of the economy: industry, construction, agriculture, transport and trade, weighted by their shares in total value added. This reference index is described in another paper included in this book (Matkowski, 2004).

The second modification concerns the detrending methods. Whereas the OECD relies entirely on the PAT procedure, we also apply linear regression for estimating the trend of short time series, which could not be detrended by PAT. At the same time, apart from the automatic PAT option, we often use a controlled option with preliminary input data on turning points, which has been found more effective. As a matter of fact, cyclical components of the individual time series are isolated using different detrending procedures, and we are choosing the best fitted variant, well corresponding with the reference cycle.

The third specific feature of our method is that, apart from genuine leading indicators, we also accept some important series with zero lead, though they may be rather called coincident indicators. The inclusion of such series in short-lead CLIs is justified by our desire to use CLIs both for forecasting and monitoring purposes. Such indicators broaden the coverage of the composite index, stabilise its cyclical pattern and lengthen the period covered by the available data.

The fourth feature of our work on CLIs is that the formal rules applied in selecting the component series (QCS ≤ 1, MCD ≤ 6) are not always strictly observed. This is especially so in case of the indicators which are deemed to be significant economically.

In spite of all these differences, our CLIs for Poland follow the basic rules of the OECD methodology and they are comparable with the OECD system of leading indicators.

The procedures used to compile our CLIs include six steps:

1. *Data preparation*

Some quarterly data were interpolated into monthly intervals. Business survey data expressed as answer balances were transformed into indexes by adding 100. Similar adjustment was made for all other series assuming positive and negative values (e.g. current account balance, profitability of enterprises). Variables negatively related to economic activity (e.g. unemployment) have been inverted. Nominal values were converted to real values using respective deflators. All the time series have been transformed into monthly indices based on 1992 = 100 (or 1995 = 100 in case of shorter time series).

2. *Seasonal adjustment*

All the time series were then subject to X11-ARIMA procedure, which gives seasonally adjusted and MCD-smoothed series, interpreted as trend + cycle.[1] The results obtained in this procedure helped us also to select the component series of our CLIs. The two criteria used were QCS (*quality control statistics*) and MCD (*months for cyclical dominance*).

3. *Detrending*

The deseasonalised and MCD-smoothed time series were then subject to detrending in order to isolate their cyclical components. The detrending was accomplished using the PAT (*phase-average trend*) procedure with automatic or controlled option. In case of very short time series, the trend and trend deviations were determined by linear regression.

[1] The original trend-cycle rendered by X11-ARIMA was not used because it is based on long-term averages, which are not proper for business cycle analysis.

4. *Cross-correlation*

Cyclical components of all the time series have been confronted with the cyclical component of the reference index by means of cross-correlation, with 25 leads and lags. The lead recorded in our analysis refers to the maximum correlation value. It should be interpreted as the dominant lead. When choosing the component series for our CLIs, we preferred those having sharp correlograms, with a definite indication of dominant lead. Flat correlograms mean that leads or lags are unstable.

5. *Normalisation*

In order to compare the individual cyclical indicators with the reference cycle, they have been normalised using the algorithm (OECD, 1987):

$$\left[(x - \bar{x}) : \frac{\sum |x - \bar{x}|}{n}\right] + 100,$$

where x denotes numerical values of the given variable, $\bar{x}$ – arithmetic mean, n – number of observations (months).

The standardised component series and composite indicators derived from them usually take values between 97 and 103. The resulting indicators express relative deviations of the values observed from their long-run average. They should not be mistaken for simple dynamic indices.

6. *Aggregation*

The selected leading indicators have been integrated into composite leading indicators as an arithmetic average (with equal weights = 1). The resulting CLIs assume comparable values, usually in the range between 97 and 103.

The above procedures are basically in line with the OECD CLI methodology.

4. Leading indicators: 1975-2002

In our search for leading and coincident indicators for the Polish economy, we have analysed scrupulously more than 150 time series representing various economic variables of direct interest in business cycle research. Most variables were analysed repeatedly, using updated series and alternative detrending procedures. The analysis allowed us to discriminate a set of about 60 indicators with well pronounced cyclical changes.

Further selection was based on the comparison of the deseasonalised, MCD-smoothed and detrended time series with the reference cycle. The main criteria applied here were cross-correlation coefficients, the average lead, the conformity of cyclical pattern (the number of missing or extra cycles) and the behaviour of the indicator around the reference turning points. As the result, about 25 single indicators – quantitative and qualitative – have been selected to be used in the composite leading index (CLI).

The list of component indicators included in the CLI was modified over time. In this analysis we use 17 component variables: nine indicators of output, two indicators of labour market, two indicators of fixed and inventory investment, two variables of the monetary market, and two indicators from survey data.

As compared with the last edition of our CLIs (Matkowski, 2001) we dropped 8 component indicators which overlapped with some other in coverage or failed to lead the reference index towards the end of period. Perhaps, some of these indicators (e.g. order-books in industry, imports, share price index, investments in machines and equipment) will improve in future and will be again incorporated into our CLIs.

Table 1. Performance characteristics of leading indicators

Code	Indicator	Start date	QCS	MCD	Cross-correlation against reference series	
					lead (-)	*R*
	Component Indicators					
	(a) Basic variables					
A001	Industrial production	01.1975	0.70	5	0	0.980
A003	Food	01.1982	0.60	6	-1	0.621
A004	Coal	01.1980	1.10	8	-7	0.477
A005	Petroleum processing	01.1980	1.59	12	0	0.863
R007	Steel	01.1980	0.78	3	0	0.676
A011	Sawn wood	01.1980	0.54	5	-4	0.840
A015	Labour productivity	01.1980	0.65	3	0	0.895
A016	Construction	01.1975	0.58	5	-8	0.820
A024	Transport	01.1975	0.38	4	+1	0.890
A033D	Investment: buildings&structures	01.1983	0.50	5	-4	0.744
R041	Issue of cash	01.1982	0.55	2	0	0.816
R045A	Personal savings	01.1982	0.94	1	-4	0.878
R060	Business tendency: industry (BS)	01.1987	0.73	1	-13	0.554
RD06	Consumer sentiments (BS)	01.1992	1.28	5	-25	0.517
	(b) Supplementary variables					
R025	Cargo reloaded	01.1975	0.96	5	-3	0.545
R027NI	Commodity stocks	01.1985	0.95	2	+3	0.834
C039	Job offers	01.1980	0.56	4	+1	0.531
	Composite Leading Indicators					
L130A	Short-lead CLI (10 series)	01.1975	1.09	1	0	0.930
L131	Long-lead CLI (7 series)	01.1975	1.06	1	-7	0.843
L132A	Mixed CLI (17 series)	01.1975	1.03	1	-1	0.913
	Reference Series					
B091	General Coincident Indicator GCI	01.1975	0.49	5	x	x

QCS – quality control statistic (required QCS ≤ 1).
MCD – months for cyclical dominance (required MCD ≤ 6).

Table 1 shows the full list of component indicators entering our CLIs, together with statistical characteristics and the results of cross-correlation against the reference cycle. Since our major aim is to develop a CLI formula applicable for both monitoring and forecasting purposes, some coincident indicators well correlated with the reference cycle

were also accepted. They improve the correlation with the reference cycle and lengthen back the CLI series.

Table 1 also shows the performance of the three CLI variants: short-lead (L130A), long-lead (L131), and mixed (L132A), out of the nine versions tested in this analysis. The short-lead CLI includes 10 component series with no lead or very short lead against the reference cycle. The long-lead CLI includes 7 component series with a longer lead. The mixed CLI integrates all the 17 component series.

The numeration of our CLIs started in 1995 with L100. New versions developed and tested over time assumed the successive numbers. The component variables are denoted with the code numbers recorded in our database, with a prefix denoting the detrending method (X stands for the automatic PAT option, A, B, C for the controlled PAT option with preliminary input data on turning points, and R for linear regression used to detrend some shorter time series).

