BOFIT
Discussion Papers
2004 ▪ No. 16

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Selecting inflation indicators under an inflation targeting regime: evidence from the MCL method

Bank of Finland
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BOFIT personnel 2004

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BOFIT Discussion Papers
Editor-in-Chief Iikka Korhonen

BOFIT Discussion Papers 16/2004
1.9.2004

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ISBN 951-686-976-9 (print)
ISSN 1456-4564 (print)

ISBN 051-686-977-7 (online)
ISSN 1456-5889 (online)

Multiprint Oy
Helsinki 2004

Contents

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Abstract

This paper seeks to fill a gap in the literature by analyzing inflation in Poland, one of only two transition economies that have adopted a strict inflation-targeting policy. The paper also introduces a new method for selecting inflation indicators. Consistent with the earlier literature, empirical results find a strong link between the producer price index and consumer price index in Poland. This shows the importance of the manufacturing sector in determining the price level in the country. Overall, wages, broad money supply and the exchange rate are good indicators of inflation.

Key words: inflation, Poland, MCL method

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Tiivistelmä

Puola on toisena siirtymätalousmaana ottanut käyttöön tiukan inflaatiotavoitteen. Tämä tutkimus täydentää Puolan inflaatioon liittyvää kirjallisuutta täysin uuden menetelmän avulla. Aiempaa inflaatioon keskittyvää kirjallisuutta seuraillen tutkimus löytää vahvan siteen tuottaja- ja kuluttajahintaindeksin välillä. Tehdasteollisuuden merkitys Puolan hintatason määräytymisessä on siten tärkeä. Hyviä inflaation mittareita Puolassa ovat palkat, rahan määrä ja valuutan vaihtokurssi.

Asiasanat: inflaatio, Puola, MCL-menetelmä

1 Introduction

In the pursuit for an ideal framework for monetary policy, a number of developed countries have adopted an inflation targeting (IT) policy. Proponents of this policy cite many benefits, for example, targeting locks in expectations of low inflation thus reducing the inflationary impact of macroeconomic shocks (Ball and Sheridan 2003), or that it is easier for the public to understand and makes monetary policy more transparent (Horska 2001). Recent evidences suggest that IT countries have significantly reduced both inflation rate and inflationary expectation (Mishkin 1999), made inflation less persistent (King 2002), and have succeeded in locking-in earlier disinflationary gains (Bernanke *et al* 1999).[1]

Since the initial adoption of the IT regime by New Zealand in 1990, about two dozen countries have anchored their monetary policy to explicit quantitative inflation goals.[2] A number of studies have analyzed the impact of IT in the developed countries [see, among others, Ball and Sheridan (2003), Bernanke *et al* (1999), Soikkela (2002) and Svensson (2000)].[3] However, very few studies have looked at the nature, effect and applicability of this policy in the transition economies [exceptions include Christoffersen and Westcott 1999, Christoffersen *et al* 2001, Horska 2001].

What is special about such a policy in the transition economies? While many of the developed countries are now in the process of stabilizing inflation at a low level, monetary authorities in the transition economies are rather looking for means to disinflate rather than stabilize low inflation. In this context, direct inflation targeting may be a better monetary strategy than using intermediate targets as it offers at least two immediate benefits - increased control over inflationary expectations and short-term flexibility in policy making [Horska 2001].

[1] Comparing a group of inflation targeting and non-targeting OECD countries, Ball and Sheridan (2003) did not find any evidence that inflation targeting improves performance as measured by the behaviour of inflation, output, or interest rates.

[2] See Finance and Development (2003) for a list of countries that have adopted a strict inflation targeting policy. The European Central Bank's two pillar system based on inflation and monetary targets has been dubbed by many as being very close to a pure inflation targeting regime [Schmidt-Hebbel and Werner (2002)].

[3] For example, Johnson (2004) has shown that inflation targets have reduced the level of expected inflation in a number of developed countries including Australia, Canada, New Zealand, and Sweden.

This paper attempts to fill the gap in the literature by analyzing inflation targeting in Poland, one of the only two transition economies that have adopted the strict IT policy.[4] Following the high inflation rates in the late 1980s, the government in Poland introduced significant disinflationary measures in the mid-1990s in order to enhance its chances of joining the European Union. They succeeded in getting the inflation under control without high costs in terms of lost output (Golinelli and Orsi 2001).

In 1999, the National Bank of Poland (NBP) adopted an IT rule for anchoring its monetary policy. The Monetary Policy Council sets the annual inflation target. Despite an explicit inflation target, the NBP has, however, missed the target every year since 1999 [see Table 1]. During 1999 and 2000 inflation overshot the target band by an average of two percentage points. This can be attributed to a sharp increase in fuel and food prices as well as domestic consumption expenditures. With an easing of the supply pressure, exchange rate appreciation and substantial output gap, inflation started to fall in mid-2000. In 2001, the inflation target of 6-8 percent was undershot by 2.5 percentage points. The year 2002 also showed similar deviation of the actual inflation rate from the target rate.

