IMF Working Paper

WP/99/41

INTERNATIONAL MONETARY FUND

European I Department

Is Poland Ready for Inflation Targeting?

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March 1999

Abstract

Monetary policymakers in advanced transition economies such as Poland are increasingly interested in how inflation responds to changes in policy instruments and other economic forces. In this paper, measures of underlying CPI inflation based upon optimal trimming concepts are developed. The sensitivity of these CPI measures to changes in a set of 25 policy and economic variables is then studied via Granger causality tests and impulse responses and a multivariate model of CPI inflation developed. The results show that a core set of variables characterize one-period-ahead underlying inflation moderately well but that statistical linkages are not yet robust.

JEL classification numbers: C32, C53, E31, E52

Keywords: leading indicators, inflation, monetary policy, inflation targeting, robust statistics, administered prices.

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I. Introduction

With inflation in some advanced transition economies in Central and Eastern Europe now dropping to single-digit levels, monetary policymakers in several countries, including Poland, are showing a growing interest in analyzing inflation dynamics (see Christoffersen and Doyle, 1998). How is inflation influenced by shifts in monetary policy instruments, such as interest rates, monetary aggregates, or the exchange rate? How does it respond to changes in other economic variables, such as wages, the unemployment rate, or capacity utilization? And how predictable is inflation? Given that Poland's Monetary Policy Council (RPP) announced in the autumn of 1998 that it was adopting an inflation targeting framework for the conduct of monetary policy, these policymakers are particularly interested in knowing the characteristics and timing of the linkages between monetary policy instruments and the rate of inflation. Understanding the strength of these relationships and their lags will help them to better calibrate their monetary policy actions, improve their timing, and better achieve their inflation targets.

This chapter looks at the inflation process in Poland in the 1990s, and attempts to answer these questions by examining the statistical linkages between inflation and monetary policy instruments and other so-called leading indicators of inflation. Because transition economies have tended to experience large increases in administered prices, wide swings in relative prices, and the introduction of new Western-style taxes (like the VAT) that have tended to complicate the inflation story, a key element in this work is to try to develop measures of "underlying inflation." The work on efficient inflation estimation of Bryan, Cecchetti, and Wiggins (1997) and others is relied upon in the development of optimally trimmed consumer price inflation (CPI) and other smoothed inflation measures. In general this paper finds that smoothing away some of the extreme price movements over the transition period tends to reveal an inflation process that is more stable and predictable than might appear at first. In addition, theoretically sound linkages between several monetary policy variables and underlying inflation are discernable in the data. In particular, the exchange value of the zloty and to some extent broad money seem to be statistically related to movements in inflation. Even so, the statistical power of inflation forecasting models in Poland still appears to be modest, especially when the forecast horizon extends for periods of one year or longer.

The organization of the paper is as follows: the first section examines the extent to which transition-related price changes in some important categories of the consumer price index (CPI) skew measures of CPI inflation. This section also describes the concept of underlying inflation and the techniques used to develop proxies of it. The second section follows Baumgarten and Ramaswamy (1996), and looks at how various potential leading indicators of Polish inflation are statistically associated with these measures of underlying inflation. The analysis relies upon Granger causality tests and on estimated impulse responses. In the third section, a multivariate model built upon the strongest explanatory variables identified is constructed to try to assess the overall predictability of inflation. A final section offers some reflections about the policy implications of this analysis for inflation targeting in Poland.

II. MEASURING UNDERLYING INFLATION

The decline in CPI inflation in Poland during the period 1992–98—from roughly 50 percent a year to single-digits—is illustrated in Figure 1. As shown in the lower right panel of the figure, however, even in seasonally adjusted terms, substantial monthly fluctuations remain. Most analyses of the inflation process presume that price changes for the main components of goods and services that make up the CPI are distributed normally. This normality is important for at least two reasons. First, as Pujol and Griffiths (1996) and Ball and Mankiw (1995) argue, skewness or high variability of relative price movements can impart a bias toward higher overall inflation because of menu effects.[2] The argument runs as follows: if costs increase sharply in a few spending categories, higher prices are likely to be passed along to consumers because it is worth it for restaurant owners to pay the fixed costs of re-printing menus, but if costs decline slightly in a number of other spending categories (such that prices on average might otherwise remain unchanged), these prices may not be lowered to consumers because of the fixed costs of re-printing menus. That is, these authors argue that inflation could increase simply because of a non-normal distribution of price increases across the various categories of the CPI. Second, normality is important because it makes it easier to characterize and forecast CPI inflation. Unfortunately, however, evidence of skewness and excess kurtosis in the distribution of price changes is widespread in many countries, and Poland is no exception.[3]

Prima facie evidence of the non-normality of Polish price changes is suggested by Figure 2. The top panel shows a histogram of seasonally-adjusted monthly price changes across the 33 main categories of goods and services in the CPI, observed over 78 months (January 1992 to June 1998)—that is, 2,574 price changes. Each price change is standardized by subtracting the average monthly inflation for each month across the 33 price groups and dividing by the corresponding standard deviation. In the middle panel, these same 2,574 price changes are first seasonally adjusted, then each price change is transformed by subtracting a third-degree polynomial time-trend for each of the 33 categories to adjust for transition effects, and finally the remaining data values are standardized as in the top panel. For reference, the bottom histogram represents a standard normal distribution. Strong departures from normality are evident in the top two histograms, especially considering the existence of numerous observations four and five standard deviations away from the means. Applying a Jarque-Bera test for the null hypothesis of normality leads to a rejection at the 1 percent level in both the top and middle panels. The actual skewness and kurtosis estimates in the three panels are:

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[2]In fact, Wozniak (1998), using a modeling framework suggested by Ball and Mankiw, has estimated that the large administered price increases associated with transition in Poland produced substantial upward inflationary pressures between 1989 and 1997. Pujol and Griffiths (1996) also find evidence of this effect.

[3]See for example, Andersen and Gudmundsson (1998) on Iceland, and Debelle and Lim (1998) on the Philippines.

Figure 1. Poland:
Consumer Price Index, 1992-1998
(percent change, as indicated)

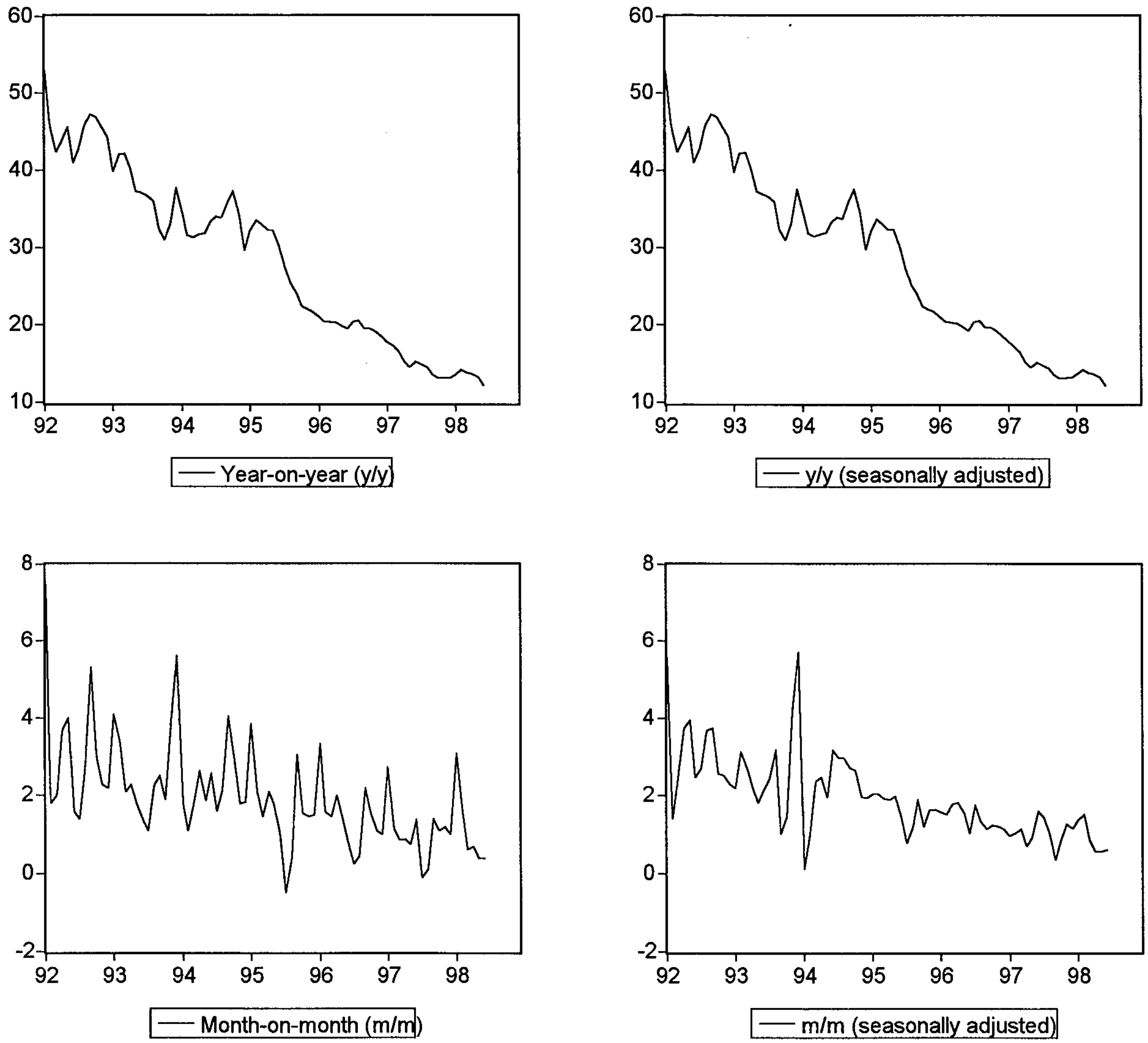
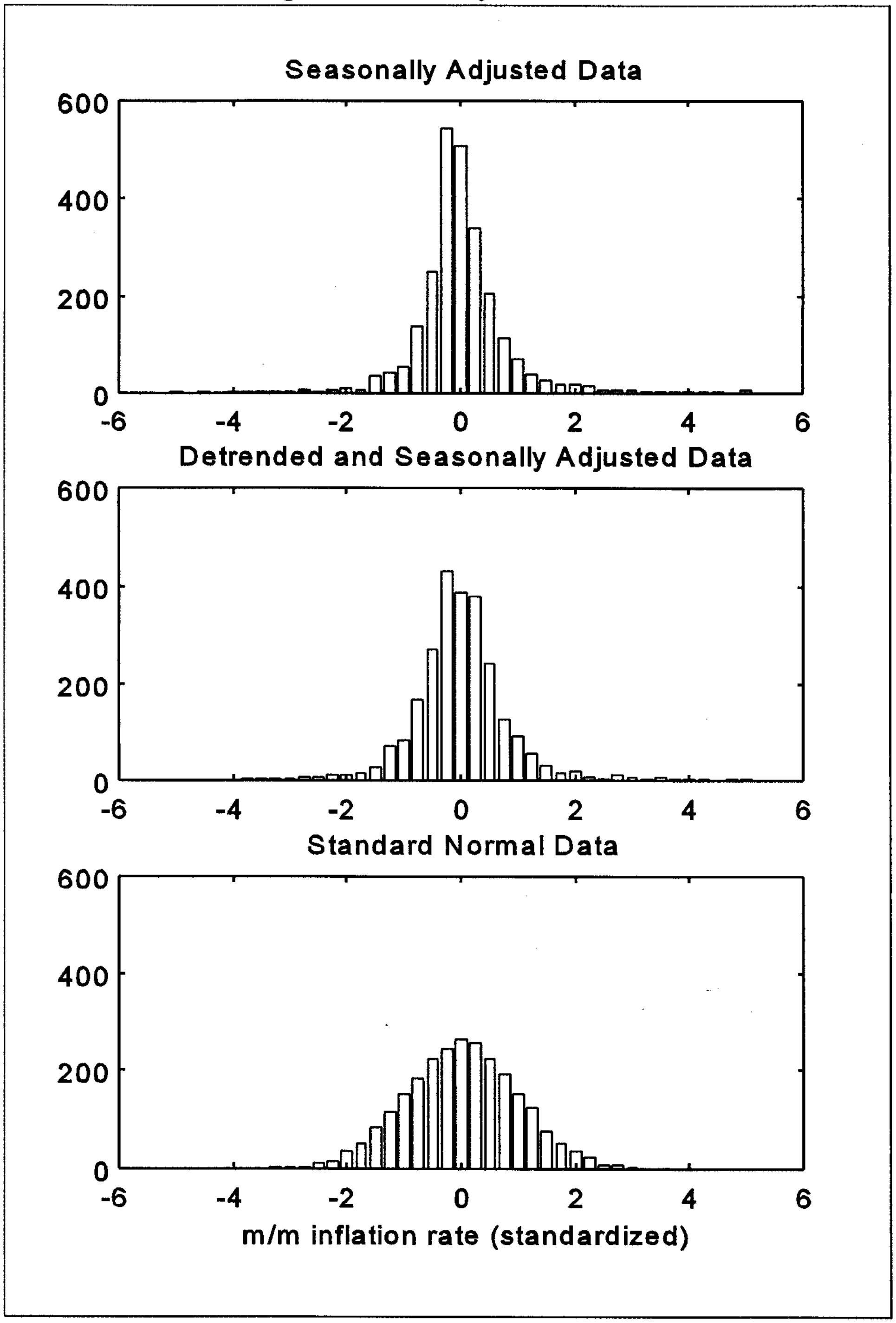