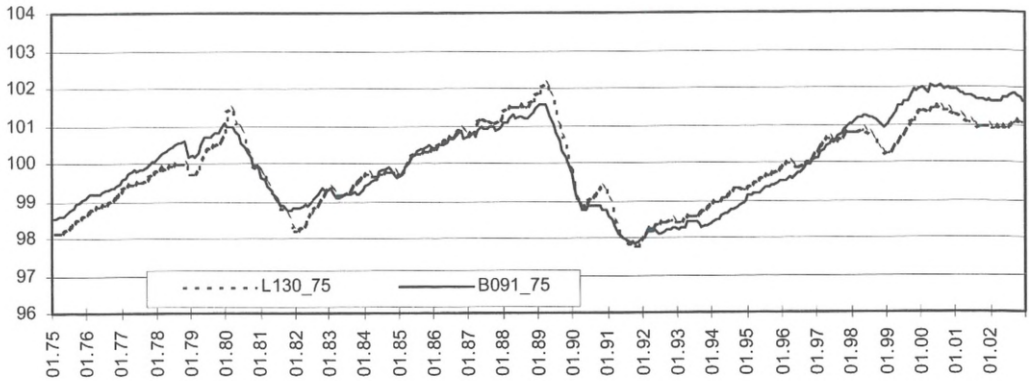
Most component indicators have acceptable QCS and MCD characteristics and are significantly correlated with the reference cycle, usually with some lead. The lead against the reference cycle was measured at the maximum value of correlation coefficient.

Table 2. Historical performance of leading indicators at turning points

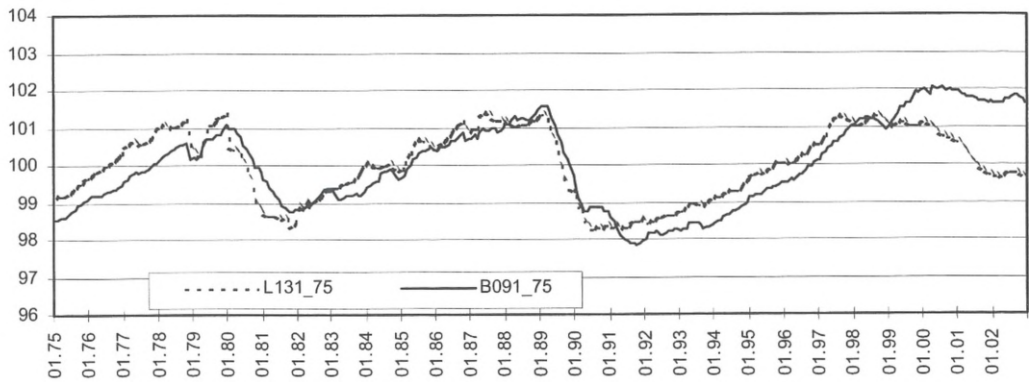
Code	Indicator	Extra (x) missing (m) cycles	Leads or lags at turning points					
			P12.79	T10.81	P03.89	T10.91	P04.00	T11.01
	Component Indicators							
A001	Industrial production	2x	0	+3	-11	0	+3	+4
A003	Food	1x	na	na	-1	-7	-28	+7
A004	Coal	1x	na	-4	-5	-8	-35	-16
A005	Petroleum processing	5x	na	+2	-1	-4	+1	.
R007	Steel	2x	+3	+3	-15	+1	+1	+2
A011	Wood	4x	na	+3	-22	-3	-3	+2
A015	Labour productivity	3x	na	+3	-1	0	+2	+5
A016	Construction	1x, 1m	0	+9	-2	-12	.	.
A024	Transport	0	+3	+3	-1	+8	+8	-3
A033D	Investment	3x	na	na	0	-6	-8	.
R041	Issue of cash	2x	na	+11	+1	-20	-3	-2
B045A	Household savings	1x	na	.	-25	-12	-15	-24
R060	Business tendency: industry (BS)	2x	na	na	-21	-18	-1	+1
RD06	Consumer sentiments (BS)	1x	na	na	na	na	-35	-1
R025	Cargo reloaded	5x	-7	0	-18	-6	-16	-17
R027NI	Commodity stocks	1x, 1m	na	na	-3	+32	.	.
C039	Job offers	1x	na	.	+2	-8	0	-8
	Composite Leading Indicators							
L130A	Short-lead CLI (10series)	1x	-1	+2	0	+2	0	-3
L131	Long-lead CLI (7 series)	0	0	-1	-1	-17	-21	+3
L132A	Mixed CLI (17 series)	0	0	+2	-2	-5	-3	+4

Figure 1. Composite leading indicators: 1975-2002

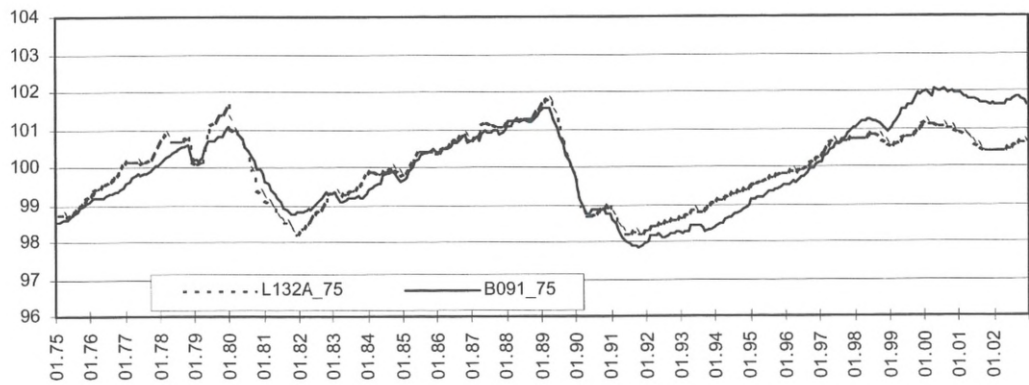
L130: Short-lead CLI



L131: Long-lead CLI



L132A: Mixed CLI



As compared with our previous records, some component variables have deteriorated in terms of their correspondence with reference cycle and their leading properties (three component series now tend in fact to lag slightly behind the reference index). Some other components that performed before quite well have been dropped due to their failure at the end of period.

Component series start at different times, depending on the available data. Four series are available since 1975, six series start in 1980, five other series begin between 1982 and 1985, and two business survey series are included since 1987 and 1992. This means that the composition of our CLIs is changing over time. Our deliberate strategy is to remove outdated variables and to include new ones.

The three CLI variants have QCS close to 1 and MCD = 1. The short-lead CLI is very well correlated with the reference index ($R = 0.93$), but it actually does not exhibit any lead. The long-lead CLI is also quite well correlated with the reference cycle ($R = 0.83$) and it tends to lead cyclical changes by 7 months. The mixed CLI is characterised by a very good correlation with the reference cycle ($R = 0.91$), but it has a very short lead of 1 month, so it may be only used to assess the current economic activity and to verify the indications of the reference index.

The performance of our leading indicators around the reference cycle turning points (as evidenced by Table 2) is less satisfactory, but it seems to improve towards the end of the period. The downturn of 1989 and the recovery in 1991 were signalled by our CLIs well in advance. For all the component indicators the average lead is 7 months at peaks and 2 months at troughs. Most component indicators reveal some minor extra cycles, apart from the reference cycle. The performance of our CLIs at turning points is also imperfect as regards the length of their signals. Nevertheless, the mixed CLI has signalled all the major swings in the economy in advance or almost simultaneously.

The historical performance of our CLIs and their component series is also illustrated by the graphs. Figure 1 shows the amplitude-adjusted CLIs against the reference cycle. The behaviour of component indicators as compared with the reference cycle is presented by the graphs enclosed in the Appendix.

Since the information lag for most statistical data is typically 1-3 months, we believe that our mixed CLI, even with its short lead, may be a useful tool in evaluating the current tendency of economic activity.

As already mentioned, the procedures used in developing our CLIs follow the OECD methodology of leading indicators. The only major exception is that some shorter time series entering the composite index, for which the PAT program failed to work or rendered doubtful results, have been detrended by linear regression. At the same time, our concept of the reference series GCI is, by and large, a new proposal in business cycle research, which may be applied as well to any other economy.