The inability to keep the actual inflation rate within the target band can be attributed to two main factors: (i) technical shortcomings in IT design, such as, narrow bands, relatively short time span and the fluctuation in targeted inflation, etc., and (ii) erratic monetary policy - the expansionary monetary policy in 1999 in reaction to the Russian financial crisis and subsequent tightening of the policy.

The question therefore arises: How feasible is inflation targeting in Poland? Usually, three preconditions are set in the literature for studying the feasibility of inflation targeting in an economy: i) central bank independence, (ii) transparency and accountability in the policy making of the central bank, and iii) the existence of a relationship between the inflation rate and its various indicators, especially monetary policy indicators.[5] A number of studies have shown the presence of the first two prerequisites in Poland [Christoffersen *et al* (2001), Christoffersen and Wescott (1999)].

This study will concentrate on the third pre-requisite: what kind of relationship there is between inflation and its various indicators? A better understanding of the strength of this relationship would help monetary authorities to calibrate their monetary policy

[4] The other transition economy to adopt a strict inflation targeting policy is the Czech Republic. In addition, fourteen other transition economies have explicit inflation targets (see IMF 2002).
[5] See Soikkeli (2002) for a detailed discussion on this issue.

actions; improve their timing and help to achieve inflation targets. Given Poland's accession to the European Union and with ERM2 on the horizon, this issue should be of primary concern to the monetary policy makers. It would help not only to understand the disinflation measures, but also to assess the possible effects of future pressure on prices. The analysis will also help to provide answers to the following two questions: (i) has it been prudent for the Polish Monetary Policy Council (MPC) to recently shift the task of monetary policy from reducing to stabilizing inflation? and (ii) whether the MPC announcement of targeting inflation from 2004 onwards at 2.5 percent with +/- 1 percent band would be appropriate in light of the significant supply shocks affecting the economy.

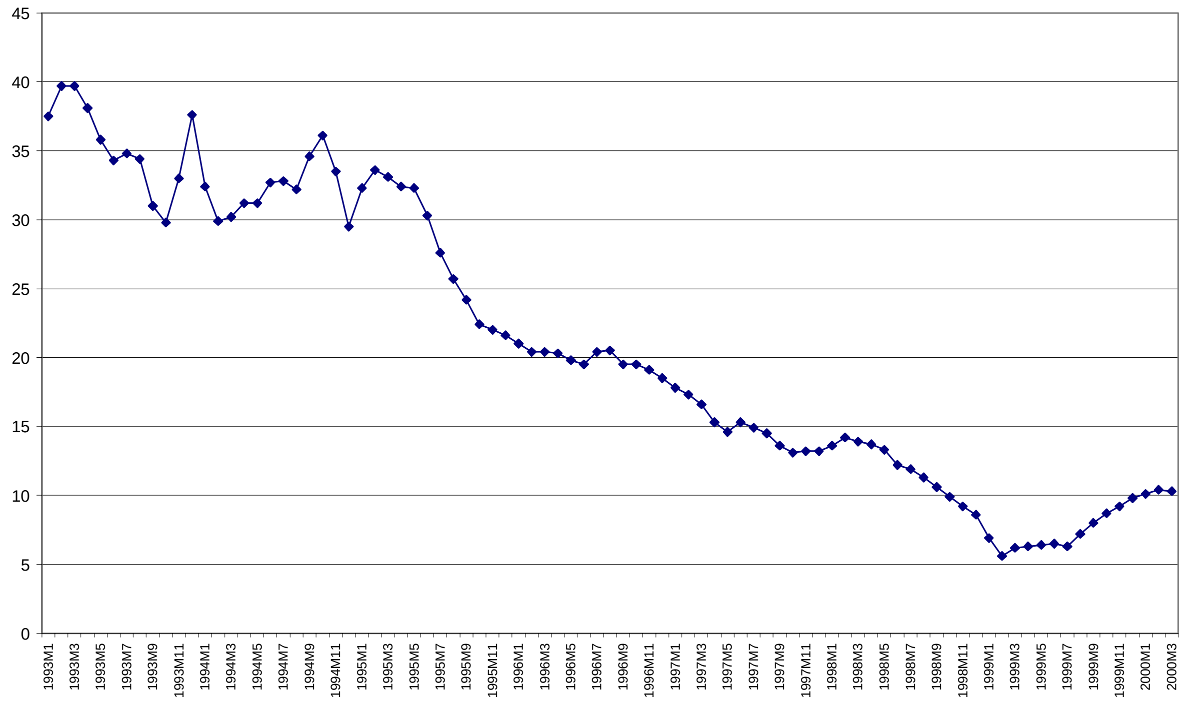
The paper is innovative for at least two reasons. To our knowledge, no other studies have attempted to analyse the role that indicators play in setting inflation targets at least in the context of a transition economy. Second, the paper uses the low entropy ratio criterion of thenewly developed Maximum Classification Length (MCL) method to predict the bestindicators of inflation. The use of the MCL criterion is appropriate for the problem that isbeing addressed in this paper as it can choose the best predictor of a variable given a list of potential candidates. Hence, the MCL differs from the common statistical methods which require selection of predictors before using them. Unlike the traditional methods, the MCL computes an objective criterion from the statistical properties of the training data for estimating the classification efficiency of the predictors. This is useful in cases where the different predictors diverge. The MCL takes similar approach as the Box-Jenkins method [see Box, Jenkins and Reinsel (1994)] although the MCL emphasizes predictor's capability to separate the classes in the predictor selection.