Figure 2. Poland:
Histograms of Monthly Price Increases



Note: The top panel shows seasonally-adjusted monthly price changes across 33 categories of goods and services observed January 1992 through June 1998. Each price change is demeaned and standardized monthly. In the second panel, each price change is additionally transformed by subtracting a third-order polynomial time-trend. For reference, the bottom histogram represents a standard normal distribution.

skewness, 0.46 (top), 0.53 (middle), and 0 (bottom), and kurtosis, 10.92 (top), 9.05 (middle), and 3.0 (bottom).

Transition dynamics, including large swings in relative prices, jumps in administered prices, and tax innovations help to account for at least some of this non-normality, as does the heavy weight in the Polish CPI on foodstuffs, which are affected by weather conditions. The role played by administered prices and the prices of goods subject to excise tax changes, which together account for roughly one quarter of the CPI by weight in the period under consideration, are documented in Figure 3.[4] Clearly many of these thirteen price index categories show large discrete price movements. The cumulative effect is to make inflation appear less stable over time, less predictable, and harder to model. Of course, as relative prices in Poland approach world prices, this effect is likely to gradually diminish in the future.

The Concept of Underlying Inflation

The preceding discussion highlights the potential difficulties of trying to explain statistically the short-run movements in headline CPI inflation, as well as its possible drawbacks as a policy target. Because of these shortcomings, researchers have tried to develop alternative concepts of inflation that behave in more a predictable manner. Often these measures are called "core inflation" or "underlying inflation."[5] To Roger (1997), core inflation is a useful concept because sometimes exceptional price movements "...give a 'distorted' impression of the general rate or central tendency of price movement or inflation in the sense that the movement in the aggregate price index is quite different from the movement of most prices comprising the index." Freeman (1998) sees core inflation measures as an attempt to identify permanent trends in inflation by eliminating temporary price fluctuations.

Among the early attempts to quantify operationally a concept of core inflation were those by Eckstein (1981) and Blinder (1982). Eckstein listed three basic sources of inflation: demand factors, supply shocks, and labor-cost and capital-induced inflation, and defined core inflation as a price change that takes place with no shocks occurring and the macroeconomy remaining in a state of neutral demand—that is, long-term equilibrium. Operationally, the Eckstein work relied upon the use of a large-scale econometric model which is not readily available for Poland.

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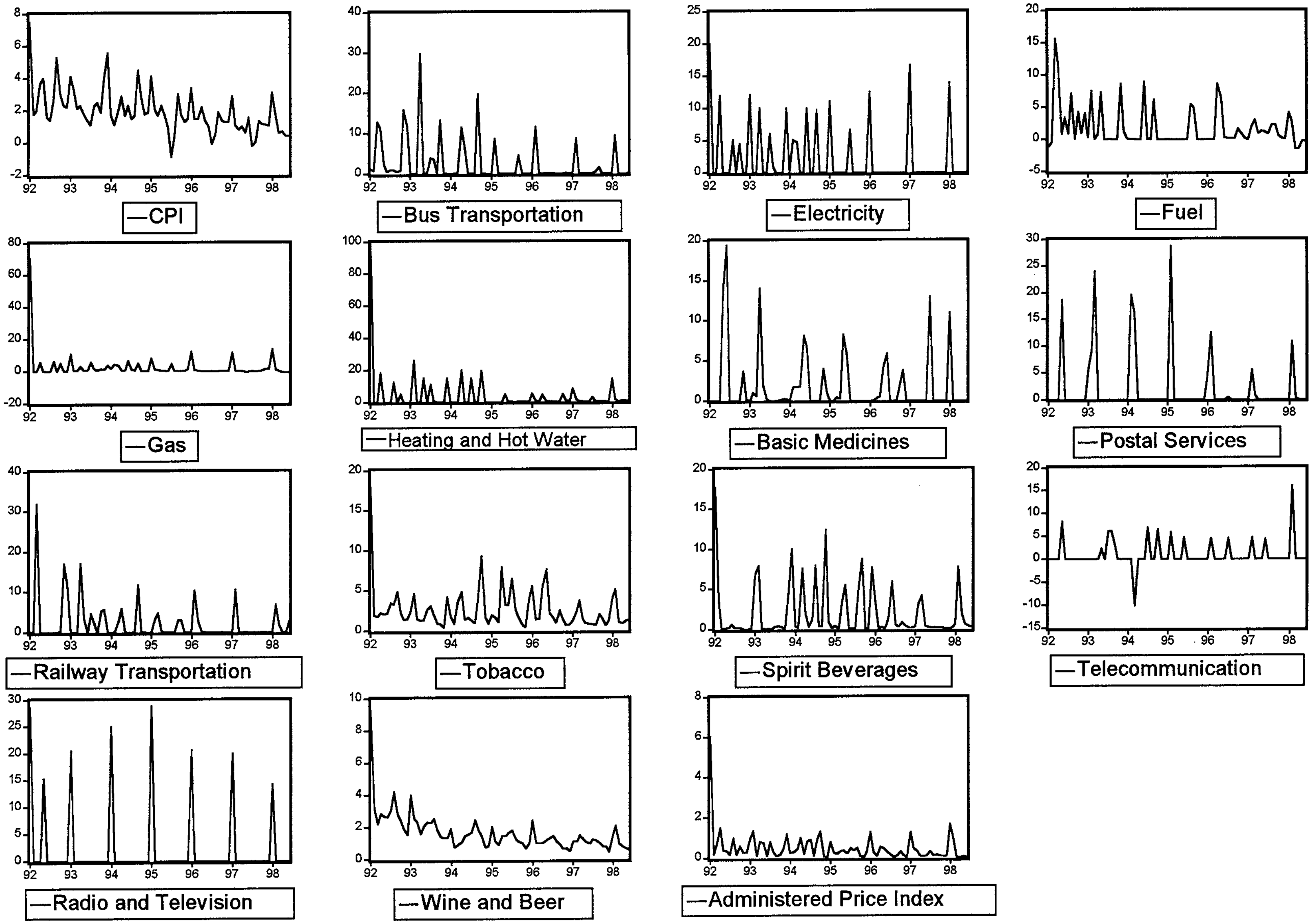
[4]The last panel in Figure 3 depicts an index of the thirteen government affected goods and service prices weighted together by their respective weights in the CPI (and rebased).

[5]In the past, headline and underlying inflation have differed in transition economies both in the short-run and over longer periods of time, so focusing on underlying inflation as a policy target would have been difficult. As administered prices, excise tax rates, etc., approach world prices and rates, it is likely that the two inflation concepts will move more together in the future. This should allow underlying inflation to play a more important policy target role.

Figure 3: Poland: Administered Prices (percent change, month-on-month)



Quah and Vahay (1995) define core inflation as the component of measured inflation that has no medium- to long-run impact on output. That is, they see part of measured CPI inflation as performing the job of signaling production levels over the business cycle, and the rest as core inflation. Kaczor and Wojcicka (1996) follow the Quah and Vahay approach and isolate the non-core inflation movements in Poland by estimating a VAR system that extracts the price changes that are due to changes in industrial production. The result, however, is a core inflation measure that is as volatile as headline inflation, which runs counter to general intuition. This unfortunate result also emerges in the original quantitative work by Quah and Vahay.

Bryan and Cecchetti (1994) define core inflation as "the long-run or persistent component of the measured price index, which is tied in some way to money growth." But unfortunately this means that a clear definition of core inflation requires a model of how prices and money are determined in the economy, and it is difficult for researchers to agree on any specific model. The authors therefore develop a model of price setting that they argue can be estimated by a limited-influence estimator, such as the median of the cross-sectional distribution of individual price components.

In the present paper, the core inflation work of Bryan, Cecchetti and Wiggins (1997) is relied upon heavily, largely because of the theoretical or operational limitations of other approaches. This work, which builds upon Bryan and Cecchetti (1994), provides an operationally straightforward definition of core inflation as a trimmed measure of a long-run moving average of CPI inflation. Another paper based upon this trimmed measure methodology is McNeilly and Schiesser-Gachnang (1998), who compute trimmed medians for the case of Albania.

In practical policymaking circles, a number of countries that rely on inflation targeting frameworks for monetary policy make adjustments to the headline CPI to better reveal what policymakers consider to be the underlying inflation pattern. The United Kingdom and New Zealand, for example, currently exclude mortgage interest rates from the CPI that they targets for monetary policy, while New Zealand in the past has also excluded the effects of what were considered to be temporary supply side shocks. Finland excludes the effects of mortgage interest payments, indirect taxes, subsidies, and house prices. Australia excludes mortgage interest payments and other volatile items.

Calculating Underlying Inflation

Following Bryan, Cecchetti and Wiggins (1997), this paper eliminates some of the largest and smallest prices changes each month among the 33 main categories in Poland's CPI to try to obtain the best measure the underlying inflation pattern in the country. Eliminating the α-percent categories that showed the largest price changes and the α-percent categories that showed the smallest price changes yields the α-percent (weighted) trimmed-mean, which is defined as:

$$\bar{x}_{\alpha,t} = \frac{1}{1-2\alpha/100} \sum_{i \in I_{\alpha,t}} \omega_{i,t} x_{i,t}$$

where α is the percentage trimmed in each tail, $\omega_{i,t}$ is the weight on commodity i at time t, and $x_{i,t}$ is the month-on-month price increase in commodity i at time t. $I_{\alpha,t}$ is the set of commodities left after trimming at time t—that is, the i's remaining after the α smallest and α largest price increases have been removed. Notice that the sample average corresponds to setting α to zero, and the sample median to setting α to 50. The weights in the index are updated annually.