Our monitoring system based on coincident and leading indicators has properly signalled the slowdown in 1998 caused by the Russian crisis and the definite slowdown in 2001. Our predictions of the GDP growth rate, based on composite indicators, were more precise than most other forecasts rendered by official and non-official sources.

5. Leading indicators for transition period

Our leading indicators calculated for the whole period 1975-2002 may be criticised as covering two different economic systems: the centrally planned economy until 1989 and an open market economy since 1990. Though we do not believe that the change of economic system has radically modified the performance of our leading indicators, a separate CLI has been compiled for the period of transition.

Table 3. Performance characteristics of new leading indicators

Code	Indicator	QCS	MCD	Cross correlation against the reference series	
				lead (-)	*R*
	Component Indicators				
R001	Industrial production	0.70	5	0	0.978
R003	Food	0.60	6	0	0.900
R005	Petroleum processing	1.59	12	0	0.843
R006	Electrical power	0.33	6	0	0.796
R011	Sawn wood	0.54	5	0	0.825
R015	Labour productivity	0.65	3	0	0.930
R016	Construction	0.58	5	0	0.736
R021AD	Agriculture	0.57	6	0	0.791
R024	Transport	0.38	4	0	0.922
R026	Trade	0.46	4	0	0.849
R027NI	Commodity stocks	0.95	2	0	0.891
R028	Exports	0.77	6	0	0.737
R029	Imports	0.78	6	0	0.906
R033J	Investment: mach & equipment	0.56	5	0	0.952
R041	Issue of cash	0.55	2	0	0.812
R045A	Household savings	0.94	1	0	0.829
	Composite Leading Indicators				
L135	All component series (16)	1.07	1	0	0.986
L135A	All except the series included in the reference index (12)	1.14	1	0	0.973
	Reference Series				
R091	General Coincident Indicator GCI	0.49	5	x	x

QCS – quality control statistic (required QCS ≤ 1).
MCD – months for cyclical dominance (required MCD ≤ 6).
Note: QCS and MCD are given for the whole period covered by the available data while cross-correlation refers to the period 1989-2002.

To this purpose we have once more analysed the performance of all the variables contained in our database for the period 1989-2002, including about 50 new series available since 1990. All component series were detrended by linear regression and correlated with the reference index GCI detrended in the same way. As the result, we could

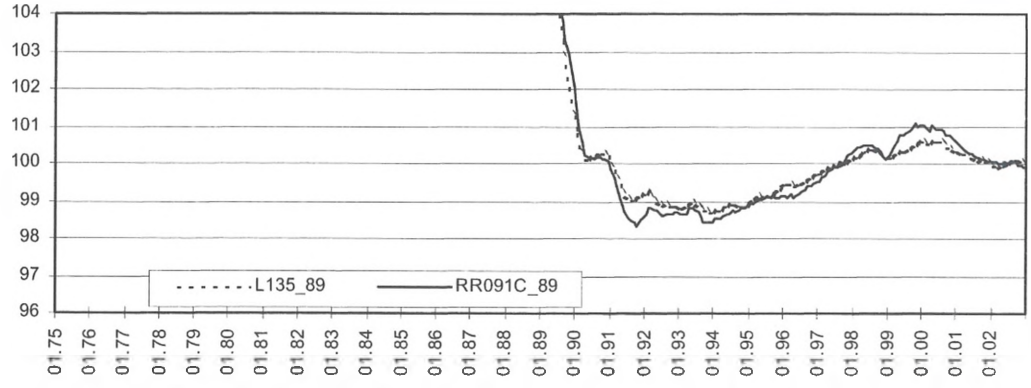
select 16 single indicators to be included in the new CLI. Most of them have been already used in our CLIs for the whole period. Unfortunately, none of the new indicators, even those that seemed to be very promising on economic grounds, could be included because of a poor correlation with the reference index.

The performance of the new leading indicators for 1989-2002 is presented in Table 3 and Figure 2. Component series are presented in the Appendix.

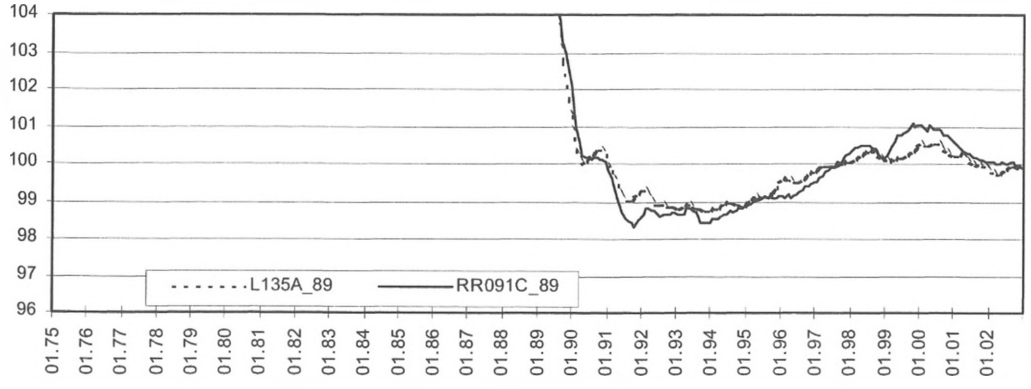
All the component series are well correlated with the reference cycle (R ranging between 0.74 and 0.98), but the real problem is zero lead shown by all the indicators at maximum cross-correlation value. The resulting CLIs (Figure 2) are almost perfectly correlated with the reference index (R equal to 0.97 or 0.99), but they have no leading properties, so they can be only used to verify the indications of our reference index about the current state of economic activity.

Figure 2. Composite leading indicators: 1989-2002

L135: All component series



L135A: All components except the those included in the reference index



In order to get any CLI for Poland with evident leading properties, we should rather rely on composite indicators presented in the former Section, which cover longer period.

6. Conclusions

1. In this paper we have presented the new results of our search for a composite leading indicator for Poland. Three CLI variants based on quantitative and qualitative data of the period 1975-2002 have been tested as to their conformity with our reference index GCI and their leading properties. Two additional CLI variants have been compiled for the period of transition, covering the years 1989-2002.
2. Even if the results obtained by now are not yet perfect, some of our CLIs may be already used for monitoring and forecasting purposes.
3. A similar approach can be taken in the construction of CLIs for any other country in transition. Of course, the list of component indicators can be different.

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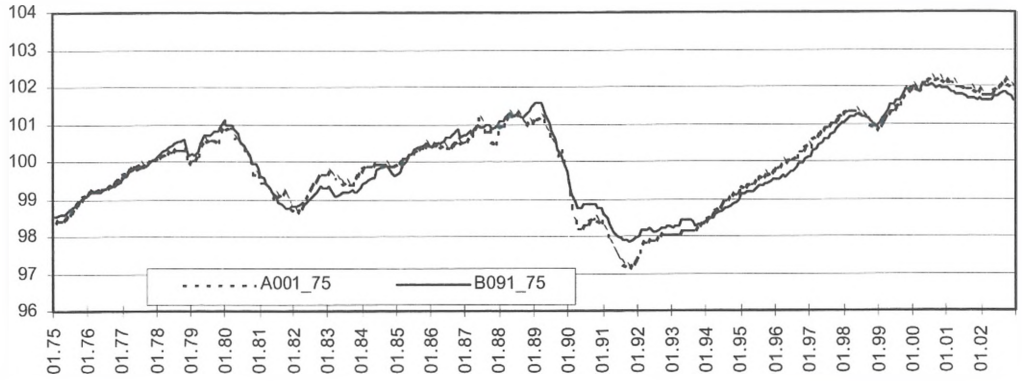
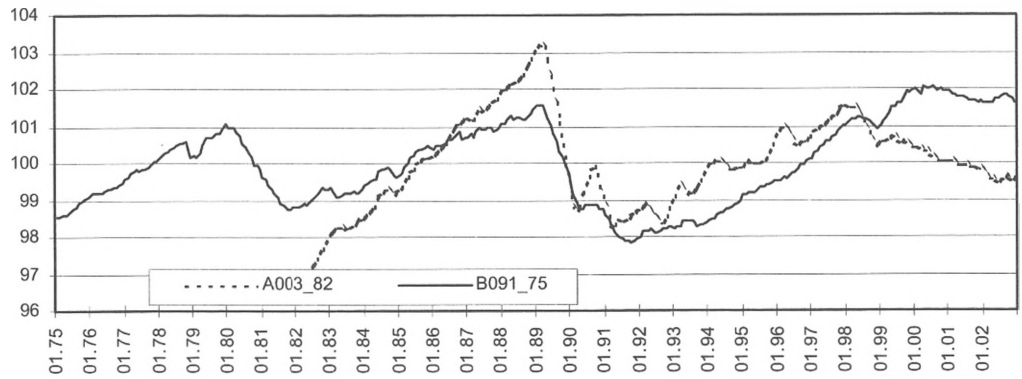
Appendix