The paper is organised as follows. Section 2 provides a brief overview of the inflation process in Poland and summarises the earlier studies on Polish inflation. The methodology is discussed in Section 3 while Section 4 presents the estimation results. The paper ends with concluding remarks.

2 Inflation in Poland during 1993-2003

Typical to a transition country, inflation rates were extremely high in Poland during the early 1990s. The period of high inflation in 1990 was the outcome of the command economy price structure which was far from being market-determined. Beginning in 1990, Poland started to implement a comprehensive stabilisation programme. The stabilisation programme was directed to rapid price liberalisation, sharp reduction of subsidies and exchange rate unification. The programme decreased the share of administered prices from 50 to 10 percent.

Figure 1. Annual inflation rate in Poland, %.



Source: WIIW Monthly Database.

Following the stabilisation programme, the inflation rate declined rapidly. From a high of 586 percent in 1990, the rate dropped to 60 percent by the end of 1991. However, since then the inflation rate did not decrease as fast as was expected and the rate remained close to 30-40 percent for several years. Significant relative price changes and the skewed distribution of price increases explain the persistence in inflation (Pujol and Griffiths 1996, Wozniak 1998). The period of stabilisation in 1990 was extremely rapid and was marked by considerable divergences in relative prices. Moreover, in the first half of 1990s, fiscal deficits were large averaging around 4.5 percent of GDP during 1991-1995.

Since 1995, the inflation has steadily slowed down. From the last quarter of 1996, the NBP has followed a restrictive monetary policy by raising interest rates and the required reserve ratios. However, the bank did not get support from the fiscal side and, consequently, the impact of monetary policy changes remained small.

Only towards the end of 1998, the rate fell under ten percent. Since then, inflation has remained quite low with inflationary pressure virtually non-existent in both 2002 and 2003. A strong zloty, falling food prices and a relatively modest recovery of consumer demand kept the monthly inflation rate falling steadily in recent years. During the first half of 2003, the CPI inflation rate in Poland was 0.4 percent (UNECE 2003).

In February 1998, Poland's Monetary Policy Council (MPC) was established for determining the monetary policy guidelines. The following September, the MPC adopted the medium term strategy of monetary policy based on an inflation targeting framework. The medium term goal of this strategy has been to reduce inflation to below 4 percent by the end of 2003 (IMF 2003). The new strategy meant the abandonment of the use of money supply growth as the official intermediate monetary policy target and can be attributed to the increasingly less stable and predictable link between the broad money supply (M2) and inflation due to the development in the financial sector and macroeconomic stabilisation. Interest rate is the main instrument of monetary policy. In addition, the monetary policy tools include open market operations, NBP loan and credit facilities as well as the exchange rate policy.

In the second half of 1999, inflation accelerated mainly due to higher fuel and food prices and the inflation target set for 1999 was not achieved. In 2000, inflation stayed higher than was aimed again mainly due to a rise in imported energy costs (Welfe 2000). In 2001, the growth rate in both domestic and external demand started to decline. As a result of this and a few other factors, inflation rate dropped below the target level at the end of the year. Subdued economic growth has furthered disinflation and contributed to outstandingly low inflation rates in Poland since the beginning of 2002 (see Figure 1).

Christoffersen and Wescott (1999) studied the linkage between inflation and monetary policy instruments in Poland in order to test the credibility of the inflation targeting policy. They did not find any firm link over the 1992-98 sample period. Kim (2001) extended the sample period to cover the years from 1990 to 1999. Using cointegration and error-correction models, he found the labour and external sectors to be the major determinants of inflation in Poland. However, their results on the dynamics of inflation changed considerably after 1994. During this period, increases in wages resulted in higher inflation. On the other hand, real exchange rate appreciation contributed to the reduction in inflation. Similar to Christoffersen and Wescott (1999), Kim also did not find a strong link from the monetary sector to inflation.

The formal adoption of the inflation targeting regime has been a logical step on Poland's gradual path towards greater exchange rate flexibility. As a part of the new strategy, the exchange rate policy was subordinated to the performance of a direct inflation target and the Monetary Policy Council started to move towards the floating exchange rate. During the 1991-98 period, the Polish currency, zloty, was under a crawling peg system. In the early period, the crawling rate was 1.8 percent per month. In the mid-1990s, the rate was gradually lowered. In February 1995, the zloty was devalued against the reference currency basket by 1.2 percent per month. Since the beginning of 1996, the zloty was allowed to fluctuate within a band of +/-7 percent around the central rate against a basket of five currencies. The central parity rate was subject to a devaluation of 1 percent per month. In 1998, the band of the zloty was widened twice to +/-12.5 percent and the "crawling devaluation" of zloty was gradually reduced to 0.5 percent by September 1998. The following year saw a continuation of the parallel policies of inflation targeting and crawling exchange rate. To adjust the exchange rate regime to lower inflation target, the monthly rate of crawling devaluation was lowered to 0.3 percent. The trading band was extended to +/-15 percent and, in addition, the NBP reduced its presence on the foreign exchange market. This had a positive impact on the development of the currency market and thus reinforced the market character of the zloty.

