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# *121*

**Przemysław Woźniak**

# *Relative Prices and Inflation in Poland 1989-1997*

*Warsaw, December 1997*

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# 1. INTRODUCTION

The relationship between inflation and relative price variability has been in the center of economic dispute since the early 1970s. It is primarily the oil shocks that made economists turn their attention to the fact that the two phenomena: the general price level and the variability of individual inflation rates have moved in the same direction for longer periods of time and that their peaks often coincided. Following that observation the extensive body of literature have tried to explain the relationship theoretically and then support it with empirical analysis. However, up to now, both the nature of the association and its causation remain unclear. Theories were developed linking relative price variability to the level of anticipated as well as unanticipated inflation. Some authors have found that it is the increased variability of individual inflation rates that raises the general price level while others maintain that the relationship is caused by macroeconomic disturbances that raise both the inflation rate and increase relative price variability.

I believe that this phenomenon, although researched extensively in the framework of mature market economies, can be of particular interest in the context of transition economies. The unprecedented nature of transition from plan to market poses a great deal of policy challenges and raises a lot of questions most of which come down to inflation stabilization issues. Inflation in post-communist economies has to be looked at through a number of factors specific to the region including, among many others, a comprehensive price reform. Relative domestic prices have undergone dramatic realignments in the wake of price liberalization, removal (or sharp reduction) of subsidies and unification of the exchange rate. Those realignments have substantially increased the variability of inflation rates of individual groups of commodities comprising the consumer price index. According to some theories I mentioned above, this ongoing process of price adjustments could prove to be a substantial factor contributing to sustained inflationary pressures in transition economies.

From the multitude of hypotheses concerning the relationship between inflation and relative price variability, I chose the one that predicts causality running from increased relative price variability to increased inflation. For a variety of reasons this group of theories seems to go very well with the developments of the inflationary processes in Poland as a representative transition economy and is the most helpful in terms of identifying the sources of inflationary pressures. I believe that the variability of relative prices in Poland, by far exceeding that of standard market economies, but mostly left out of the inflation analysis so far[1], could improve our understanding of the inflationary processes in Poland as well as in other transition economies.

Estimating the approximate short-term impact of the relative price adjustment on the overall price level could also prove useful in terms of providing some sort of

[1] The topic has been taken up in Pujol and Griffith [1996] for Poland and in a cross-sectional framework by Coorey, Mecagni and Offerdal [1996]

policy recommendation with respect to administrative price increases. In the case of a country like Poland where a certain number of prices is either directly set by the government or regulated by it in some other way, the adjustments are being made at discreet intervals. As predicted by the theory, those increases may, under certain conditions, have a substantial impact on the general price level. Finally, a better understanding of the transmission mechanism between the two phenomena in question, can prove helpful with respect to setting proper inflation targets by the government or the central bank as well as provide an additional tool for a yet better inflation forecasting.

Additionally the paper examines individual inflation rates of CPI components on a cumulative basis. While relative price variability may affect inflation in the short run, it need not result in permanent relative price realignments. It is therefore essential to detect those groups of goods and services that registered extraordinarily big relative price increases to identify the long-run sources of inflationary pressures.

The paper is organized as follows: Section 2 discusses briefly two main groups of theories that link inflation and relative price variability and provides a sketch of a survey of the literature. Section 3 takes on Ball and Mankiw's models predicting the causality from relative price variability to inflation and discusses it in more detail. Section 4 provides a brief background of the factors underlying Polish relative price variability and empirical evidence on relative price behavior in Poland. The theoretical model as well as obtained regression results are discussed in section 5. Section 6 takes a closer look at relative price changes on a cumulative basis and section 7 introduces the Cukierman and Leiderman model of price controls with its policy-related implications. Finally, section 8 concludes with a summary of results, conclusions and a sketch of possible policy recommendation.

# 2. THEORETICAL BACKGROUND

Despite dozens of publications aiming to explain the nature of the association between the movements in relative prices and inflation that have appeared in economic journals since the mid-60s, the main question of the analysis still remains unanswered. While most economists now acknowledge that relative price variability and inflation move closely together, there seems to be no unanimity as to the direction of causality between the two indicators and the theoretical grounds on which this causality should occur. The different theories linking aggregate price changes to relative price variability fall into two broad categories:

1) Increased relative price variability is a cause for increased inflation,
2) Increased inflation is a cause for increased relative price variability.