Component leading indicators: 1975-2002 & 1989-2002

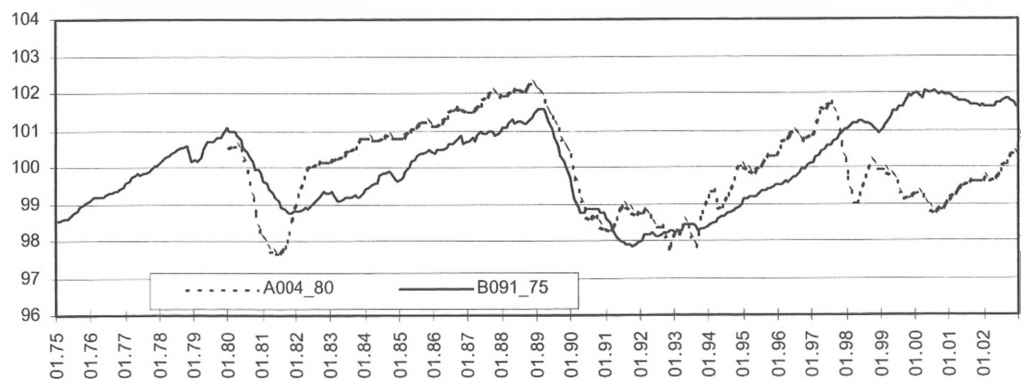
A001: Industrial production



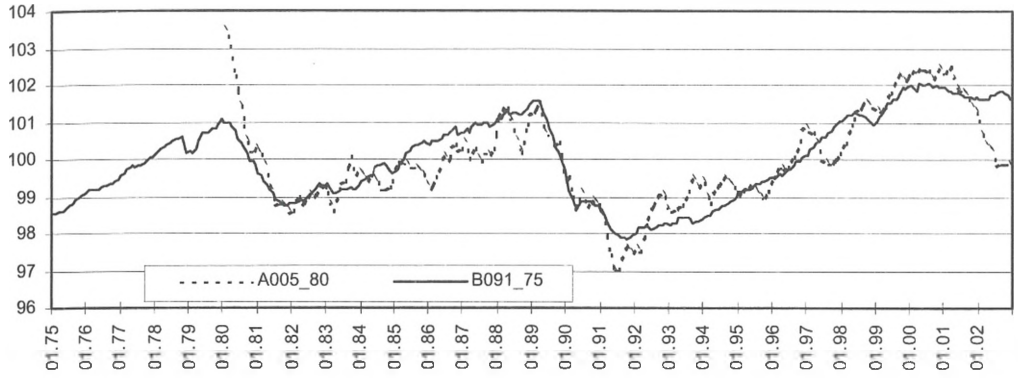
A003: Food



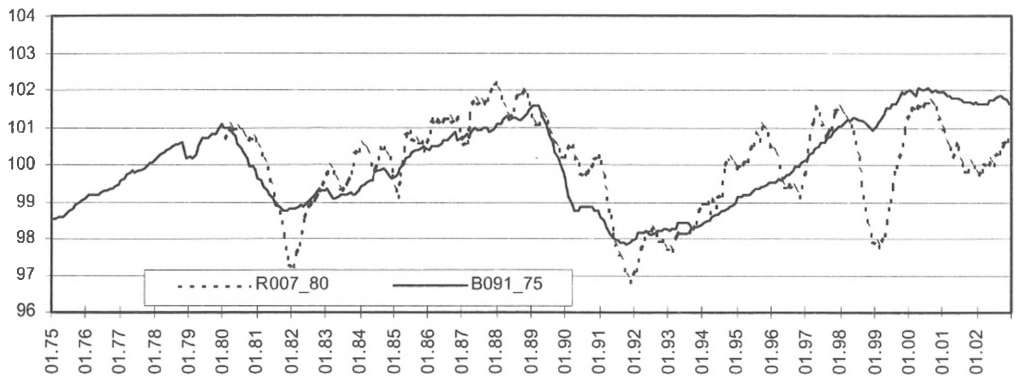
A004: Coal



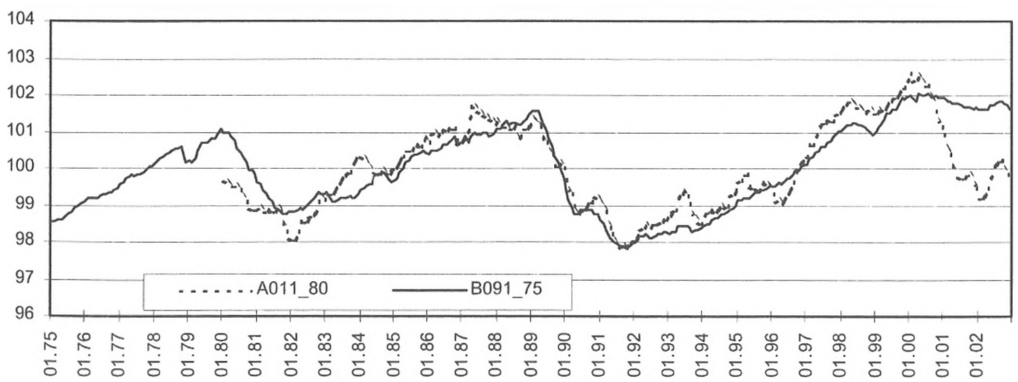
A005: Petroleum processing



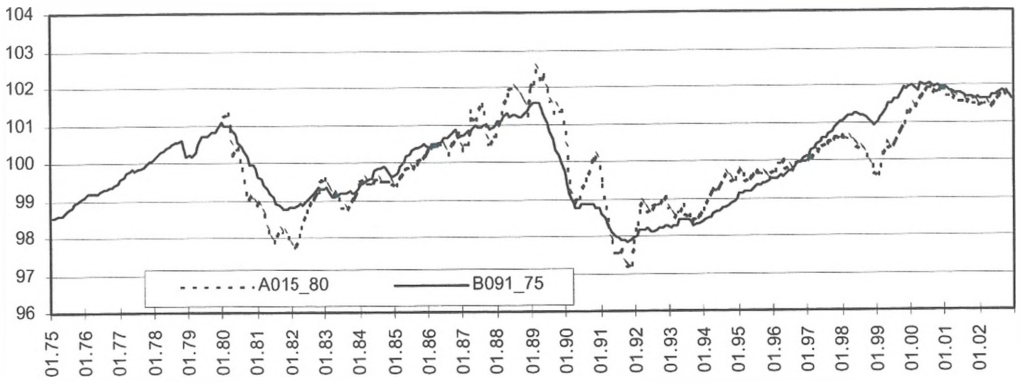
R007: Electrical power



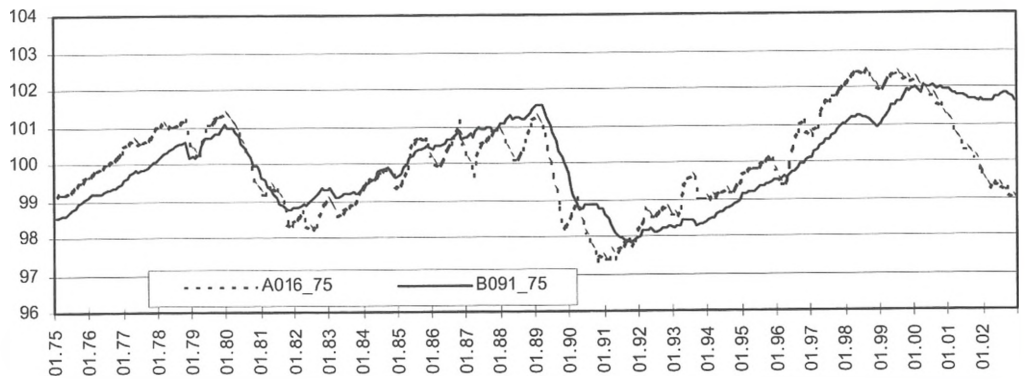