Finally, in April 2000, the zloty started to float freely. Under the current exchange rate arrangement, the central bank does not set any target for predetermined exchange rates. Accession to the EU, and the inclusion of the zloty in the ERM2 system for at least two years have made the fully floating exchange rate regime essential. Without a period of free floating, the equilibrium exchange rate would have been difficult, if not impossible, to be determined.

From the above discussion, it is clear that keeping inflation rate within the target band is essential for the success of the inflation target policy. So the question is: how can the monetary authorities better predict the inflation rate. A number of studies in the literature looked at various predictors of inflation rate in order to see if those could be used for a better prediction. In this paper, the newly developed MCL method is used to investigate which of the predictors can provide useful information in forecasting inflation in Poland. In the next section, the MCL method is introduced and discussed.

3 Methodology

Economic data has conventionally been studied with time-series analysis methods. These methods can be applied for studying the four major components that characterize time series data: *long-term* or *trend movements*, *cyclic movements*, *seasonal movements* and *irregular* or *random movements* [see Han and Kamber (2001), pp. 418-427]. Typical time series methods include regression methods and ARMA models (Auto-Regressive Moving Average) [see Hamilton (1994)]. These methods model the problem by predicting future values of the selected attributes by minimizing the error between previous observations and the predicted value. This approach, however, requires the prediction model selection before any data might be available. An example of such model selection is ARMA model order selection, which is a difficult task. Using the modelling approach of [Friedlander (1983)] and [Friedlander and Sharman (1985)], the difficult problem of spectral estimation is reduced to the *AR* model parameter estimation from the data. Typical approach for parameter estimation is the *Maximum Likelihood* (*ML*) principle which aims for selecting model parameters in such a way, that the *posterior probability* of a given observation is maximized (or equivalently, the expected risk of misclassification is minimized). Preference to use simpler models (models with small number of parameters) instead of more complex ones was suggested in [Box, Jenkins and Reinsel (1994)]. *Box*, *Jenkins* and *Reinsel* also emphasized using *operator estimates* that are derived from the data instead of using the ‘true operators’.

In contrast to the conventional methods, the MCL approach models the problem by representing the knowledge of some phenomenon in terms of *classes*. The different classes contain *observations* of the respective phenomenon, and the MCL method can classify new observations in terms of the past observations in the classes. Three different classes of inflation are considered in this work – low, moderate and high inflation. The objective in this paper is to determine which of the attributes in the data can most efficiently separate these classes. Such attributes characterize the different classes very well, and may be considered as good indicators of inflation. The MCL approach does not require model order selection beforehand like the ARMA models. Instead, the model order is selected dynamically.

3.1 The MCL method

The collected data consists of matrices

$$C_k = \{ y_{k(i,j)} \}, \text{ where } k=1,\dots,t \quad \textbf{(1)}$$

Matrices C_k, $k=1,\dots,t$ are called *classes* and they contain observations that represent *knowledge* about phenomenon k;

$$C_k = \begin{bmatrix} y_{k(1,1)} y_{k(1,2)} \cdots y_{k(1,j)} \cdots y_{k(1,m)} \\ y_{k(2,1)} y_{k(2,2)} \cdots y_{k(2,j)} \cdots y_{k(2,m)} \\ y_{k(i,1)} y_{k(i,2)} \cdots y_{k(i,j)} \cdots y_{k(i,m)} \\ y_{k(n,1)} y_{k(n,2)} \cdots y_{k(n,j)} \cdots y_{k(n,m)} \end{bmatrix}, \quad \textbf{(2)}$$

where $i=1,\dots,n$, $j=1,\dots,m$ for all k. Each row represents m outcomes from the corresponding *attribute*, which is regarded as an independent random variable.

First, an estimated probability density function (PDF) is computed for each attribute in the training data as equal bin number histograms, where the probability of bin B_y is $p_{k(i)}(y)$;

$\Delta_i = \max_j(y_{k(i,j)}) - \min_j(y_{k(i,j)})$ is the *range* of the attribute, and

$\delta_i = \left\lceil \frac{\Delta_i}{r} \right\rceil$ the *bin width*, determined from the given number of bins (r).

Thus, the probability

$$p_{k(i)}(y) = \frac{\# y_{k(i,j)} \quad in\, B_y}{m} \tag{3}$$

The *class specific empirical entropies* are computed for attributes in each class C_k [see Shannon, p.11 (1948)]:

$$H_{k(i)} = \sum_y - p_{k(i)}(y) \log_2 (p_{k(i)}(y)), \tag{4}$$

where the summation is over *all* values *y* for attribute *i* in class *k*.