## 2.1. Variability in Relative Price Changes as a Cause of Inflation

A basic paradigm of economic theory is that relative prices and general price level are unrelated. Relative prices are determined in the real sphere of economy on the basis of supply and demand differences, availability of resources, etc. while aggregate price level is a nominal concept widely believed to follow money expansion path. Neoclassical economists put a strong emphasis on the importance of studying the two concepts separately and independently of each other. However, the developments following the oil shocks have made many economists take up the issue again and reconsider the classical dichotomy. The unusually big increases in the price of oil and food products in the 1970s were coupled with exceptionally high inflation levels[2] and the overall impression was that the phenomenon is not purely coincidental and deserves a closer scrutiny. This is how Milton Friedman parried the attacks and defended the classical separation of the real and nominal phenomena in *Newsweek* in 1975:

> *(...) what of oil and food to which every government official pointed? Are they not the immediate cause of the price explosion? Not at all. It is essential to distinguish between changes in **relative** prices from changes in **absolute** prices. The special conditions that drove up the price of oil and food required purchasers to spend more money on them, leaving them less to spend on other items. Did that not force other prices to go down or to rise less rapidly than otherwise? Why should the **average** level of prices be affected significantly by changes in the price of some things relative to others?*[3]

Responding to the same critique of neoclassical fundamentals, Edgar Fiedler claimed that the controversy is caused by "*the widespread confusion between inflation, which reflects the general level of prices, and price changes for individual commodities*" and pointed to soybeans and pocket calculators, whose prices all fell significantly during the period concerned but nobody called it deflation.[4] Another economist, Alan Greenspan, drew an even more suggestive picture of what is and what is not the neoclassical view of inflation: *"(...) I do not believe that, in the longer run, the general price level is determined by the sum of its parts.*"[5]

Solow was one of the first to respond to the discussion by abandoning the crucial implicit assumption of flexible prices. By contrast, backed with empirical observations, he claimed that there is a significant degree of price inflexibility and not all prices adjust to the current market conditions. Solow argued that with no government programs aiming at stabilizing output (by, for example, money accommodation), prices are more flexible since producers facing prolonged reduced sales will see to maintaining their market shares by cutting prices. However, if

[2] Blinder [1982] gives a detailed description on the magnitude of food and energy price shocks and general inflation level

[3] Friedman [1975], p. 73

[4] Edgar Fiedler [1974] in Elwertowski and Vining [1976], p. 700

[5] A. Greenspan [1974], p.2

economic agents have reasons to expect some kind of government intervention, there is less pressure to reduce prices when demand contracts.[6]

Downward price inflexibility can also be modeled using the Asymmetric Price Response models. The newest version of the model as developed and augmented by Ball and Mankiw[7] will be discussed in more detail in section 3. The concept of asymmetric price response introduced to the literature by Solow has been used by many economists since then, including Tobin (1972) and Fischer (1981, 1982). In general, the model predicts that firms react more to excess demand than to excess supply. For instance, if individual markets experience relative disturbances (shocks), asymmetric price response means that markets in which the disturbances produced excess demand respond by raising prices but markets in which disturbances produced excess supply respond very little or do not respond at all.[8] There may be various reasons why markets respond asymmetrically. Blinder (1982) suggests that the differences in price response observed across markets may depend on the degree of storability of commodities, i.e. prices for commodities which can be stored for longer periods are more likely to remain downwardly rigid even if the shocks leave the industry with excess supply. Parks (1978) adds other factors (at the industry level) to the list including the degree of market organization as well as market concentration.

In this framework it is obvious that increased relative disturbance variability raises the general price level. It is precisely for the unwillingness of firms to adjust prices downwards that higher dispersion of shocks to the economy produces more price increases than decreases. While this result holds in the short run, any long run effect depends on the degree of monetary accommodation. Tight monetary policy unresponsive to relative price shifts may stop inflationary pressures, however, at a high risk of inducing a prolonged recession. This risk, as predicted by Solow, would restore downward flexibility in individual prices. That this is very unlikely to happen is reflected in a strong resistance of firms to cut prices.