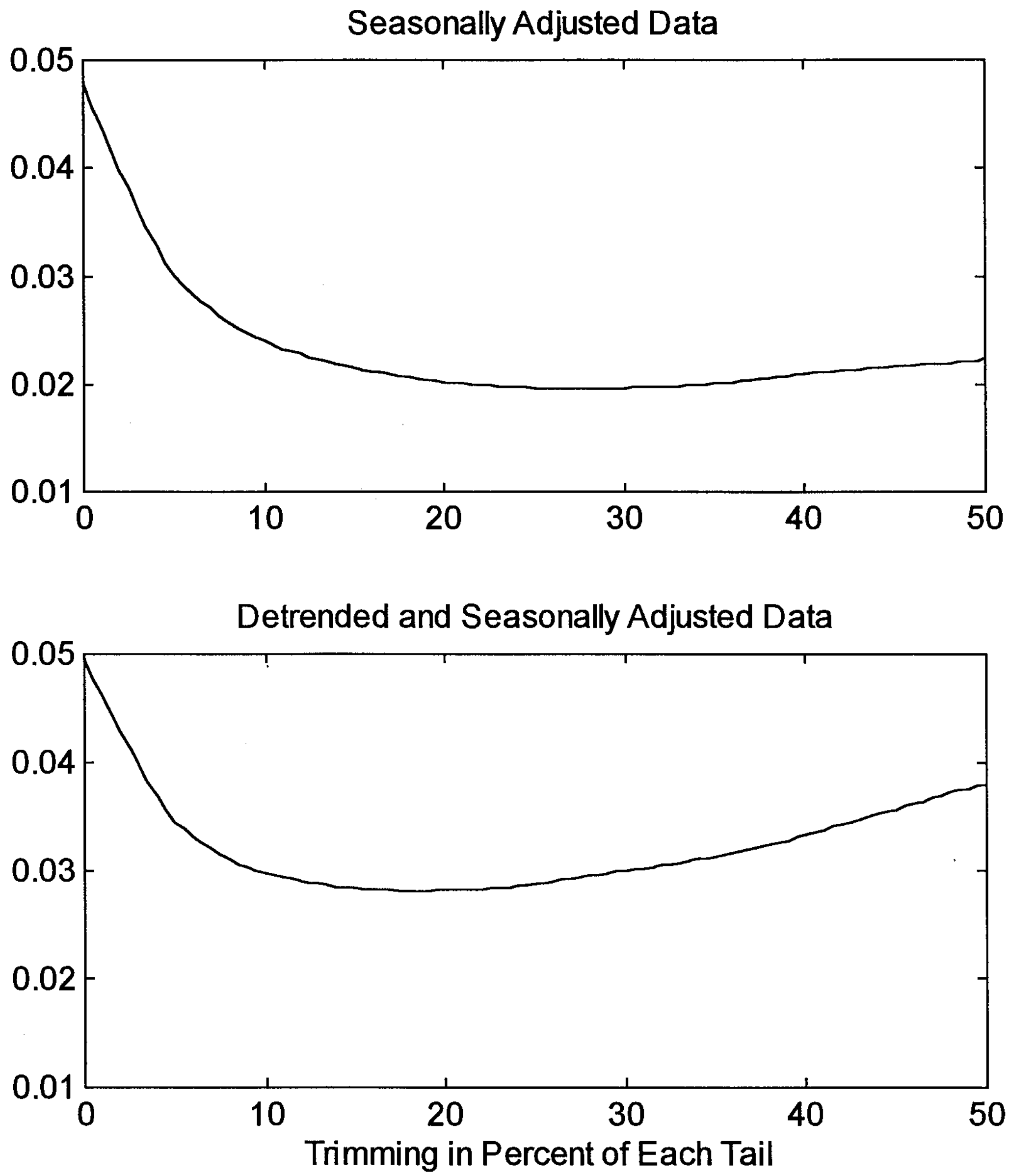
Note that it is categories with certain weights that are removed from each tail, not a specific number of categories. For example, with α=20, it is possible that in March 1995, the food category alone might represent 20 percent of the weight of the CPI and have the lowest inflation that month, so only food prices would be deleted from the lower tail in the computation of the CPI that month. On the other hand, it might be necessary to remove the price effects of say, fuels, education services, and telecommunications from the upper tail in the computation of the CPI if these three categories represented 20 percent of the weight in the CPI and these three categories had the highest inflation that month.

A key question, of course, is how much should be trimmed to develop the best measure of underlying inflation? In other words, which value should the parameter α take on? Bryan *et. al.* (1997) resample with replacement from each commodity group (picking a random month in a random year for each commodity) to build up a large Monte Carlo sample of trimmed means. This is repeated for different values of α and the mean squared error (MSE) for each α across the Monte Carlo replications is computed as:

$$MSE(\alpha) = \frac{1}{J}\sum_{j=1}^{J} (\bar{x}_{\alpha,j} - \mu)^2$$

Finally, the α corresponding to the lowest MSE is chosen. The same procedure is followed here. The data underlying the histograms in Figure 2 are sampled with replacement, and the results are presented in Figure 4, which plots MSE as a function of α for seasonally adjusted

Figure 4. Poland:
Mean Squared Error of Trimmed Means



Note: Mean squared error is plotted for various trimmed means as a function of the percentage trimmed in each tail. A trimming of 0 corresponds to the sample mean, and a trimming of 50 percent to the sample median. In the top panel, the underlying data is deseasonalized, in the bottom panel, the data is deseasonalized and detrended by a third-order polynomial in time.

data (top panel) and detrended and seasonally adjusted data (bottom panel).[6] Because the data have been demeaned a priori, the true mean, μ, is simply zero. This analysis suggests that according to the MSE criterion, approximately 20 percent of the CPI categories should be trimmed from each tail.

Four alternate CPI inflation measures are now apparent: headline CPI inflation (CPI), which is the sample average; $\alpha = 20$ percent trimmed mean inflation (T20); median inflation (MED), which is the inflation rate of the median CPI component at time t; and private-sector inflation (UPI), which is headline CPI excluding administered prices. The month-on-month seasonally adjusted increases for these four CPI measures are plotted in Figure 5.[7] Notice that even when administered prices are excluded in private-sector inflation measure (UPI), many outliers remain, while the 20 percent trim (T20) and the median inflation (MED) measures seem reasonably smooth except for large outliers in December 1993 and January 1994.[8]

III. LEADING INDICATORS OF INFLATION

In this section, the statistical linkages between monetary policy instruments and inflation are examined, as are the linkages between various so-called leading indicators of inflation and inflation. Relationships involving all four of the above described inflation concepts are explored.

The Data

The variables investigated are listed in Table 1. The list includes monetary aggregates, interest rates, exchange rates, real activity variables, labor market variables, foreign price indices, and

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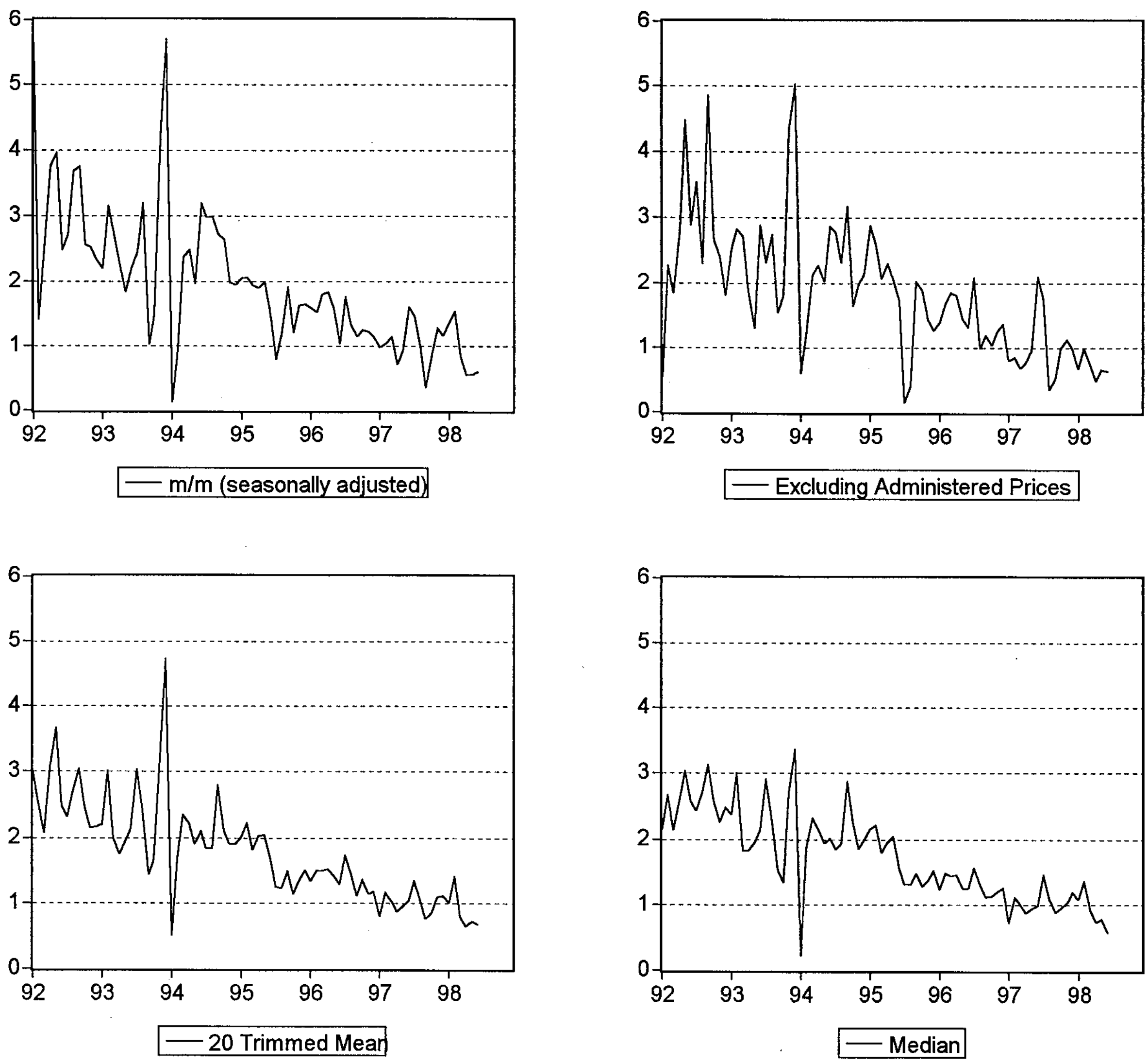
[6]The McNeilly and Schiesser-Gachnang (1998) approach raises the issue of rebalancing in the case of trimmed-weighted means. In the standard trimmed-means case the rebalancing simply consists of dividing by N-T instead of N. But when working with weighted means the trimming needs to consider whether trimming should be done with respect to number of observations (probability mass) or weighted number of observations (weighted probability mass). As an example, should one remove 4 out of 16 observations (categories) each time—or rather 25 percent of the weights? In either case the new mean must be properly rebalanced. McNeilly and Schiesser-Gachnang remove 4 categories in each month but do not seem to rebalance the index for reasons that are not clear.