A011: Sawn wood



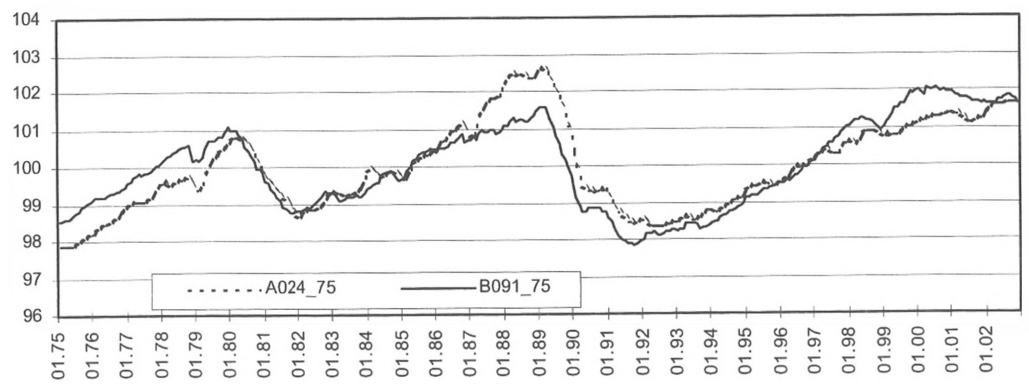
A015: Labour productivity



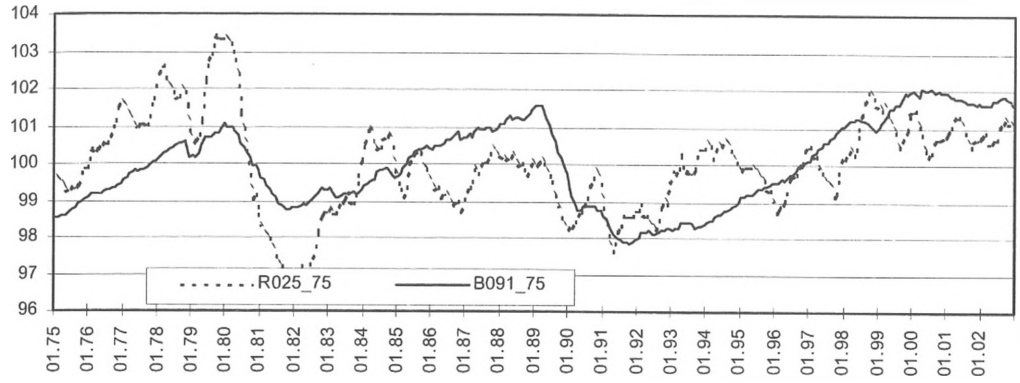
A016: Construction



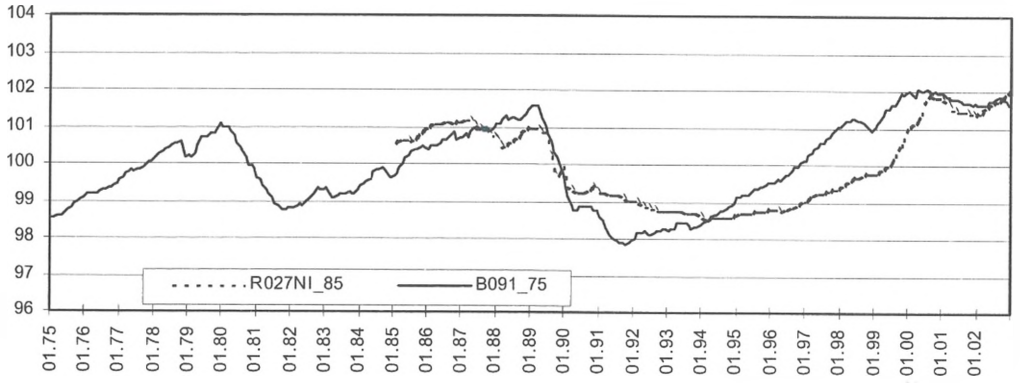
A024: Transport



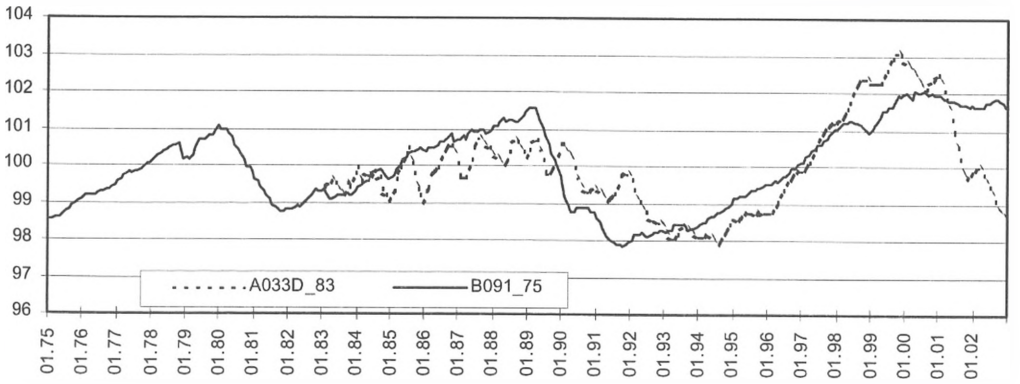
R025: Cargo reloaded



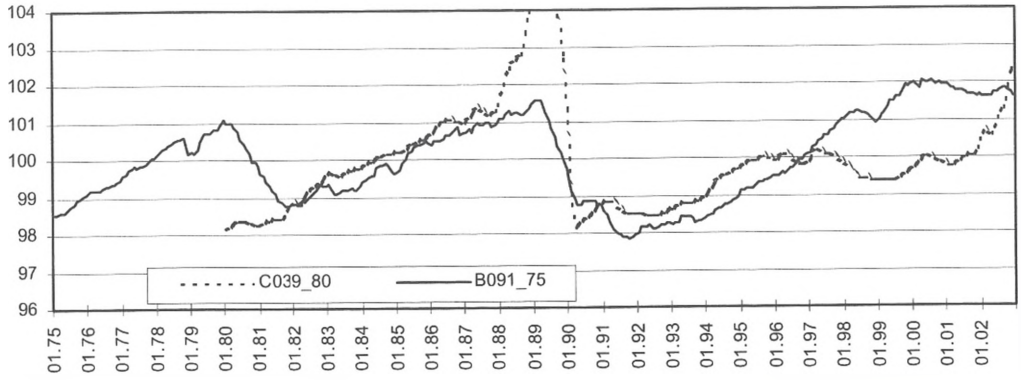
R027NI: Commodity stocks



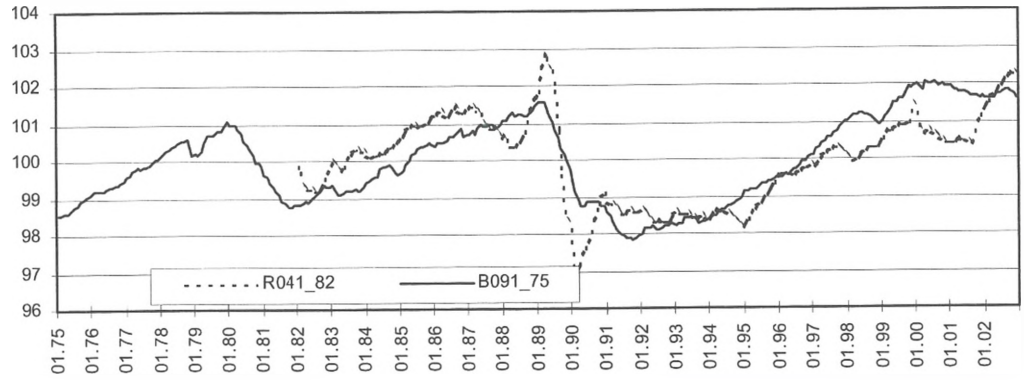
A033D: Investments: buildings & structures