Despite impressive amount of theoretical research done on the subject of asymmetric price response, the author is aware of a very small number of studies that offer empirical tests evaluating the impact of the phenomenon on the inflation rate. Fischer (1982) in his study of inflation in the United States and Germany performs a series of small vector autoregressive (VAR) models. Granger causality tests do not give the decisive answer as to the direction of causality but VARs detect, especially in the case of United States, that relative price variability can play an independent macroeconomic role in that it can influence the inflation rate. The quantitative results, however, are not strong enough to legitimize a more definitive statement about the impact of relative price changes. Ball and Mankiw (1994, 1995) build on the asymmetric price response and menu costs to develop interesting models linking inflation and sectoral price dispersion with a special role of the skewness of price change distributions. In their 1995 paper they find a statistically robust relationship

[6] Solow (1975)
[7] Ball and Mankiw [1991] and [1995]
[8] S. Fischer [1981]

suggesting a significant impact of the shape (in particular, the asymmetry) of the distribution of individual price changes on the general price level.[9]

Pujol and Griffith's is the first attempt to investigate the impact of relative price shifts on inflation in Poland[10]. Using Ball and Mankiw model's reasoning, they regress standard deviation and skewness of the distribution of sectoral price changes as well as a lagged rate of inflation on the current rate of inflation and obtain statistically significant positive coefficients. However, the regression did not have impressive explanatory power ($R^2$=0.59) and the authors used high-frequency monthly data which seems to seriously distort the pattern of actual longer-lasting relative price changes.[11] Finally, Coorey, Mecagni and Offerdal (1996) take up the issue in the context of transition economies. They estimate the effect of relative price variability on inflation within a framework controlling for nominal and real shocks using quarterly data for 21 transition economies including Poland. They find that money and wage growth were the most important determinants of inflation with relative price variability having a sizable effect at high inflation during initial stage of transition and a much reduced impact on inflation afterwards.

## 2.2. Higher Inflation as a Cause of Higher Variability in Relative Prices

The body of theoretical literature as well as empirical tests treating inflation as a cause rather than the result of relative price variability has been by far the largest. However, introducing the concept of causality running in that direction forced economists to reconsider just as many fundamental assumptions as was the case with the previous set of theories implying the opposite direction. Acknowledging the influence of “nominal” inflation on “real” relative prices was equivalent to abandoning the neutrality-of-money paradigm or at least modifying it substantially.

Most of the theories building on this link draw from the Lucas' Imperfect Information Model. In a setting where economic agents lack the perfect information about the aggregate price level and form their expectations using past information, it is possible for suppliers to be fooled temporarily into believing that a shift in the price of their product reflects a real change in its relative price. A natural response to a relative price change is to change the quantity produced. This is the reasoning behind Lucas' upward-sloping aggregate supply curve. Of course, producers cannot be fooled systematically and consistently confuse the aggregate price level increase with their product's relative price increase, so over time they develop a more cautious approach. When the price of their good increases, they attribute part of the change to an increase in the general price level and part to a change in the relative price induced by real

[9] In their paper, Ball and Mankiw consider numerous measures of the shape of the distribution including standard deviation, skewness and asymmetry variables measuring the difference between the mass in the upper tail and the mass in the lower tail of the distribution. The paper will be discussed in more detail in section 3.

[10] Pujol and Griffith [1996]

[11] Blejer [1983] finds that using higher-frequency data substantially increases the variability of relative prices

demand factors.[12] In that framework, producers may perceive an increase in the level of inflation as a signal to reduce their supply-elasticity. In other words, while they are still unable to distinguish the source of the price increase, they become less responsive to it. In aggregate terms this means that greater price level instability makes individual as well as aggregate supply curves steeper. With steeper supply curves the same random demand shocks (demand expansion as well as contraction) induce higher price variability.

Modifications of this theory found in the literature give a special role to unanticipated inflation and inflation rate variability in explaining relative price variability. In general, the group of models based on Lucas-type confusion between aggregate and relative price movements predicts that relative price variability is affected by aggregate shocks (both anticipated and unanticipated) and that both relative and aggregate price variability are associated through their relationship to the variance of aggregate shocks.

Another theory predicting positive impact of inflation on relative price variability are based on the costs of price adjustment, the so-called "menu costs". It is assumed that changing prices is costly and thus prices change only at discrete intervals. When the inflation rate goes up, prices are being adjusted more frequently but the relative price structure is not likely to remain intact. Different costs of adjusting prices in different industries implies that the process of making up for inflation will not be even across sectors and will be therefore accompanied by greater overall relative price variability. This reasoning also implies that more rapid price deflation leads to greater relative price variability. This hypothesis was theoretically developed with the use of the basic assumption of direct costs of adjusting prices by Mussa (1977) and Sheshinski and Weiss (1977). Bordo (1980) augmented the analysis by introducing differential contract periods across markets leading to different pace of adjustment in the economy.