[7]Not surprisingly, the different inflation measures are quite correlated. Headline CPI is most highly correlated with the 20 percent trimmed inflation (0.90), followed by median inflation (0.83), and lastly, private-sector inflation (0.76).

[8]These outliers reflects a change of government at the time and large expected changes in administered prices.

Figure 5. Poland:
Four Measures of Consumer Price Inflation



Note: All measures are month-on-month increases in seasonally adjusted prices.

Table 1. Poland: Variable Definitions and Transformations

Name	Definition	Seasonal Adjustment	Logs
Measures of Inflation			
cpi	Consumer Price Index	X	X
upi	CPI: excluding administrative prices	X	X
t20	CPI: 20 percent of weights trimmed in each tail	X	X
med	CPI: median of all components	X	X
adm	Index of administered prices	X	X
Monetary Policy Instruments and Leading Indicators of Inflation			
aip	Industrial production	X	X
ars	Retail sales (nominal)	X	X
ars_r	Retail sales (real)	X	X
we_grs	Wages (gross) X	X	
we_net	Wages (net) X	X	
lulcm	Unit labour costs	X	X
lur	Unemployment rate	X	X
ppi	Producer prices	X	X
fmb	Broad money (M2)	X	X
fmn	Narrow money	X	X
fad	Domestic assets	X	X
firr	NBP refinance rate (real)	X	
fid6ma	Deposit rate (6-month, real)	X	
fitb13w	T-bill rate (13 week, real)	X	
fitb52w	T-bill rate (52 week, real)	X	
fibor1m	WIBOR (1 month, real)	X	
wse	Warsaw Stock Exchange index		X
neer	Nominal effective exchange rate		X
prcpizl	Foreign CPI (in Zlotys)	X	X
prppizl	Foreign PPI (in Zlotys)	X	X
enda	Nominal exchange rate (Zl per $, average)		X
reerc	Real effective exchange rate (CPI)	X	X
reerp	Real effective exchange rate (PPI)	X	X
gcbal	Central Gov't surplus in percent of revenues	X	

Note: All variables are observed at the monthly frequency. Based on the unit roots tests, all variables are applied in first differences. Real interest rates are computed by dividing one plus the nominal interest rate by one plus the 12-month percent change in the headline consumer price index, then subtracting one and multiplying by 100.

other financial market variables. The data sources include the Polish Central Statistical Office and the National Bank of Poland. Most variables are seasonally adjusted and transformed by taking logarithms.

Using conventional augmented Dickey-Fuller (ADF) tests, the null hypothesis of a unit root cannot be rejected for most of the indicators (Table 2). Taking first differences and reapplying the ADF tests, the presence of a unit root is typically rejected when including one lag. When including more than one lag on the right-hand-side, the power of the ADF tests drops, and the null hypothesis of a unit root again often cannot be rejected. Although an argument could be made for keeping the interest rates in levels, it was decided to work with first differences of all variables in the analysis below.

Bivariate Relationships

To illustrate the bivariate relationships between the four candidate inflation measures and the monthly economic indicators, the P-values from bivariate Granger causality tests are presented in Table 3. Each of the four panels corresponds to one of the four inflation measures, and each column to an economic indicator.[9] Each panel contains eight rows corresponding to 1 though n lags in the bivariate regressions, where n = 1, 2,.., 8. Each entry in the table gives the P-values for the null hypothesis that the indicator does not Granger-cause the inflation measure—that is the probability of obtaining a sample which is even less likely to conform to the null-hypothesis of no Granger causality than the sample at hand. Values smaller than 5 percent are presented in bold italics.

A few features are common across the inflation measures in Table 3: the effective exchange rates and foreign price indices (neer, reerc, reerp and prcpizl, prppizl) are significant across lag orders for all four inflation measures. Other variables that are significant for some inflation measures for some lags include broad money (fmb), the interest rate variables (fidbma and fitb13w), administered prices (adm), and the retail sales activity variables (ars and ars_r). On the other hand, among the stock price index (wse), the fiscal deficit (gcbal), the nominal exchange rate (enda), and the labor cost variables (lulcm), none appear significant at any lag order. Some differences across inflation measures emerge. The unemployment rate (lur) appears highly significant for headline inflation, for example, but is much less significant for the other inflation measures.

An important drawback of crude Granger causality testing is that it provides no information about whether the sign of the (dynamic) bivariate relationship is correct from the point of view of economic theory. The unemployment example mentioned above illustrates this point. In Figure 6 the impulse responses from a 4th order bivariate VAR for the trimmed inflation measure (T20) are plotted as they relate to the monthly economic indicators. Each panel in

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[9] The variable mnemonics are listed in Table 1.

Table 2. Poland: Augmented Dickey-Fuller Tests for Unit Roots

	ADF Test -- log-Levels, one lag			ADF Test -- log-Levels four lags			ADF Test -- log-Levels 12 lags		
	No Constant	Constant	Constant and Trend	No Constant	Constant	Constant and Trend	No Constant	Constant	Constant and Trend
Series	t-stat (-1.95)*	t-stat (-2.90)*	t-stat (-3.47)*	t-stat (-1.95)*	t-stat (-2.90)*	t-stat (-3.47)*	t-stat (-1.95)*	t-stat (-2.90)*	t-stat (-3.47)*
CPI	3.10	***-5.63***	-0.87	0.76	***-3.69***	-0.52	0.04	-2.46	-0.16
UPI	3.31	***-5.22***	-0.36	0.94	***-3.67***	-0.27	0.13	-2.72	0.73
T20	3.19	***-6.36***	-0.31	0.68	***-3.87***	0.00	-0.55	-2.22	0.251
MED	2.77	***-6.67***	-0.46	0.25	***-3.55***	-0.69	-0.23	-2.19	0.224
ADM	6.46	***-3.60***	-1.52	3.12	***-2.96***	-0.64	0.89	***-2.95***	-0.71
AIP	3.10	-0.37	***-5.16***	4.91	-0.11	-2.65	1.75	-0.62	***-3.88***
ARS	5.45	-0.97	-3.40	5.10	-1.59	-2.73	2.06	-0.73	-2.6
ARS_R	0.88	-0.64	-2.01	1.66	1.11	-0.37	1.07	0.37	-0.66
WE_GRS	7.04	-2.86	-0.52	3.38	***-4.84***	0.24	0.14	-2.87	0.972
WE_NET	7.71	-2.75	-0.64	3.40	***-4.21***	0.48	0.06	-2.76	0.684
LULCM	4.09	-1.25	-1.50	4.94	-2.43	0.35	1.13	-2.12	-0.01
LUR	-1.10	0.84	-1.55	-1.24	0.28	-1.59	-1.49	-0.43	-1.8
PPI	4.14	***-5.12***	-0.75	1.67	-2.29	0.09	0.67	-2.23	-0.05
FMB	5.44	***-4.29***	-1.60	1.75	-2.53	-1.28	1.54	-2.45	0.416
FMN	5.83	-2.00	0.60	1.27	-2.08	0.51	-0.13	-2.09	1.591
FAD	6.54	-1.48	-2.20	2.32	-1.02	-3.00	2.60	-0.79	-2.29
FIRR_R	-0.23	-0.94	***-3.73***	0.23	-0.49	-3.12	0.88	0.38	-2.73
FID6MA	-1.81	-1.60	-3.45	-0.92	-0.54	-2.66	-0.45	0.89	-1.84
FITB13W	-1.46	-1.46	-2.94	-1.19	-1.16	-2.93	0.01	0.36	-1.84
FITB52W	-1.74	-1.96	-2.53	-1.31	-1.58	-2.21	0.02	-0.41	-0.88
FIBOR1M	-0.72	-0.71	-3.03	-1.12	-1.06	***-3.57***	-0.08	0.43	-1.98
WSE	1.24	-1.80	-1.45	1.11	-2.42	-1.97	1.14	***-3.07***	-3.01
NEER	***-3.78***	***-3.69***	-1.83	***-2.03***	-2.26	-0.34	-0.93	***-3.07***	-0.85
PRCPIZL	3.96	***-4.28***	-1.78	1.56	-2.31	-0.23	0.39	***-3.10***	-0.72
PRPPIZL	4.56	***-3.24***	-2.69	2.65	-1.39	-1.20	1.32	-2.42	-2.18
ENDA	2.16	-2.30	-2.63	1.96	-2.00	-1.76	0.33	-1.72	-2.8
REERC	1.95	-0.10	***-3.65***	2.62	-0.65	-2.89	2.50	0.44	-2.21
REERP	0.05	-1.62	-2.24	0.28	-1.91	-2.17	0.08	-1.07	-2
GCBAL	***-2.83***	***-5.23***	***-5.61***	-1.17	-2.51	-2.79	***-2.39***	***-4.52***	***-4.11***

Note: * denotes 5% critical value from Davidson & MacKinnon

Table 3. Poland: P-Values from Bivariate Granger Causality Tests

cpi

Lags	adm	aip	ars	ars_r	we_grs	we_net	lulcm	lur	ppi	fmb	fmn	fad	firr	fid6ma	fitb13w	fitb52w	fiborlm	wse	neer	prcpizl	prppizl	enda	reerc	reerp	gcbal
1	***0.01***	0.46	0.71	0.64	0.85	0.37	0.62	***0.00***	0.27	0.97	0.28	0.97	0.47	0.52	0.14	0.41	0.45	0.80	***0.02***	***0.01***	***0.04***	0.13	***0.01***	0.12	0.92
2	0.42	0.41	0.81	0.80	0.93	0.55	0.86	***0.00***	***0.02***	***0.04***	0.75	0.86	***0.02***	***0.01***	***0.01***	0.09	***0.03***	1.00	***0.00***	***0.00***	***0.00***	0.26	***0.00***	***0.01***	0.14
3	0.69	0.56	0.98	0.99	0.94	0.71	0.64	***0.00***	0.09	0.16	0.96	0.57	***0.01***	***0.02***	***0.01***	0.25	***0.01***	0.54	***0.00***	***0.00***	***0.00***	0.68	***0.00***	***0.03***	0.33
4	0.54	0.43	0.33	0.41	0.79	0.14	0.78	***0.00***	0.37	0.13	0.79	0.73	0.13	0.10	0.20	0.41	0.15	0.39	***0.01***	***0.00***	***0.01***	0.77	***0.00***	0.06	0.42
5	0.53	0.27	0.26	0.36	0.85	0.18	0.78	***0.00***	0.46	0.20	0.87	0.86	0.15	0.16	0.27	0.58	0.12	0.52	***0.01***	***0.00***	***0.02***	0.47	***0.00***	0.11	0.52
6	0.41	0.35	0.32	0.44	0.57	0.06	0.81	***0.00***	0.30	0.40	0.98	0.79	0.27	0.24	0.25	0.22	0.32	0.50	***0.02***	***0.00***	***0.02***	0.25	***0.00***	***0.04***	0.49
7	0.50	0.43	0.06	0.06	0.61	***0.05***	0.72	***0.01***	0.22	0.63	0.85	0.87	0.07	0.11	0.06	***0.04***	0.19	***0.02***	***0.01***	***0.00***	***0.01***	0.52	***0.00***	***0.01***	0.56
8	0.89	0.50	0.06	***0.04***	0.73	0.06	0.74	***0.02***	0.33	0.58	0.93	0.74	0.10	0.09	0.21	0.16	0.31	0.05	***0.01***	***0.00***	***0.01***	0.63	***0.00***	***0.02***	0.67