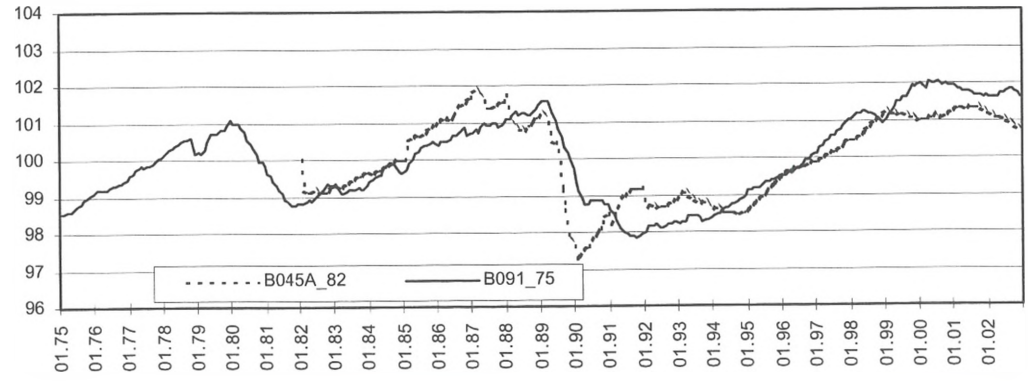
C039: Job offers



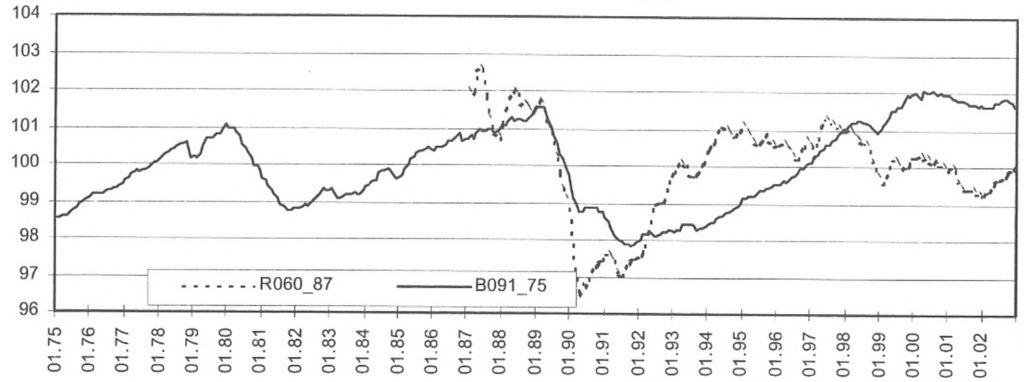
R041: Issue of cash



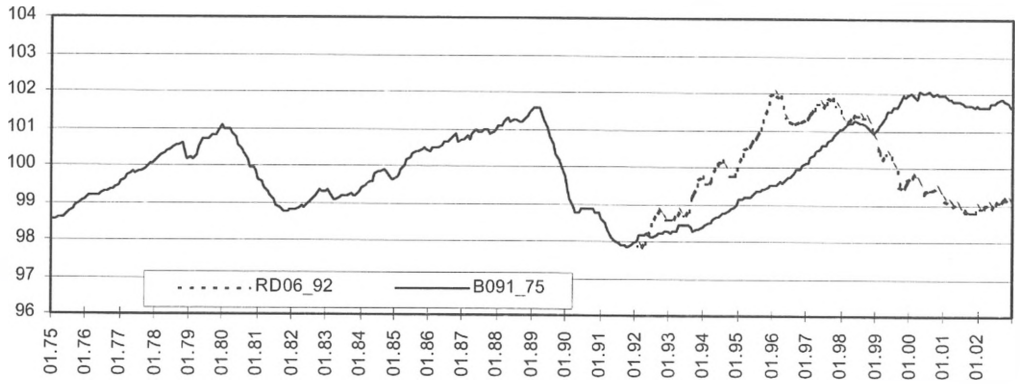
B045A: Household savings



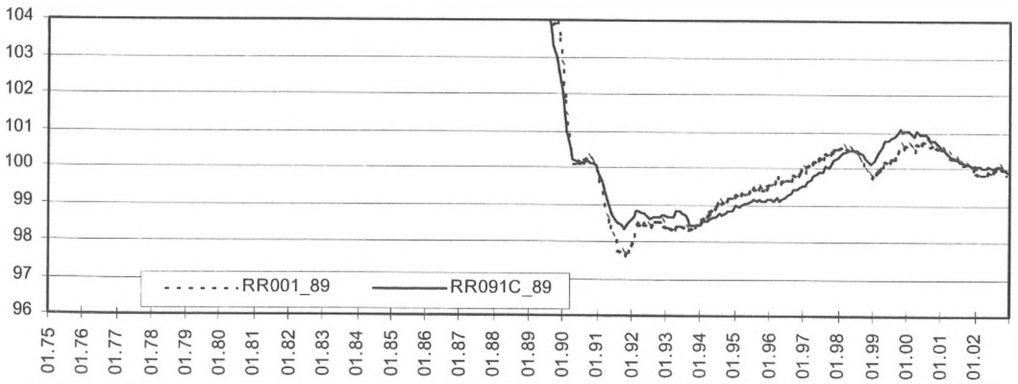
R060: Business tendency: industry (BS)