Much of the empirical tests of these theories takes the form of models with relative price variability as a dependent variable in its relationship with inflation. Glejser (1965) finds that the above relationship is positive in a cross-sectional study. Vining and Elwertowski (1976) discover the positive relationship between relative price variability and general price level instability in the United States. Since, as many studies suggest, the variance and the level of inflation are positively correlated, the study confirms the general pattern. Parks (1978) examines the data from Holland and the United States (including the period of the Great Depression) and finds the variability of relative prices to be positively associated with the square of unanticipated inflation. Hercovitz (1981 and 1982) uses German hyperinflation data to find support for positive relationship between variability of relative prices and unanticipated money growth. More recently, Lach and Tsiddon (1991) document similar findings for Israel and Domberger (1987) for the United Kingdom.

[12] Lucas [1973] and Romer [1996] p. 242-255

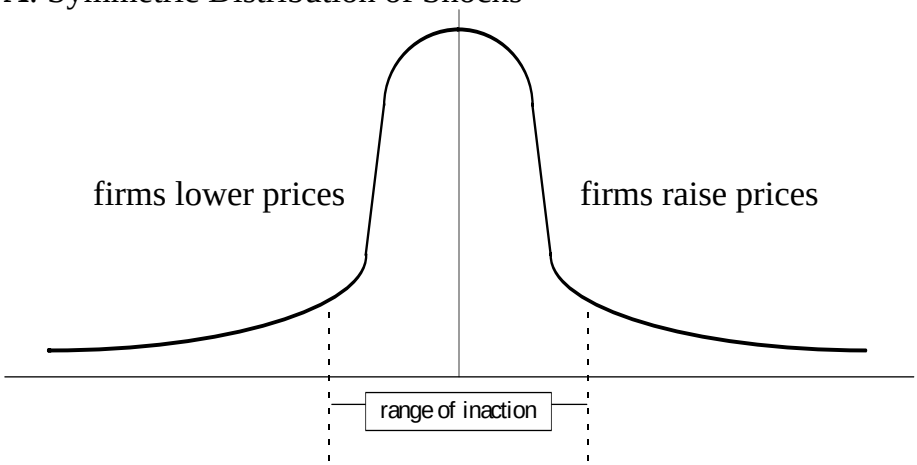
# 3. BALL AND MANKIW MODEL

While economists still cannot unanimously agree on the direction of causality, recent works by Ball and Mankiw (1992,1994 and 1995) seem to best serve the purpose of evaluating the impact of relative price shifts on inflation in Poland. In this section I review Ball and Mankiw's models as well as try to position its main findings in the framework of a representative transition economy.

Ball and Mankiw's 1994 and 1995 models belong to the first group of hypotheses as sketched in section 2 and predict that causality runs from relative price variability to aggregate price level. In their 1995 paper "Relative Price Changes as Aggregate Supply Shocks" authors develop and test a model incorporating costs of price adjustments ("menu costs") to show the mechanism in which aggregate inflation is influenced by the shape of the distribution of relative supply shocks. Their 1994 model adds a great deal to the discussion by introducing positive trend inflation[13] and identifying other channels through which the association is enforced.

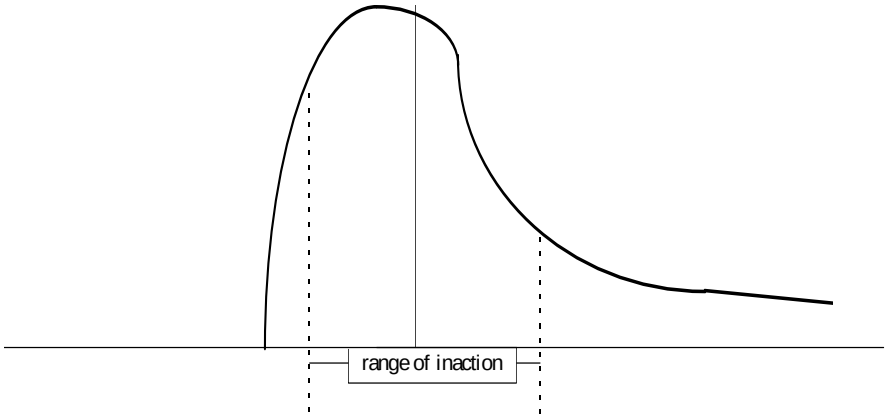
*Figure 1*
**Distribution of Shocks and Range of Inaction Caused by Menu Costs**