t20

Lags	adm	aip	ars	ars_r	we_grs	we_net	lulcm	lur	ppi	fmb	fmn	fad	firr	fid6ma	fitb13w	fitb52w	fiborlm	wse	neer	prcpizl	prppizl	enda	reerc	reerp	gcbal
1	0.54	0.68	***0.03***	0.08	0.67	0.52	0.79	***0.00***	***0.02***	0.41	0.73	0.94	***0.01***	***0.03***	0.08	0.07	0.06	0.60	***0.03***	***0.02***	0.06	0.07	0.07	0.22	0.70
2	0.33	0.68	0.07	0.14	0.88	0.65	0.72	***0.01***	***0.01***	0.15	0.71	0.95	***0.01***	***0.01***	***0.00***	***0.05***	***0.02***	0.42	***0.00***	***0.00***	***0.00***	0.15	***0.00***	***0.01***	0.36
3	0.59	0.47	0.24	0.33	0.87	0.79	0.49	0.05	0.06	0.21	0.74	0.62	***0.01***	***0.03***	***0.02***	0.33	***0.04***	0.74	***0.00***	***0.00***	***0.00***	0.27	***0.00***	***0.00***	0.42
4	0.11	0.32	0.84	0.85	0.53	0.39	0.61	0.32	0.28	0.14	0.43	0.60	0.09	0.16	0.33	0.82	0.28	0.68	***0.00***	***0.00***	***0.00***	0.33	***0.00***	***0.01***	0.75
5	0.30	0.49	0.47	0.74	0.73	0.41	0.79	0.14	0.15	0.29	0.74	0.97	0.26	0.31	0.61	0.98	0.33	0.76	***0.00***	***0.00***	***0.00***	0.31	***0.00***	***0.01***	0.89
6	0.27	0.56	0.60	0.85	0.78	0.53	0.85	0.14	0.05	0.44	0.82	1.00	0.39	0.38	0.78	0.99	0.31	0.80	***0.00***	***0.00***	***0.00***	0.45	***0.00***	***0.00***	0.92
7	0.12	0.67	0.65	0.87	0.89	0.58	0.85	0.10	0.10	0.58	0.89	1.00	0.32	0.25	0.48	0.72	0.46	0.12	***0.00***	***0.00***	***0.00***	0.60	***0.00***	***0.00***	0.88
8	0.25	0.70	0.11	0.24	0.90	0.75	0.92	0.21	0.16	0.65	0.99	1.00	0.39	0.43	0.55	0.82	0.76	0.07	***0.00***	***0.00***	***0.00***	0.77	***0.00***	***0.01***	0.90

med

Lags	adm	aip	ars	ars_r	we_grs	we_net	lulcm	lur	ppi	fmb	fmn	fad	firr	fid6ma	fitb13w	fitb52w	fiborlm	wse	neer	prcpizl	prppizl	enda	reerc	reerp	gcbal
1	0.95	0.65	***0.02***	0.11	0.43	0.62	0.65	***0.01***	***0.01***	0.05	0.28	0.73	***0.00***	***0.01***	***0.02***	***0.01***	***0.03***	0.56	0.12	0.07	0.22	0.17	0.26	0.49	0.29
2	***0.04***	0.88	***0.03***	0.06	0.70	0.87	0.38	0.08	***0.01***	0.09	0.53	0.94	***0.00***	***0.01***	***0.01***	***0.02***	***0.04***	0.43	***0.00***	***0.00***	***0.00***	0.42	***0.00***	0.05	0.29
3	0.25	0.32	***0.04***	0.05	0.84	0.98	0.08	0.35	***0.01***	0.14	0.49	0.60	***0.01***	0.05	***0.04***	0.28	0.23	0.64	***0.00***	***0.00***	***0.00***	0.43	***0.00***	***0.03***	0.64
4	***0.02***	0.20	0.24	0.21	0.65	0.78	***0.05***	0.82	0.07	0.13	0.30	0.75	0.12	0.15	0.23	0.67	0.56	0.51	***0.00***	***0.00***	***0.00***	0.52	***0.00***	***0.01***	0.87
5	0.15	0.35	0.67	0.67	1.00	0.95	***0.04***	0.60	0.07	0.43	0.59	0.98	0.44	0.37	0.74	0.92	0.88	0.52	***0.00***	***0.00***	***0.00***	0.20	***0.00***	***0.01***	0.83
6	0.11	0.47	0.81	0.78	0.96	0.89	0.07	0.72	***0.03***	0.49	0.51	0.86	0.56	0.44	0.88	0.93	0.87	0.59	***0.00***	***0.00***	***0.00***	0.30	***0.00***	***0.02***	0.85
7	***0.02***	0.59	0.73	0.74	0.98	0.95	0.06	0.66	***0.05***	0.62	0.65	0.82	0.21	0.07	0.28	0.45	0.50	0.06	***0.00***	***0.00***	***0.00***	0.43	***0.00***	***0.02***	0.81
8	0.12	0.54	0.64	0.74	0.94	0.99	0.21	0.72	0.16	0.76	0.92	0.94	0.23	0.08	0.42	0.61	0.41	0.08	***0.00***	***0.00***	***0.00***	0.40	***0.00***	***0.00***	0.72

upi

Lags	adm	aip	ars	ars_r	we_grs	we_net	lulcm	lur	ppi	fmb	fmn	fad	firr	fid6ma	fitb13w	fitb52w	fiborlm	wse	neer	prcpizl	prppizl	enda	reerc	reerp	gcbal
1	0.10	0.65	0.32	0.77	0.96	0.48	0.34	***0.00***	***0.01***	0.18	0.91	0.72	***0.01***	***0.03***	0.08	0.07	0.06	0.91	***0.04***	***0.04***	0.16	0.16	0.39	0.44	0.54
2	0.62	0.64	0.72	0.90	1.00	0.83	0.68	***0.01***	***0.00***	0.12	0.82	0.99	***0.01***	***0.01***	***0.00***	***0.05***	***0.02***	0.94	***0.00***	***0.00***	***0.00***	0.08	***0.00***	***0.00***	0.33
3	0.18	0.75	0.95	0.99	1.00	0.83	0.49	***0.04***	***0.01***	***0.05***	0.44	0.44	***0.01***	***0.03***	***0.02***	0.33	***0.04***	0.98	***0.00***	***0.00***	***0.00***	0.15	***0.00***	***0.00***	0.49
4	***0.01***	0.80	0.23	0.07	0.80	0.98	0.59	0.16	0.10	0.16	0.72	0.53	0.09	0.16	0.33	0.82	0.28	0.44	***0.00***	***0.00***	***0.00***	0.13	***0.00***	***0.00***	0.89
5	0.39	0.52	***0.02***	***0.01***	0.89	0.83	0.50	0.28	0.65	0.96	0.80	0.95	0.26	0.31	0.61	0.98	0.33	0.58	***0.00***	***0.00***	***0.00***	0.42	***0.00***	***0.03***	0.47
6	0.05	0.66	***0.02***	***0.02***	0.76	0.52	0.63	0.42	0.09	0.96	0.70	0.97	0.39	0.38	0.78	0.99	0.31	0.10	***0.00***	***0.00***	***0.00***	0.43	***0.00***	***0.04***	0.47
7	0.14	0.77	***0.04***	***0.02***	0.82	0.77	0.62	0.22	0.20	0.97	0.90	0.98	0.32	0.25	0.48	0.72	0.46	0.13	***0.00***	***0.00***	***0.00***	0.55	***0.00***	***0.00***	0.68
8	***0.02***	0.83	***0.00***	***0.01***	0.69	0.82	0.74	0.32	0.27	0.97	0.89	0.98	0.39	0.43	0.55	0.82	0.76	0.12	***0.00***	***0.00***	***0.00***	0.54	***0.00***	***0.01***	0.67

Figure 6. Poland:
Impulse Responses of Trimmed Inflation (T20) to Indicator Shocks

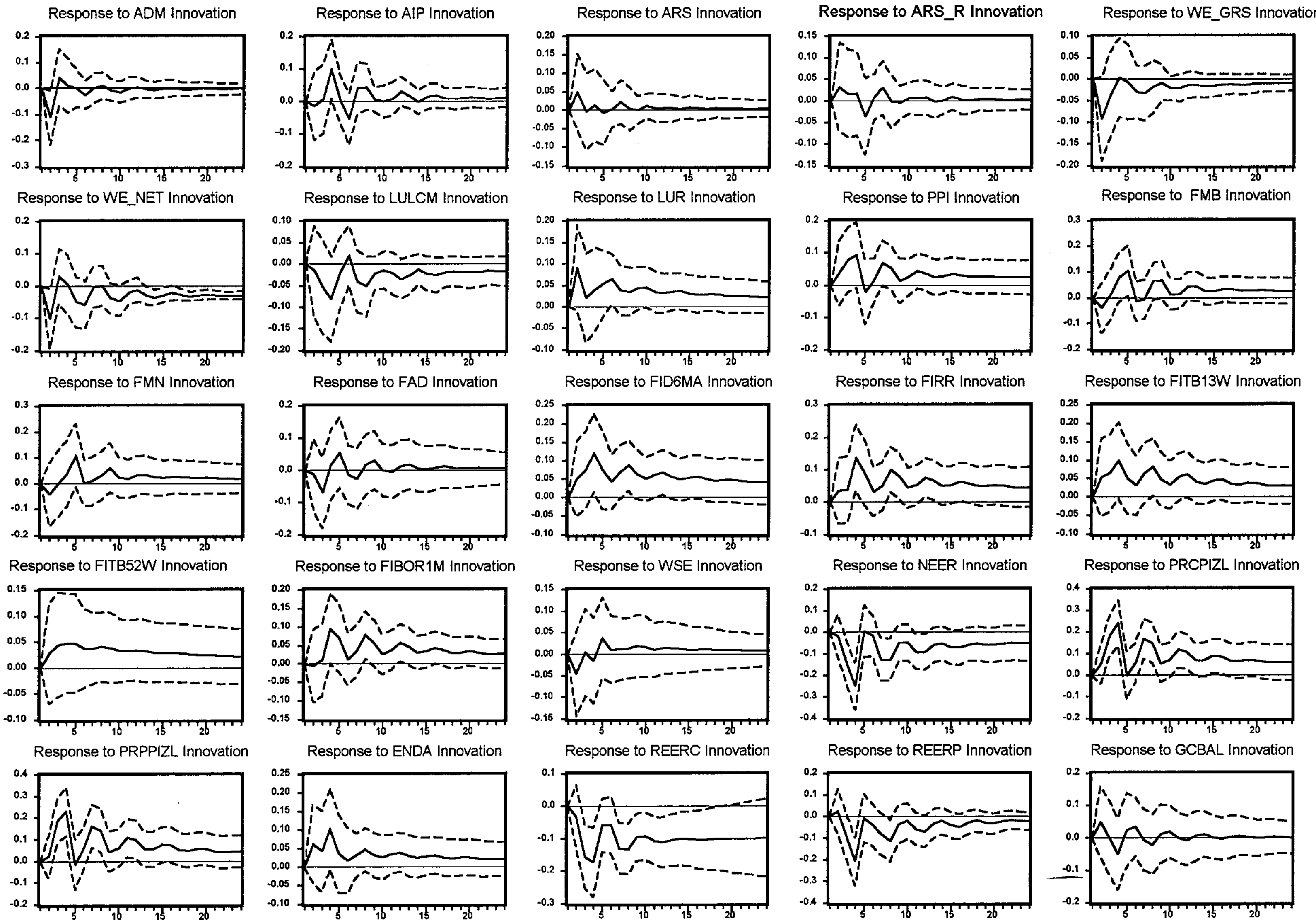

Figure 6 gives the percentage point change in month-on-month trimmed inflation at time t+i, i=1, 2,.., 12, for a one standard deviation increase in the monthly indicator at time t. Also depicted are plus/minus two (asymptotic) standard error bands. While the unemployment rate appeared to be significant in Granger causing inflation in Table 3, it is clear from Figure 6 that the dynamic relationship between unemployment and inflation is economically incorrect, because an increase in unemployment increases inflation in all twelve months ahead.[10]