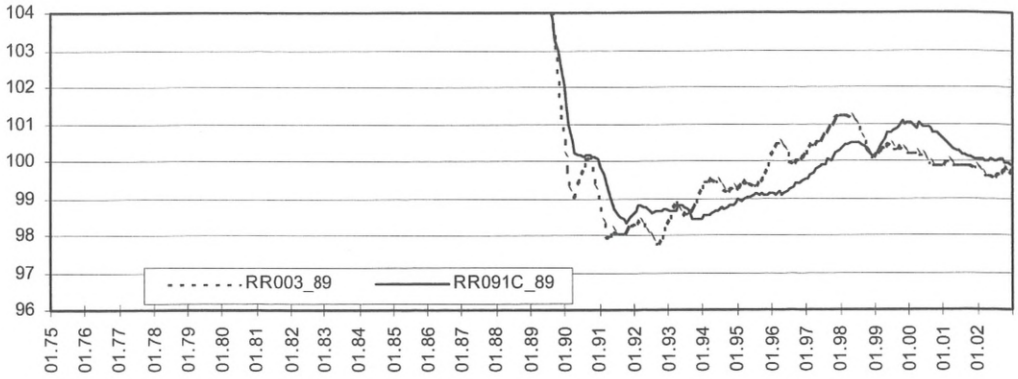
RD06: Consumer sentiments



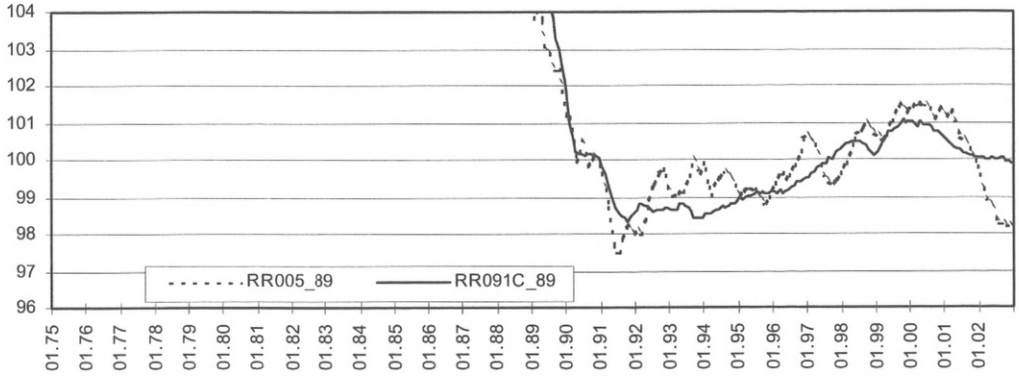
R001: Industrial production



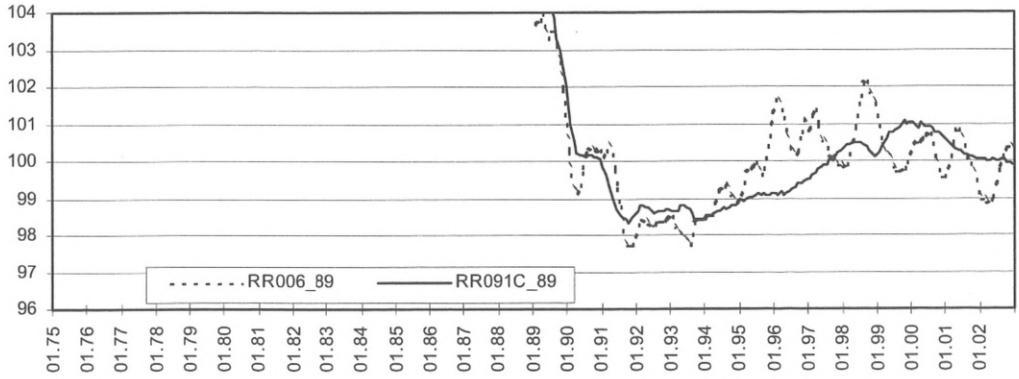
R003: Food



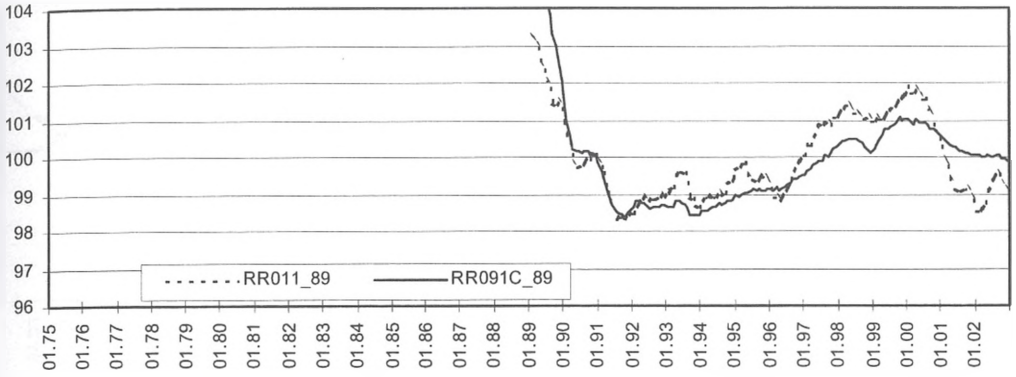
R005: Petroleum processing



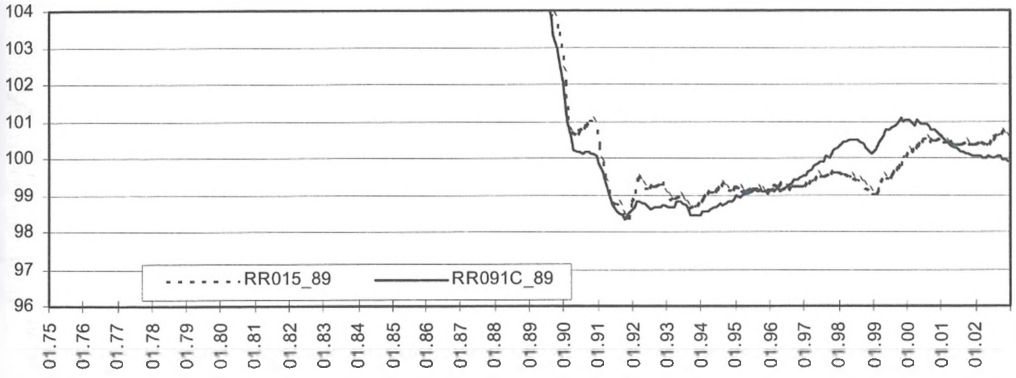
R006: Electrical power



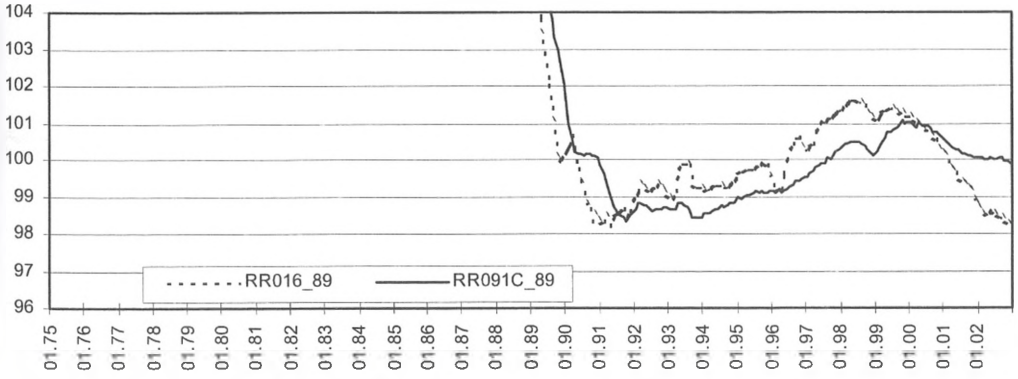
R011: Sawn wood



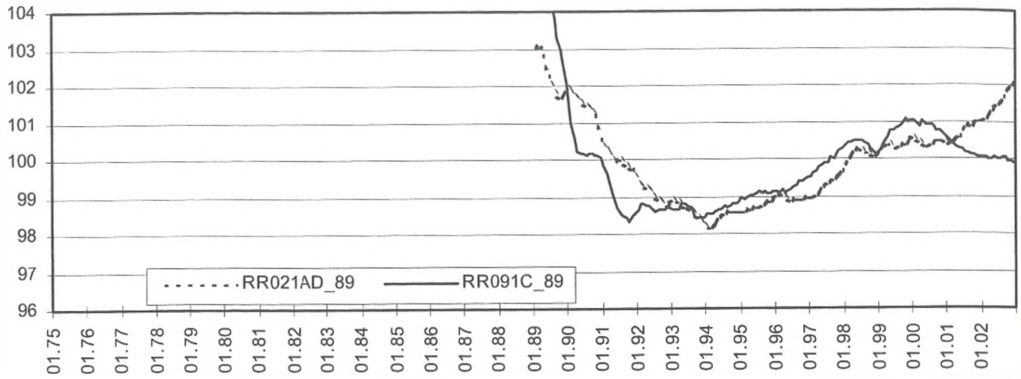
R015: Labour productivity



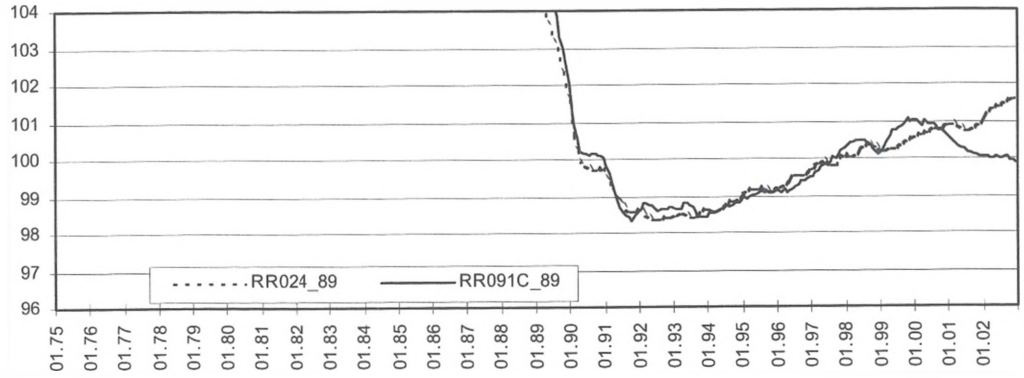