**A**: Symmetric Distribution of Shocks

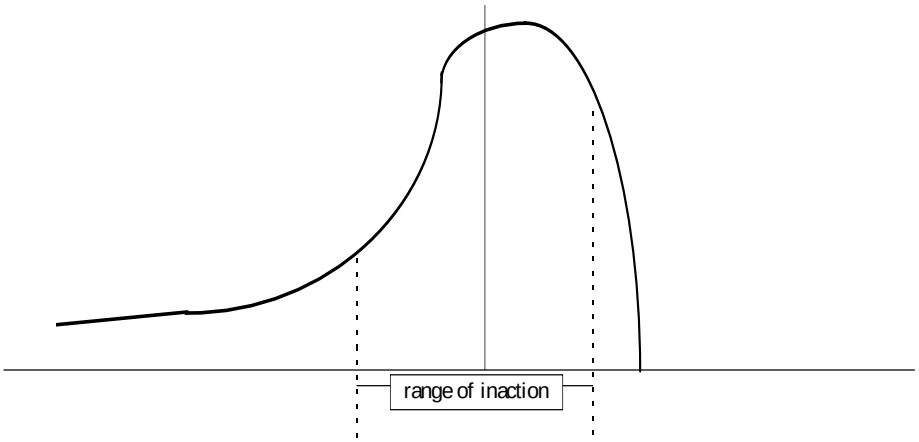



[13] Introducing positive trend inflation is crucial in the context of transition economies

**B**: Distribution Skewed to Right




**C**: Distribution Skewed to Left




The idea central to Ball and Mankiw's 1995 model is the firms' response to supply (cost) shocks. With the assumption that the average relative shock is zero, they consider different distributions of shocks and look at the consequences that these differences have after the imposition of menu costs. **Figure 1** shows three kinds of distributions of shocks and a "range of inaction" that firms develop as a result of menu costs. In the environment in which it is costly to adjust prices, firms do not react if shocks are relatively small and respond only to shocks large enough to make paying the menu cost worthwhile. When the distribution of shocks is symmetric the range of inaction covers the same number of positive and negative shocks (1a) and the net effect on the price level is zero. However, when a distribution is skewed[14] to the right (1b) the upper tail is larger than the lower tail and menu costs imply that firms react to more positive shocks than they do to negative. Finally, if the distribution is skewed to the left (**Fig. 1c**) the situation is reversed: the mass in the lower tail of the distribution is bigger and more firms experience downward shocks to their prices which results in the fall of the aggregate price level.

The basic implication of this reasoning is that in periods during which the distribution of shocks is skewed to the right, aggregate price level may rise as menu costs imply more price increases than price decreases. The authors formalize these

[14] Positive skewness arises when there are few unusually large positive shocks and many small negative ones

ideas in a one-period theoretical model. They also observe that the analysis refers to the relationship of the distribution of ***unobserved*** real sectoral shocks and the rate of inflation. Recognizing that fact, they carry out a numerical analysis that proves that the relationship between the first, second and third moment of the distribution of unobserved shocks carries over to actual price changes under reasonable assumptions. In other words, one can use relative price data as a proxy for unobserved shocks since the two phenomena move monotonically closely together.

In the empirical analysis Ball and Mankiw use the annual PPI data for the United States disaggregated at the 4-digit industry level for the sample 1949 through 1989. The number of industries in the sample has steadily increased from 213 in 1949 to 343 in 1989. They run a series of regressions with inflation rate as a dependent variable and lagged inflation and various measures of the distributions of relative price changes as the explanatory variables. The results indicate strong and statistically significant positive relationship between standard deviation[15], skewness and their product[16] on the rate of inflation.

While Ball and Mankiw's 1995 paper offers sound justification for including skewness of the distribution of relative price changes as an explanatory variable, their earlier paper "Asymmetric Price Adjustment and Economic Fluctuations" (1994) explains the mechanism through which inflation is influenced by the variance of that distribution. The underlying assumption of this paper is the positive trend inflation that all economic agents have to account for. With that assumption authors come much closer to the reality of transition economies, all of which have had to cope with high inflation levels. Introducing steadily growing price level adds a great deal of credibility to the analysis since intuition strongly suggest that high inflation has a substantial distortionary impact on firms' pricing decisions.

The model, as developed by Ball and Mankiw in 1994, assumes that in an inflationary environment firms make regular price adjustments to keep up with the growing price level[17] as well as change their prices in response to shocks for which they have to pay the menu cost. In this context, positive shocks trigger greater adjustment than do negative shocks of the same size and asymmetries arise even with a symmetric distribution of shocks. Firms affected by a negative sectoral shock putting downward price pressure have the incentive not to pay menu costs by simply waiting with unchanged nominal prices until inflation does the desired erosion to the relative price of their product. By contrast, positive shocks call for prompt and a more than offsetting action[18] on the part of the affected firm as the upward price pressure

[15] Even though in their 1995 paper authors do not assign an independent role to the variance of the distribution of relative price changes, they include standard deviation in their regressions and obtain statistically significant positive coefficients.