Considering class C_k and attribute *i*, it seems intuitively clear that if $H_{k(i)}$ is small the attribute would be considered good as all outcomes tend to form a tight cluster. When there are several classes this suggests that a good classifier might be one for which the sum,

$$H_i = \sum_{k=1}^{t} H_{k(i)} \tag{5}$$

is small. However, the summed entropy H_i is not a good criterion for ranking the features since $H_i = 0$ would imply that each term $H_{k(i)} = 0$, too. Furthermore, it could happen that the histograms for the classes have just one bin, including all the data for one and the same bin B_y, e.g., $p_{k(i)}(y)=1$ for all *k*. This means that this feature has no information about the classes. In contrast, if the bins containing all the outcomes are different for all the classes, in other words, $C_1 \neq C_2 \neq \ldots \neq C_a$, then the feature outcomes C_k would separate the classes perfectly. Now, this situation differs from the former in that the entropy defined by the *k* histograms is large – certainly not zero as it would be in the former case. This suggests computing the *combined histogram* from all the *t* histograms, namely

$$p_i(y) = \frac{\sum_{k=1}^{t} p_{k(i)}(y)}{t} \tag{6}$$

and the *total entropy*;

$$H_i^{total} = \sum_y - p_i(y)\log_2(p_i(y)) \qquad (7)$$

Then, we compute the *entropy ratio* between the *summed entropy* and the *total entropy*;

$$D_i = \frac{H_i}{H_i^{total}} \qquad (8)$$

Definition of the entropy ratio D_i is similar to the *Kullback-Leibler distance* [see Dupuis and Robert (2003)]. While the *Kullback-Leibler distance* (also known as the *relative entropy*) represents the affect of some feature to the total entropy, D_i represents how well the attribute *i* can separate the classes *k*. Attributes that have low entropy ratio seem to characterize the differences between the classes better than those that have a high entropy ratio. The attribute is considered the better classifier the smaller the value D_i is. D_i will further be called the *attribute inter-class similarity measure*.

Results in Brandt (1999), Browne *et al* (1998), Dash and Liu (1999) indicate that distributions with relatively small entropies are better classifiers than the ones with high entropy values. Thus, these papers support the use of minimum entropy as a criterion for attribute selection. In addition, the method performs according to the *Sequential Forward Selection* (SFS) procedure, which is widely used for feature selection [see Devijver and Kittler (1982), pp. 216-217].

One can argue about the assumption of attribute independency. However, it is intuitive because one cannot determine complex associations between the attributes. Furthermore, all attributes cannot always be obtained. Prioritizing the measurement order of the input signal attributes is sought in such cases, as well.

3.2 Class prediction

Properties of the collected data can be used for predicting unknown attribute values. In this paper, the inflation in terms of the measured attribute values is predicted.

The value of attribute *i* in the measured input signal ***x*** is denoted by ***x(i)***. The likelihood function *L* [see Severini (2000), p.73] is:

$$L(C_k(i)) = \begin{cases} p_{k(i)}(y), if\ y \in C_k \\ 0, otherwise \end{cases} \quad \text{,where } y = \{ y_{(i,j)}\ which\ minimizes\ | y_{(i,j)} - x(i) | \} \quad \textbf{(9)}$$

$$\Rightarrow L(C_k) = \prod_i L(C_k(i))$$

Index *i* in (9) denotes attributes that were *actually measured*. Computation of $L(C_k)$ uses the same principle as the 1-NNR method [see Devijver and Kittler (1982), pp. 69-127], e.g., that the nearest value to the observation should appear in classes where the sample is most likely to belong. The likelihood of each class C_k is then estimated using the *a priori probabilities* taken from the respective PDF. Thus, the predicted class is

$$C_k = arg(max(L(C_k)) \quad \textbf{(10)}$$

Clearly, if $L(C_k)=0$ for all classes C_k none of the prototypes in the training data have similar values to ***x(i)***. In this case, none of the classes is predicted. Instead, it will simply be stated that the measured signal does not belong to the training data. If $L(C_k)>0$ for a *single class* C_k, it is possible to *predict* that ***x*** belongs to the remaining class, or that ***x*** is a previously unknown signal having at least one similar attribute value as the prototypes of that class. Thus, it is unnecessary to measure any additional attributes of ***x*** unless *all of them* could be measured. However, if $L(C_k)>0$ for several classes, additional attributes are measured. However, it should be noticed that the feature ranking as well as the classification are sensitive to the quantization which can be seen as the weak point in the method.

The initial attribute ranking order holds globally for the training data, because the attributes are taken as independent random variables. This enables straightforward processing even in cases when all attributes of ***x*** could not be obtained. It is extremely important, however, to decide how the missing value(s) should be treated in the likelihood computation.

4 Estimation results

The primary interest of this paper is to investigate if there is a stable and predictable relationship between the inflation rate and its various indicators. Based on the literature in general and the case of Poland, in particular, a list of the most probable, leading inflation indicators is included in the estimation process.[6] The list includes exchange rate, monetary aggregate, deposit rate, producer price and import price indices, labour market variables, volume of exports and industrial production. In particular, the following ten variables are included – official exchange rate, broad money supply (M2), deposit rate, producer price index, industrial employment, wages, unemployment rate, volume of exports, import prices, and industrial production. In the following discussion, these ten variables are referred to as attributes 1 through 10, respectively. A detail description of the variables and their sources are provided in the Appendix 1.