R016: Construction



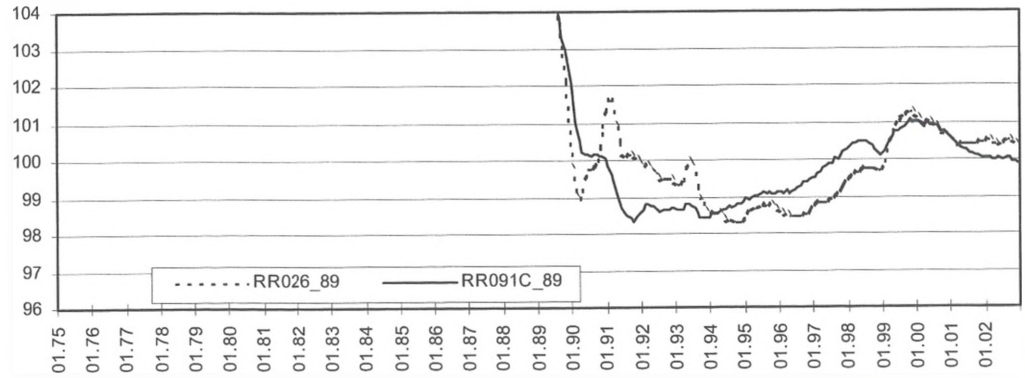
R021AD: Agriculture



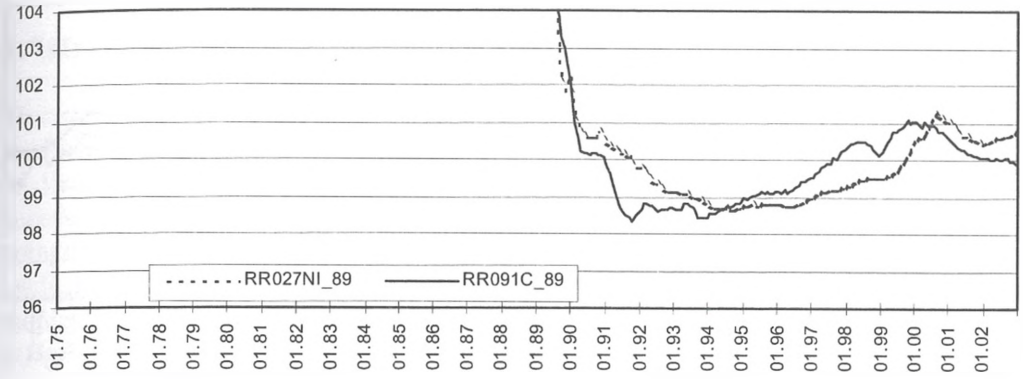
R024: Transport



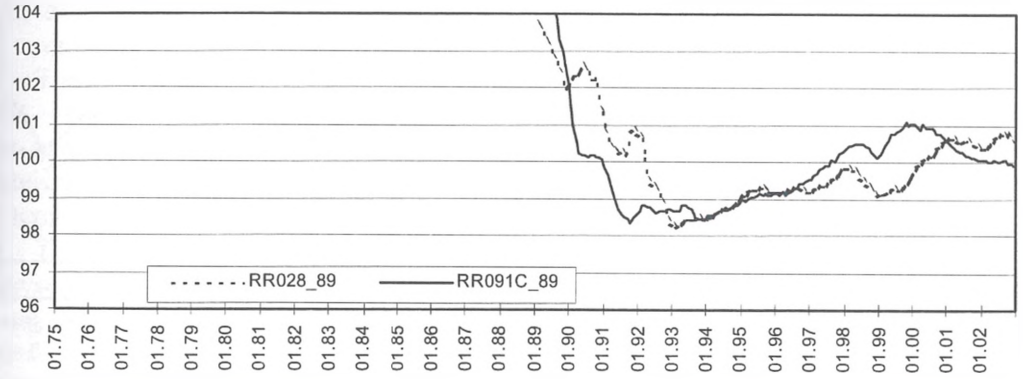
R026: Trade



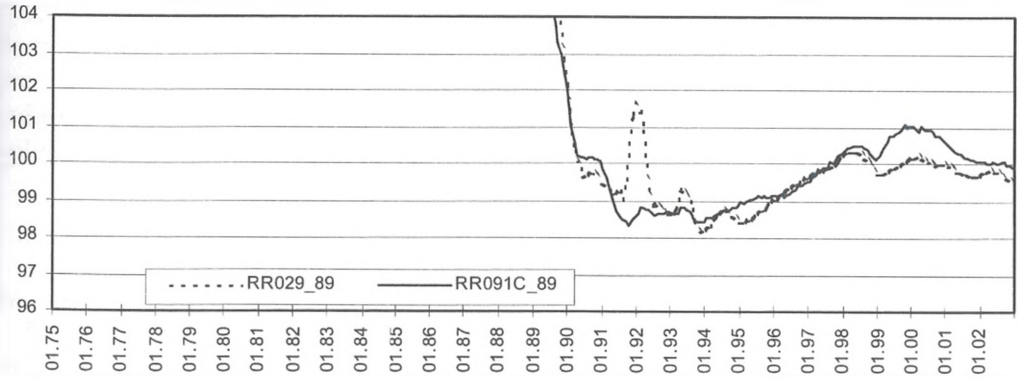
R027NI: Commodity stocks



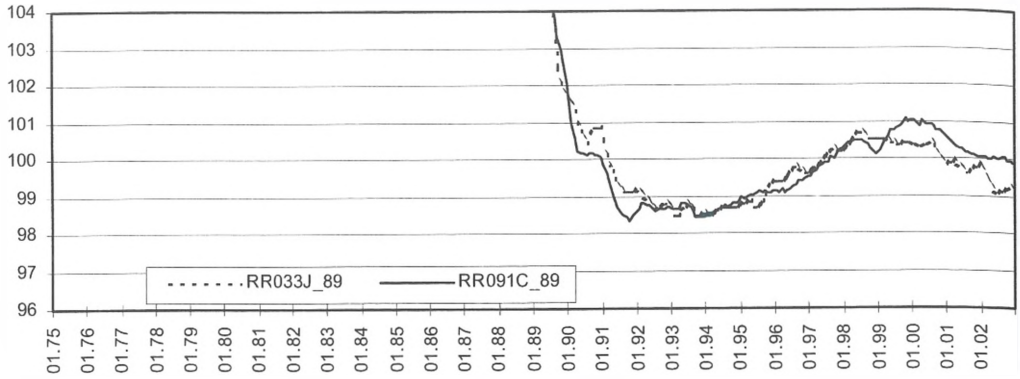
R028: Exports



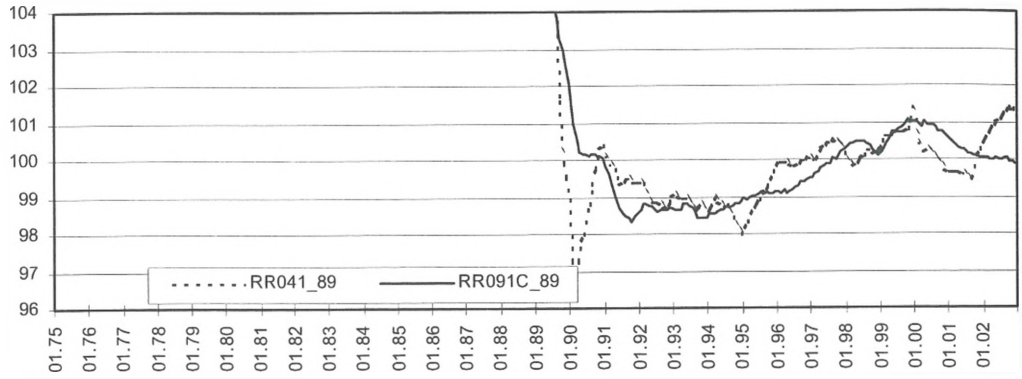
R029: Imports



R033J: Investment: machines & equipment



R041: Issue of cash



R045A: Household savings