[16] According to the authors, larger variance interacts with skewness in that it magnifies the effect of asymmetry and therefore contributes to the increased inflation.

[17] In the model authors assume steady rate of inflation. However, introducing variable (steadily falling) inflation does not change the findings as long as the rate is well-known and anticipated (which seems to be the case in Poland).

[18] In Ball and Mankiw's model both range and size of adjustment are assymetric. If struck by a positive shock, firms adjust more in absolute value than would be the case with a negative shock because they raise their prices in reponse to the shock as well as catch up with inflation

resulting from the shock is magnified by inflation which is continuously widening the gap between the firm's actual and desired relative price. From the intuitional discussion it should be clear that positive shocks cause firms to adjust quicker and more fully than negative shocks which, if not exceptionally large, are likely to leave firms' prices unchanged. Ball and Mankiw's model offers therefore a microeconomic-based justification for a frequently implicitly assumed downward price rigidity (section 2.1).

With the asymmetric price adjustment assumed, distribution of sectoral shocks need not be asymmetric to have a positive influence on the price level. Unlike in the 1995 paper where it was the asymmetry (skewness) of the distribution of shocks that pushed prices upwards, in the 1994 model it is the greater relative price variability that itself exerts inflationary pressures. In the light of the model a shock that raises some firms' desired prices and lowers others' induces more upward than downward adjustment. It is precisely for that reason that **greater relative price variability** is likely to be accompanied by **higher inflation** and lower output[19].

In their paper Ball and Mankiw develop a formal partial-equilibrium model, calibrate it and then solve it numerically. The main findings, some of which have been briefly discussed above, emerge as the pattern of the economy behavior over time. While long-run trend inflation reflects long-run trend money growth, high variance of sectoral shocks[20] pushes inflation above the trend and depresses output whereas periods of low sectoral dispersion are characterized by lower, below-the-trend inflation and higher output. Therefore, higher (lower) variance of sectoral shocks can be thought of as an adverse (conducive) supply shock with all its implications to the economy.

Combining the two models would yield a coherent and useful theoretical basis for studying the link between inflation and relative price variability in Poland. The authors themselves suggest putting the two hypotheses together and predict that the results would carry over.[21] The resultant model would view short run inflation developments in the light of the shape of the distribution of sectoral shocks as proxied by relative price shifts. With positive trend inflation, both variance and skewness of the distribution should add to the inflationary pressures as both downward price rigidity and prevalence of large positive price hikes result in a bigger asymmetry of firms' adjustment.

The modification of the model could be visually depicted by slightly modifying figures illustrating Ball and Mankiw's 1995 model. In the same framework that authors considered the effect of the asymmetry of the shocks' distribution we now replace the unobserved shocks by actual price changes triggered by those shocks. The distribution is now composed of the components of the price index. The individual inflation of each product/group of products is multiplied by its weight in the index and weights add up to one.[22] The mean of so defined a distribution is equal to the general inflation

[19] In the absence of monetary accomodation, if firms fail to adjust their prices downward they have to face substantial output cuts. A more detailed discussion (beyond the scope of this paper) can be found in Ball and Mankiw [1994] pp. 252-256

[20] demand or costs shocks

[21] Ball and Mankiw [1995] p. 173

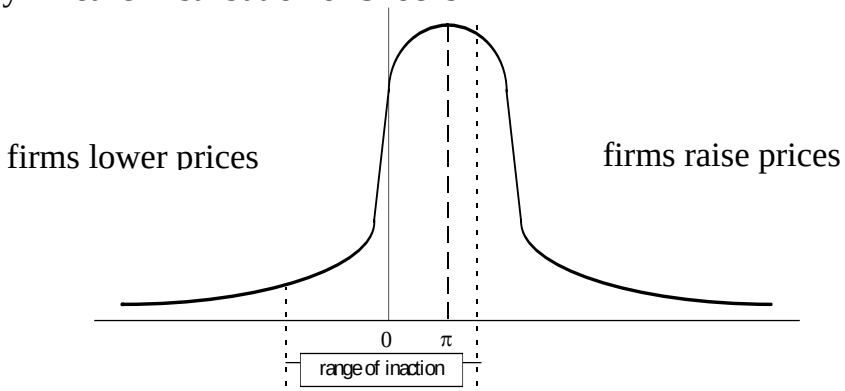
[22] The analysis covers the entire basket