Three nominal classes are used to classify inflation – strong inflation, moderate inflation, and weak inflation. Classes were obtained by separating the consumer price index (CPI) data as following. Class 'Low inflation' contains samples that have annual inflation rate below 14 %, 'Moderate inflation' contains samples having inflation rate from 14 % to 30 % and 'High inflation' samples that have annual inflation rate over 30 %. Monthly data during the period 1/1993 – 3/2000 was used in estimation. It should be noticed, however, that the criterion of dividing the data into the three classes (in this case, the value of CPI) strongly influences the analysis.

Each training class C_k, $k=1,2,3$ contained 14 observations ($m=14$). All observations were vectors (dimension [10x1]) containing 10 variables characterizing inflation. The test data contained three different data sets: First data set contained 13 samples of class Strong inflation, second data set 16 samples of class Moderate inflation, and the third data set 16 samples of class Low inflation. Selection of bin numbers establishes the prediction model and thus, different prediction models were tested using cross validation.

As Table 2 shows, the overall ranking of variables characterizing inflation remains practically the same when different amount of bins were used. Presented results indicate that *Producer price index* appears to be the best attribute in all prediction models.

[6] Christoffersen *et al* (2001), Doyle (2001) and Horska (2001) provide an exhaustive list of inflation indicators in Poland.

Moreover, the attributes can roughly be divided into three groups. Attributes *Official exchange rate*, *M2*, *Producer prices* and *Wages* seem to be the best indicators of inflation. The separate models, however, have some important differences. Models 1 and 2 (with 7 and 41 bins) seem to work best, while model 4 (150 bins) is much more conservative leaving more samples unclassified than other models. Model 1(7 bins), on the other hand, makes more wrong classifications than any other model. Naturally, the differences between the models are caused by the method's sensitivity to the quantization.

The attribute ranking remains practically unchanged when the training and test sets are switched. These results are shown in Table 3. However, as the number of samples is very small, the distributions of the classifiers change very rapidly when the training and test sets are switched. Hence, one should use as many training samples as possible in order to get meaningful results. The best classification setup of Table 3 is the one using 55 bins where attribute *Producer prices* appears again among the best classifiers.

Figure 2 shows the Probability density functions (PDFs) of predictors *Producer prices*, *M2*, *Industrial employment* and 8 *Volume of exports* with the prediction model having 7 bins in the quantization. As Figure 2 illustrates, the PDFs of *Producer prices* and *M2* do not overlap as much as PDFs of *Industrial employment* and *Volume of exports*. This is basically the reason why *Producer prices* and *M2* are among the best predictors for inflation. Attribute inter-class similarity measures for prediction model 1 (7 bins) are $D_4 = 1.6455$, $D_2 = 1.7355$, $D_5 = 2.1036$ and $D_8 = 2.1658$.

Figure 3 *shows* the original values of the different inflation types divided by attributes *Producer prices*, *M2*, *Industrial employment* and *Volume of exports*. One can see that setting decision boundaries between the classes is relatively easy using attributes *Producer prices* and *M2*. In contrast, the values of attributes *Industrial employment* and *Volume of exports* do not seem to vary between the different inflation classes.

5 Concluding remarks

A number of studies have established the feasibility of inflation targeting in Poland (Christoffersen *et al* 2001). This paper looks at a more policy-oriented question: how can the announced inflation target be achieved.

The results show that the producer price index and the consumer price index are strongly connected to each other in Poland. The result is consistent with earlier studies as the link from producer prices to consumer prices is well known in the literature. This also shows the importance of the manufacturing sector in determining the price level in the country. In addition, wages, broad money supply and the exchange rate are also good indicators of inflation.

Our results follow relatively closely the results from earlier studies. Christoffersen and Wescott (1999) and Gottschalk and Moore (1999) also found the exchange rate to have a strong relationship with inflation. However, unlike this study, Christoffersen and Wescott (1999) found foreign inflation to have a significant relationship with Polish inflation. Overall, the new method that we have applied to economics for the first time seems to fit quite well to inflation studies where the aim is to find the best indicators for inflation. In the future, the method could be used also to try to predict inflation. So far, we have not tested the causality between the indicators and inflation with the MCL method.

The results have important policy implication as the monetary authorities need to closely monitor variables, such as, the producer price index, wages, broad money supply and exchange rate in order to have a better understanding of how inflation targets could be achieved. Finally, it is true that inflation could be influenced in the short run by temporary shocks. Moreover, the inability of the National Bank of Poland to keep the actual inflation within the target could be attributed to the delayed impact on prices of adjustments to monetary policy parameters in response to unanticipated inflationary impulses. Hence, in addition to achieving the targets, the performance of the strategic monetary policy targets should also be taken into account.

Table 1 Inflation Targets and Outcomes in Poland, 1992-2001

Year	Target Inflation	Actual Inflation	Deviation
1992	36.8	44.4	7.6
1993	32.2	37.6	5.4
1994	23.0	29.4	6.4
1995	17.0	21.6	4.6
1996	17.0	18.5	1.5
1997	13.0	13.2	0.2
1998	9.5	8.6	-0.9
1999	7.8-6.6	9.8	2.0
2000	6.8-5-4	8.5	1.7
2001	8.0-6.0	3.5	-2.5
2002	4.0-2.0	0.8	-1.2
2003	4.0-3.0		

Source: IMF: Poland, Selected Issues, 2002;
National Bank of Poland: Inflation Report, 2003

Table 2 Simulation results of different prediction models and the respective predictor rankings.