Much uncertainty surrounds the estimated impulse responses in Figure 6. The standard error bands usually contain zero, especially for the headline inflation measure, meaning that the absence of any statistical relationship cannot be ruled out. This is partly due to the high lag order chosen for the VAR. The strongest relationships between the monetary policy variables and the various CPI inflation measures again appear to come from the effective exchange rate (neer) and foreign inflation in zloty (prcpizl). The broad money measure (fmb) has the right sign and is marginally significant, although this is not the case for headline CPI inflation. The interest rate variables generally show a positive relationship with inflation, which is counter-intuitive from the point of view of economic theory. The activity variables rarely appear to be significant in signaling movements in inflation. Only the retail sales variable is marginally relevant in signaling movements in median inflation.

Table 4 presents information on the question of whether the inflation measures Granger cause each other internally. There is quite strong evidence that the private-sector inflation is Granger caused by the other three measures, and some evidence that the headline CPI inflation is Granger caused by the 20 percent trimmed-mean CPI (T20) and the median CPI (MED).

IV. A Simple Multivariate Model of Inflation

While bivariate analysis gives a rough indication of the statistical relationships between inflation itself and leading indicators of inflation, omitted variable bias could be distorting the estimates significantly. In this section the insights gained in the bivariate analysis above are used to specify and estimate a multivariate model for each of the four inflation measures. The models specified are vector autoregressions (VARs) and are therefore straightforward extensions of the regressions run in Section III. The VARs allow for an immediate assessment of the dynamic relationship between inflation measures and economic indicators using impulse response functions similar to those above.

Model Specification and Estimation

Economic theory and econometric modeling of the transition experience suggest that CPI inflation is driven by pressures in goods markets, labor markets, foreign markets, by changes

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[10]This is probably because both the unemployment rate and CPI inflation in Poland have been falling monotonically for most of the 1990s and labor markets have not yet reached equilibrium.

Table 4. Poland: Granger Causality Among Inflation Measures

cpi

Lags	cpi	t20	med	upi
1		***0.02***	***0.00***	***0.00***
2		***0.04***	***0.00***	0.31
3		0.08	***0.00***	0.55
4		0.54	0.08	0.29
5		0.18	0.06	0.41
6		0.39	0.27	0.85
7		0.10	0.36	0.70
8		0.16	0.26	0.69

t20

Lags	cpi	t20	med	upi
1	0.52		***0.00***	0.25
2	0.27		***0.02***	0.36
3	0.19		0.26	0.27
4	0.20		0.51	0.16
5	0.10		0.72	0.21
6	***0.05***		0.49	0.16
7	***0.04***		0.54	0.13
8	0.08		0.50	0.09

med

Lags	cpi	t20	med	upi
1	0.82	***0.05***		0.82
2	0.60	0.09		0.81
3	0.08	0.41		0.40
4	0.07	***0.04***		0.60
5	0.26	0.38		0.69
6	***0.03***	0.32		0.71
7	0.05	0.40		0.27
8	0.14	0.52		0.60

upi

Lags	cpi	t20	med	upi
1	***0.02***	***0.03***	***0.00***	
2	0.14	0.26	***0.03***	
3	***0.01***	***0.02***	***0.00***	
4	***0.00***	***0.00***	***0.00***	
5	0.17	***0.04***	***0.02***	
6	***0.00***	***0.03***	***0.04***	
7	***0.02***	0.09	0.06	
8	***0.00***	***0.01***	***0.01***	

Note: Table shows P-values from bivariate Granger causality tests.

in government prices, and by shifts in monetary policy. The direct contemporaneous effects of changes in government prices are eliminated to varying degrees with the different left-hand-side concepts of inflation that trim away large price movements and are completely eliminated in the private-sector inflation measure (UPI) that explicitly subtracts out their effect. The lagged values of changes in these administered prices are included in the models here, however, to capture their secondary effects (that is, their "knock on" effects) on inflation. Labor market variables, including the unemployment rate, were tested in the multivariate context, but consistently entered the equation with the wrong sign—a result foreshadowed by the analysis in Section III.[11] Consequently, inflation is modeled using just four groups of variables: 1.) effective exchange rate measures, 2.) monetary policy instruments, 3.) activity variables, and 4.) administered prices.

Several variables are available in each group and an informal specification search was performed relying on standard statistical measures of fit and significance. The following general specification was chosen as the best: each of the four inflation measures was regressed on its own two lags, a constant, and two lags each of foreign inflation denominated in zloty (prcpizl), broad money (fmb), retail sales (ars), and the index of administered prices (adm). In order to control for the large outliers in December 1993 and January 1994, a dummy was added for both of these observations. Adding the dummies significantly improves the fit of the models and the statistical significance of the parameters, but it does not qualitatively change any of the results. The estimation results are shown in Table 5. Overall the fit is reasonably good, considering the large amount of variation in monthly inflation rates. Not surprisingly, the R^2s of the (jagged) headline CPI and private-sector CPI (UPI) are the lowest, but it is interesting to note that the fit of the optimally trimmed CPI inflation measure (T20) is slightly better than even the smoother median CPI measure (MED).

The qualitative features of the model are captured in the impulse response plots in Figure 7. As always, the ordering of variables affects the shape of impulses, and the following ordering was used: foreign prices → broad money → retail sales → administered prices → consumer prices. In contrast to the bivariate plots in Section III more evidence of significance is apparent, and the signs of the impulses conform to standard economic theory. The lag order was chosen pragmatically in a trade-off between capturing all the dynamic relationships on one hand and parameter parsimony on the other. Estimating the model with only one lag does not qualitatively change the results.

A first check of model specification is to simply plot residuals and this is done in Figure 8. It is clear that the residuals and outliers in the headline CPI (CPI) and private-sector CPI (UPI) cases are much larger than in the trimmed (T20) and median inflation (MED) cases. More thorough diagnostic checking is performed below.

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[11]When the unemployment rate (lur) was added to the four multivariate models of inflation (one for each of the four definitions of inflation), it always entered with an economically nonsensical positive coefficient.

Table 5. Poland: VAR Model Estimation Results

Regressor	Inflation Measure CPI	T20	MED	UPI
PRCPIZL(-1)	0.091112	0.06588	0.04414	0.031857
	(.04096)	(.02732)	(.02517)	(.0495)
PRCPIZL(-2)	0.194515	0.137095	0.103138	0.251175
	(.03677)	(.02497)	(.02248)	(.04454)
FMB(-1)	0.197076	0.071821	0.067008	0.125136
	(.06329)	(.04519)	(.04204)	(.07854)
FMB(-2)	0.045331	0.044042	0.027141	0.120441
	(.06846)	(.04717)	(.04383)	(.08462)
ARS(-1)	0.001561	0.025246	0.023677	-0.011518
	(.01612)	(.01075)	(.00994)	(.01963)
ARS(-2)	0.024875	0.027848	0.033482	0.005655
	(.0156)	(.01075)	(.00993)	(.01914)
ADM(-1)	0.121614	-0.099908	-0.229263	0.396311
	(.23477)	(.14662)	(.13454)	(.22984)
ADM(-2)	-0.031704	-0.120217	-0.093645	-0.167241
	(.13057)	(.07422)	(.06678)	(.12991)
INFL(-1)	0.436724	0.498407	0.47804	0.305236
	(.11341)	(.09982)	(.09533)	(.10622)
INFL(-2)	-0.03727	0.14019	0.258863	0.078657
	(.0905)	(.07338)	(.07622)	(.0853)
DUM1	2.768889	2.212694	1.261042	2.404441
	(.56087)	(.3653)	(.32798)	(.66194)
DUM2	-3.618039	-2.876996	-2.39517	-2.844575
	(.57763)	(.38854)	(.33)	(.68586)
R-squared	0.785795	0.837579	0.827282	0.700048
Adj. R-squared	0.748978	0.809663	0.797596	0.648493
Sum sq. resids	15.30422	6.834462	5.85602	22.72237
S.E. equation	0.489008	0.326785	0.30249	0.59585
Mean dependent	2.490791	2.490791	2.490791	2.490791
S.D. dependent	0.840577	0.840577	0.840577	0.840577

Note: The effective sample runs from March 1992 to June 1998 and contains 76 observations.
Standard errors are reported in parentheses.