rate. Introducing positive trend inflation to the model means that the mean of the distribution is not zero as assumed in 1995 paper, but some positive number (see **Fig. 2**). Menu costs however, stay where they used to be as the asymmetry around zero still holds (**any** price adjustment is costly). The width of the range of inaction varies across firms as it is not uniformly determined. In their calculations, Ball and Mankiw use 15 % as the maximum deviation between desired and actual prices that the average firm will tolerate.[23] In order to draw the figure correctly one has to know if the right wing of the range of inaction hits the actual aggregate inflation and covers some of the portion with higher inflation or is entirely located in the area to the left of the actual inflation rate. In any case, as is clearly visible in the picture, moving from 0 mean of the distribution to some positive $\pi$, means exacerbating the situation in terms of making firms even less likely to make downward price adjustments than before. As predicted by Ball and Mankiw, introducing the asymmetry in distribution (**Fig. 2b** and **2c**) magnifies the extent of non-adjustment in the case of positive skewness and reduces it for negative skewness.

Summing up, the implications of Ball and Mankiw's models for the relationship between aggregate inflation rate and the distribution of individual inflation rates are straightforward. Aggregate price level tends to rise more rapidly during periods of high sectoral price dispersion especially with unusually large price increases of few goods. In other words, inflation rate should be positively correlated with the variance and skewness of the distribution of sectoral price changes.

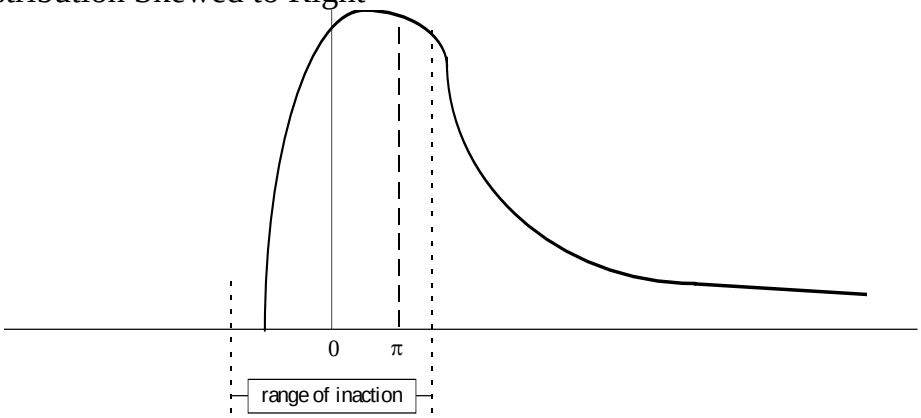
*Figure 2*
**Distribution of Shocks and Range of Inaction in the Presence of Trend Inflation**

**A**: Symmetric Distribution of Shocks

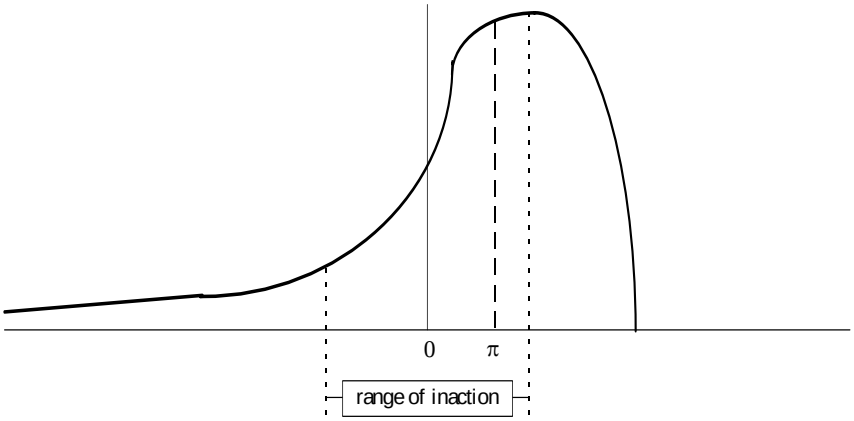



[23] Authors infer the figure from papers by Cechetti [1986] and Blinder [1991] where it is proven to be consistent with microeconomic evidence on the frequency of price adjustment

**B**: Distribution Skewed to Right




**C**: Distribution Skewed to Left




# 4. RELATIVE PRICE DISTRIBUTIONS IN POLAND

## 4.1. Historical Factors

One of the particularities of a centrally planned economy has been the plan which set output goals for all sectors taking into account the availability of labor and capital. Money and credit passively adjusted to ensure meeting the planned equilibrium. Wages and prices have also been set by central planners. The resulting allocation of resources has been therefore highly inefficient and created serious distortions throughout the economy. Relative prices of goods did not reflect the

relative demand and supply interactions, but rather government's perception and preferences. All throughout the Eastern Europe and specifically in Poland, prices of staple foods, municipal services and transportation were set at extraordinarily low levels usually well below cost recovery. Additionally, heavy implicit and explicit subsidies were prevalent in many sectors which disabled the signaling role of prices even more. As a result relative price structure deviated greatly from market patterns and carried no valid information on resource allocation. The consequence of the system were pervasive shortages of most goods reflecting their inappropriate pricing so that the rationing system had to be put in place.