Model	Bins in quantization	Correct/ Unsolved/ Wrong (total 45 samples)	Ranking *R*
1	7	35/ 0/ 10	{ 1 4 6 2 3 7 5 8 9 10}
2	41	33/ 11/ 1	{ 6 4 1 3 2 5 7 9 10 8}
3	55	20/ 17/ 8	{ 3 6 1 4 2 7 5 9 8 10}
4	150	22/ 18/ 5	{ 3 6 4 8 2 1 9 10 7 5}

Table 3 Simulation results of different prediction models from the 2nd setup and the respective predictor rankings.

Model	Bins in quantization	Correct/ Unsolved/ Wrong (total 42 samples)	Ranking *R*
1	7	34/ 1/ 7	{ 4 6 2 3 1 5 8 7 9 10}
2	41	30/ 10/ 2	{ 3 6 4 2 8 1 7 5 9 10}
3	55	33/ 9/ 0	{ 3 4 6 1 8 2 7 5 9 10}
4	150	20/ 20/ 2	{ 3 8 1 7 2 6 4 5 9 10}

Figure 2. PDFs of predictors *Producer prices* (top left), *M2* (top right), *Industrial employment* (bottom left) and *Volume of exports* (bottom right).

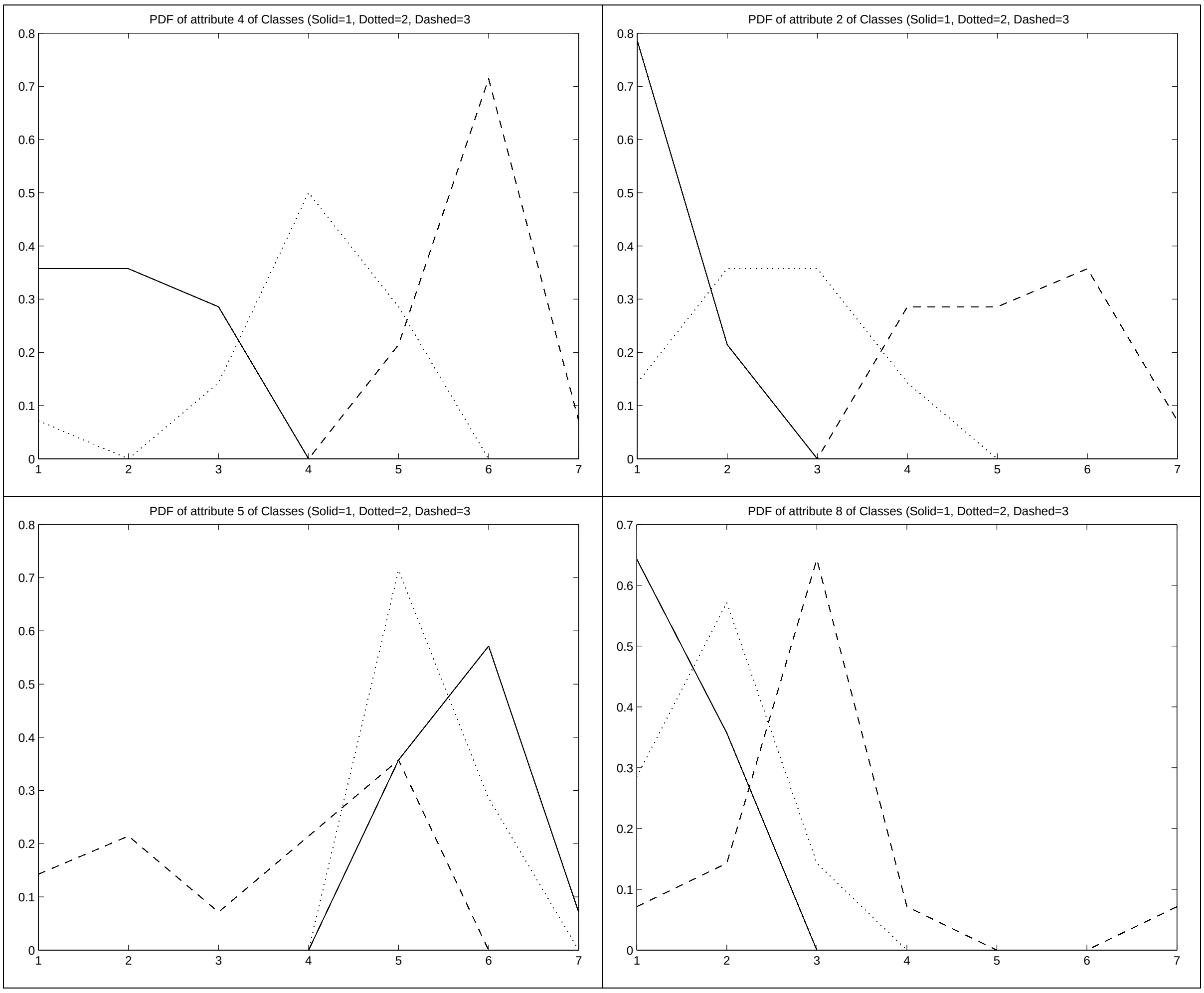
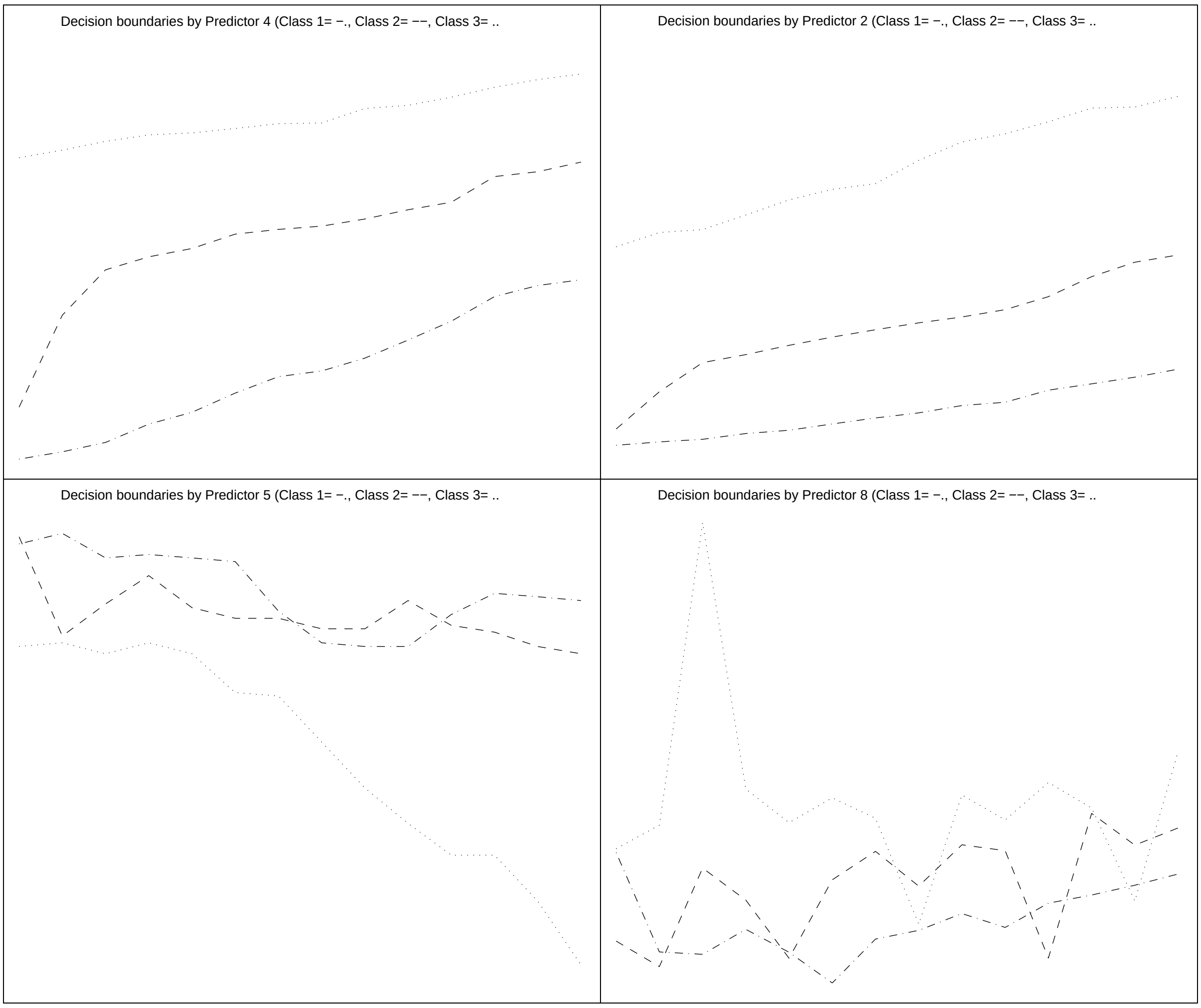


Figure 3. Original data samples of *Producer prices* (top left), *M2* (top right), *Industrial employment* (bottom left) and *Volume of exports* (bottom right).



Appendix

List of variables and sources:

Variable	Definition	Source
1) Official exchange rate (Period average)	National Currency per US Dollar	IFS
2) M2	Money + Quasi-money	IFS
3) Deposit rate	Per cent per annum	IFS
4) Producer prices (Industry)	1995=100	IFS
5) Industrial employment	1995=100	IFS
6) Wages	1995=100	IFS
7) Unemployment rate		IFS
8) Volume of exports	1995=100	IFS
9) Import prices	1995=100	IFS
10) Industrial production	y-o-y change	WIIW
Inflation rate	y-o-y change in consumer prices	WIIW

IFS – International Financial Statistics
WIIW – The Vienna Institute for Comparative Economic Studies

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