Figure 7. Poland: VAR Impulse Responses to Indicator Shocks

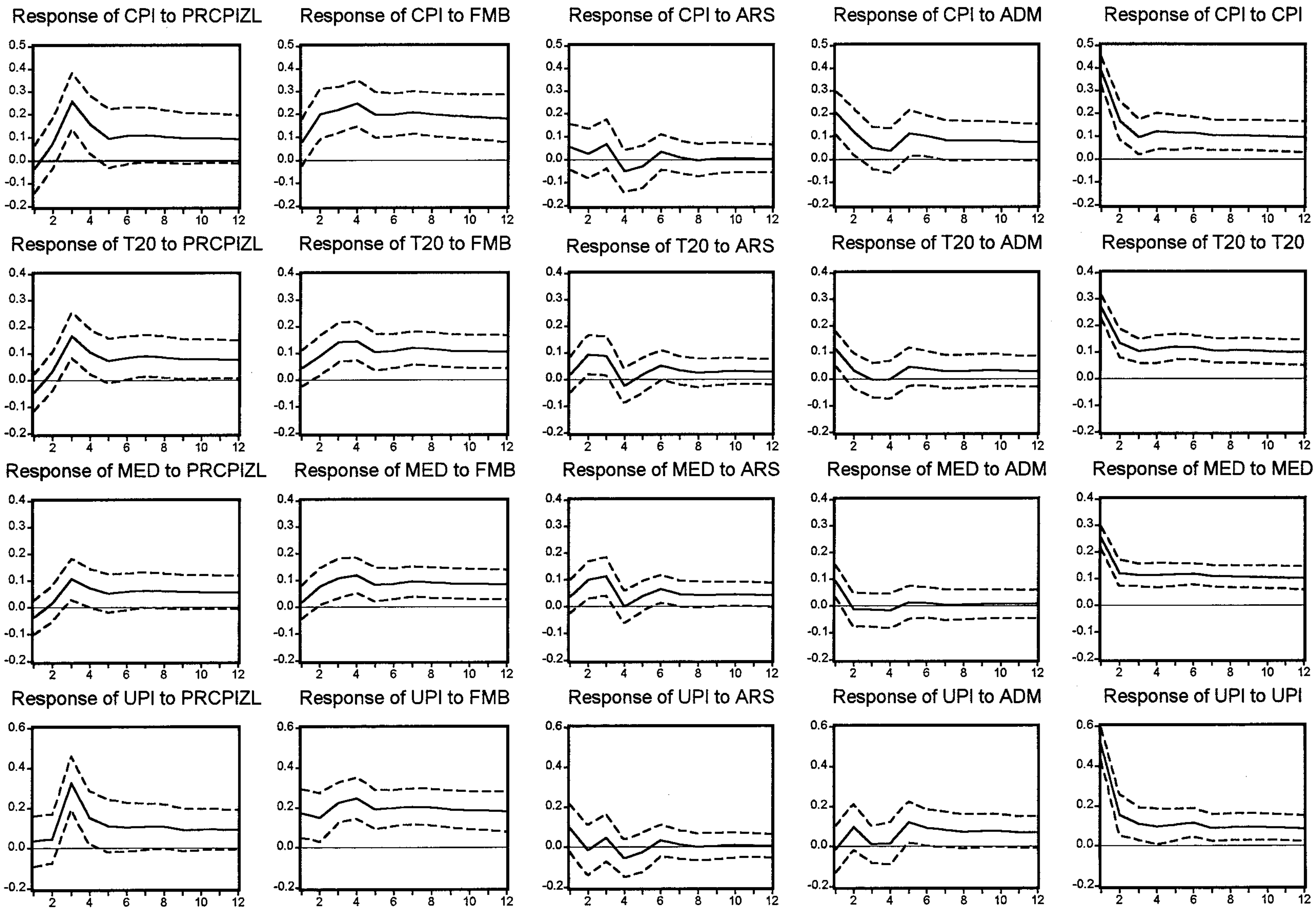
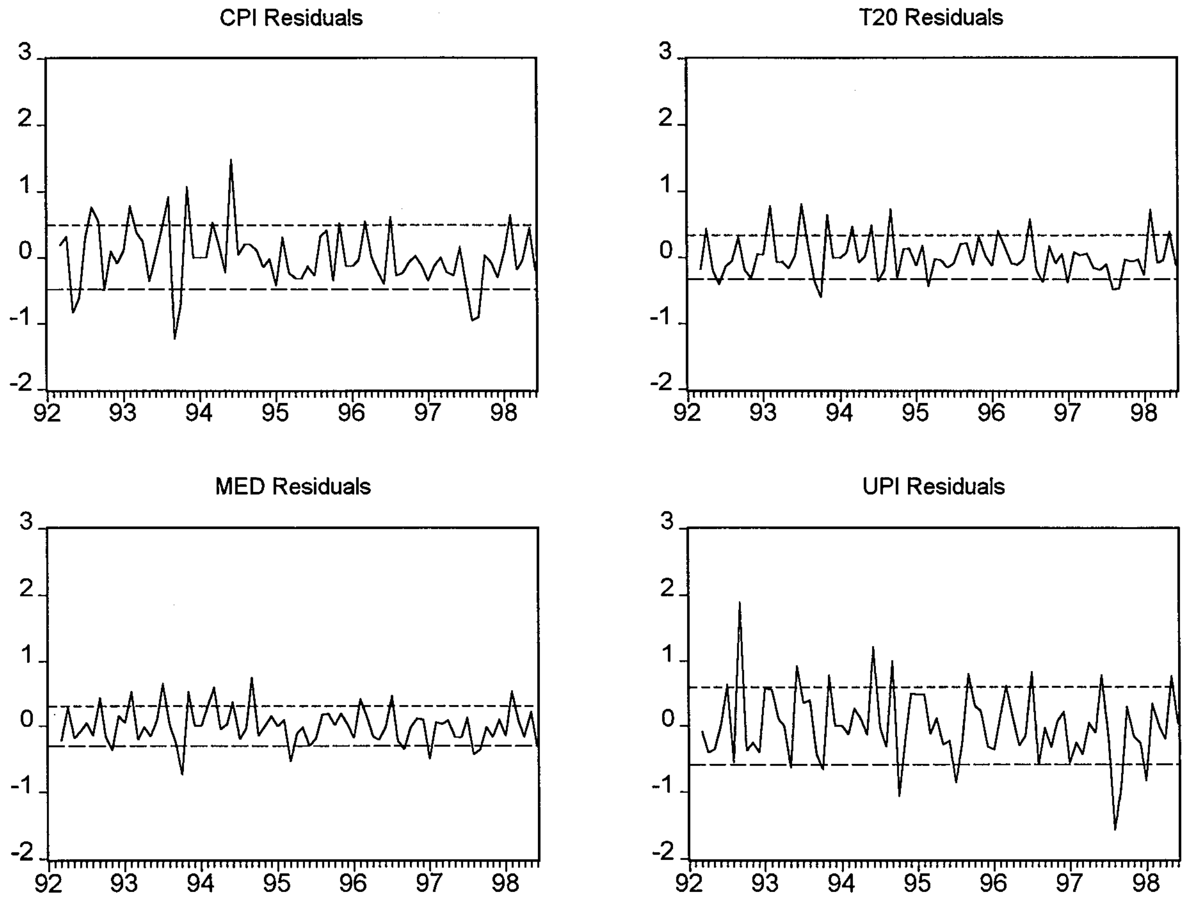


Figure 8. Poland: VAR Model Residuals



Note: Each panel plots the residuals from the consumer price inflation equation in a four-variable VAR models including two lags of foreign cpi in zloty, broad money, retail sales, producer price inflation, and consumer price inflation. The horizontal lines represent plus/minus two standard error bands.

Parameter Stability in Recursive Estimation

In order to assess the stability of the estimated parameters as the sample period is changed, two exercises were performed. First, keeping the sample endpoint at June 1998, the twelve observations in the calendar year 1992 (representing the first part of the sample) were consecutively dropped from the sample, and the parameters recursively estimated. The resulting set of estimates along with their two standard errors bands are plotted in Figure 9.a. It is clear that the estimates vary somewhat–especially in the left part of the panels as the first observations in 1992 are dropped. Notice also that not all variables are significant at both lags. Second, the twelve observations in the period July 1997 through June 1998 (representing the end of the sample) were consecutively included in the sample and the parameters were estimated recursively, keeping the sample starting point at January 1992. The resulting set of parameters are plotted with two standard error bands in Figure 9.b. In this part of the sample, the parameters appear to show more signs of stability, and thus hold some promise for the future modeling of macroeconomic relationships in Poland.

Out-of-Sample Prediction

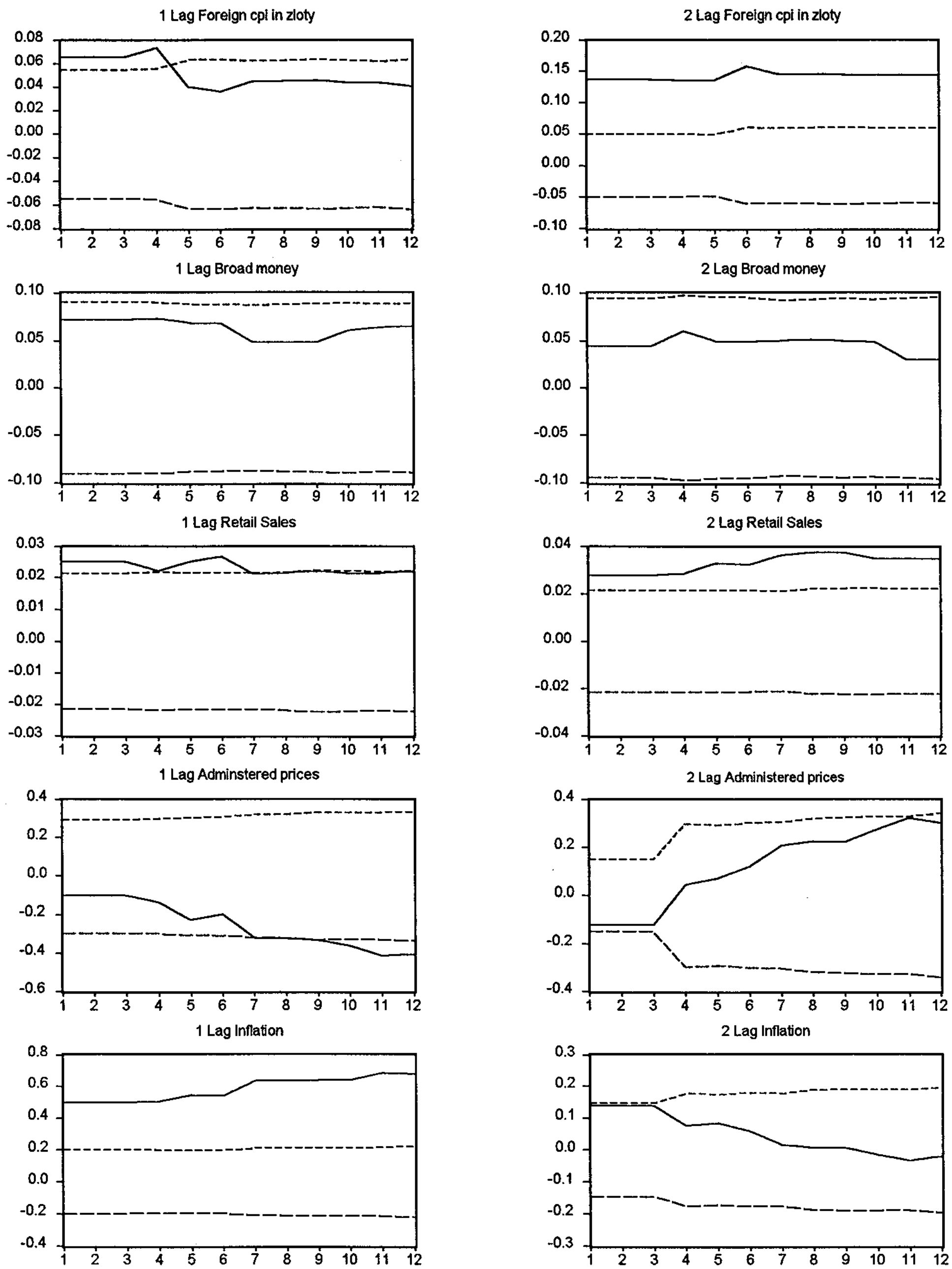
A final form of model validation is to perform out-of-sample forecasts. Models were estimated over the sub-period 1992 through June 1997 for all four inflation measures, and these were then used to produce one through twelve period-ahead out-of-sample forecasts for the period July 1997 through June 1998.[12] The errors from these models are shown in Figure 10. All four models overpredicted inflation over this period, although the models for trimmed (T20) and median (MED) inflation did relatively better than the other two models. This result provides some further evidence that there may be some advantage in trying to forecast and target one of these underlying inflation concepts, rather than headline CPI. Nevertheless, the overpredictions for even the most accurate forecasts, made for trimmed and median CPI inflation, were on the order of 2–2.5 percentage points after 12 months (the actual outcome was about 12 percent headline CPI inflation in this 12-month period). For headline CPI inflation the overprediction was over 5 percentage points. As more data becomes available, more out of sample forecasting will be useful.

V. Policy Considerations

Inflation targeting is a framework for monetary policy in which the overriding objective of the central bank is the achievement of a specific inflation target. Authorities typically set an inflation target for the medium term—often with intermediate annual targets—and then make

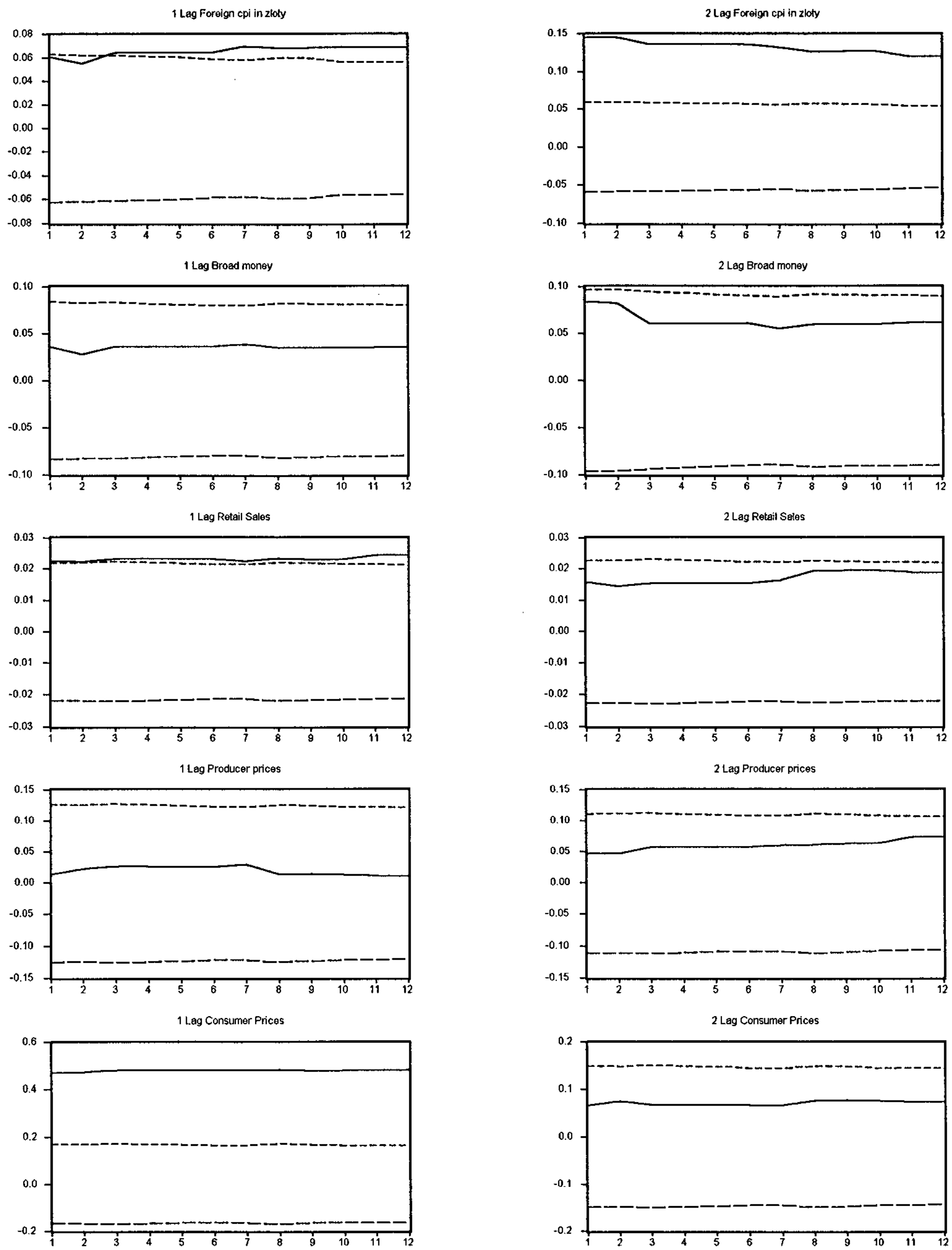
[12]These out-of-sample forecasts were produced using the "chain" method, whereby the VAR equations for each right-hand-side variable are used to produce period ahead forecasts, which then are used to produce forecasts of the relevant left-hand side inflation measure. That is, the methodology assumes no additional information beyond what was known at the start of the out-of-sample forecast period (i.e., June 1997).

Figure 9.a. Poland:
Coefficient Variation in T20 Equation as 1992 is Excluded



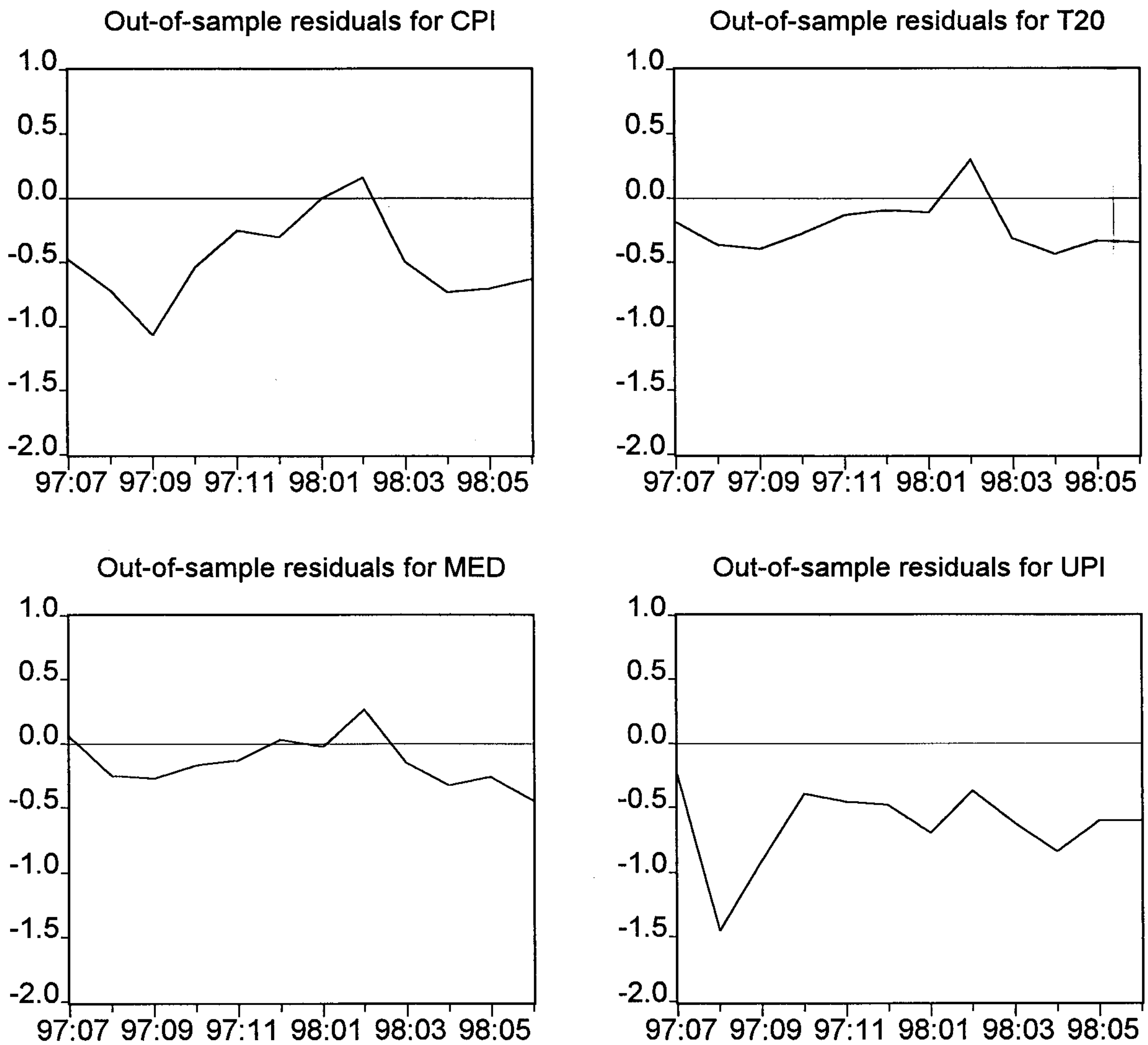
Note: The evolution of the coefficients from the second order VAR equation for trimmed inflation is plotted as the estimation sample is recursively updated to exclude observations from January to December 1992. The sample ends in June 1998. The dashed lines show plus/minus two standard error bands.

Figure 9.b. Poland:
Coefficient Variation in T20 Equation as 97:7-98:6 is Included



Note: The evolution of the coefficients from the second order VAR equation for trimmed inflation is plotted as the estimation sample is recursively updated to include observations from July 1997 through June 1998. The sample starts in January 1992. The dashed lines show plus/minus two standard error bands.

Figure 10. Poland:
Out-of-Sample Forecast Errors
(1-12 Months Ahead)



Note: The one through twelve-months-ahead out-of-sample forecast errors for July 1997 to June 1998 are plotted from forecasts made in June 1997 for the four consumer price inflation measures using their respective VAR models.

regular forecasts of expected inflation. When expected inflation exceeds the target, monetary policy is tightened and vice versa. According to Debelle (1997) and Masson *et. al.* (1997), one of the key pre-requisites for the successful adoption of inflation targeting is that the central bank must have an adequate ability to produce inflation forecasts and to assess the impact of changes in monetary instruments on inflation (the magnitude of the effects, their lags, etc.) To fulfill of these conditions, many central banks that use inflation targeting rely upon an econometric model of inflation, but there is no formal requirement for this. Many rely at least in part upon leading indicators of inflation of the type examined in this paper and on judgment.

What does the preceding analysis suggest about the statistical readiness of Poland to be able to meet these requirements? Statistical relationships between various representations of the CPI—headline, median, trimmed, and private-sector—and various leading indicators of inflation are beginning to emerge in Poland. Among monetary policy instruments, there is a reasonable linkage between the exchange rate and these inflation measures, for example, and there is some evidence that movements in broad money also may influence certain representations of inflation. These relationships are not strong and tight, however. In particular, the lack of a clear statistical linkage between changes in the short-term policy interest rates and changes in inflation, at least in the historical period, is somewhat disappointing. Also, the ability of multivariate econometric models to forecast inflation developments has been quite limited to date. These models' out-of-sample prediction powers during 1997–98, for instance, have not been impressive, especially for time horizons of one year and longer. On the other hand, there is evidence that measures of underlying inflation are somewhat more predictable than headline inflation, a fact that the authorities may want to keep in mind as they determine exactly what role underlying inflation will play in their implementation of inflation targeting.

The lack of a firm statistical linkage between inflation and monetary policy instruments, such as policy interest rates, is not surprising, given that both variables have been falling nearly monotonically in Poland over the sample period (1992–98). Given such historical data trends, it would be extremely difficult for statistical tests to identify the kind of normal negative relationship between inflation and interest rates suggested by economic theory and monetary transmission channel analysis. As the Polish economy continues to mature in coming years, it is likely that the relationship between the policy interest rates and inflation will become more regular and will begin to illustrate the expected negative relationship. In the meantime, as the statistical basis for more normal relationships strengthen, it will be important for monetary policymakers in Poland to rely on economic theory as well as benchmarks from other countries as guides for their monetary policy decisions.

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