Even though prices have been partially adjusted in Poland in the mid- and late-1980s, the price structure was far from being market-determined when the first comprehensive reform package was initiated on January 1, 1990. The program often called *the Balcerowicz Plan* had been one of the "big-bang" type and called for rapid and economy-wide price liberalization, sharp reduction of subsidies and exchange rate unification. The goal of the program, macroeconomic stabilization, has been extremely difficult to achieve in the economy hovering on the edge of hyperinflation. The monetary overhangs that have been built up in the form of forced savings during years of rationing and shortages, have now made their way to the goods market. The much needed comprehensive price liberalization additionally contributed to inflationary pressures. Price controls were removed for most goods and the exchange rate was unified reducing the portion of administered prices from 50% to 10%.[24] The extent of upward adjustment was often bigger than expected and resulted in almost 80% inflation in January 90.[25].

Following sharp upward movements of individual nominal prices, price relations have undergone significant shifts. It is obvious that inflation has not been even across all sectors. Some sectors, especially those in need of establishing higher relative prices of their products, have led the inflation process with others lagging behind. Even prior to looking at the distributions of relative price changes it should be expected that in many periods individual inflation rates of CPI components were dominated by one or two disproportionately big price increases (see footnote 25). Those could result from administrative price increases or occur in sectors struck by unusually large supply shocks. Whatever the reason, the outcome should be high positive skewness of the distribution as few outlier price hikes are matched with a large number of relatively small price increases.[26] According to the theory, it is these asymmetries that can fuel the inflation process contemporaneously as well as with a time lag.

[24] Wellisz (1997) p. 157

[25] In January 1990 the price of bread rose by 147%, electrical energy by 370% and furnace fuel, central heating and hot water by almost 400 %.

[26] Unlike in the analysis of American inflation, the mean of the distribution in the case of Poland cannot be assumed to be close to zero and the distribution itself cannot be thought of as being composed of price increases and commensurate price declines. Rather, with the mean located at some positive $\pi$, the distribution is composed of big price increases matched with small price increases on the other side of the distribution.

## 4.2. Statistical Evidence

The statistical data I use have been collected from various issues of Central Statistical Office (GUS) Monthly Bulletins on Price Changes.[27] They are individual inflation rates for more than 60 groups of goods and services. The level of disagregation varies within the sample for different years reflecting the availability of data. The number of categories is: 61 (for 1989 and 1990), 62 (for 1991 and 1992), 64 (1993, 1994 and 1995) and 63 (for 1996 and 1997). They cover the entire basket of goods and services constituting the basis of the Polish CPI index, so that the weights of all categories add up to one for each year[28].

Even though the data were taken from the monthly bulletins they were aggregated to quarterly changes to eliminate excessive volatility due to high frequency[29] and focus on the shifts in relative prices that are stable over longer periods. For each quarter two distributions have been created:

*1) Distribution of unweighted inflation rates* was obtained from quarterly inflation rates for individual groups of goods and services.

*2) Distribution of weighted inflation rates* was obtained from quarterly inflation rates for individual groups of goods and services multiplied by their weight in the basket.

Using those distributions various measures of variance and skewness have been calculated.

### *Variance*

- conventional variance of the unweighted distribution

$$\text{var} = \frac{1}{n-1}\sum_{i=1}^{n}(\pi_i - \tilde{\pi}/n))^2$$

- conventional variance of the weighted distribution

$$w\text{var} = \frac{1}{n-1}\sum_{i=1}^{n}(w_i\pi_i - \bar{\pi}/n))^2,$$

where $\bar{\pi} = \sum_{i=1}^{n} w_i\pi_i$ *and* $\tilde{\pi} = \sum_{i=1}^{n}\pi_i$

### *Skewness*

- conventional skewness of the unweighted distribution

[27] Miesieczna Informacja o Zmianach Cen,, various issues

[28] The weights used by GUS to calculate inflation were updated every year and this paper takes that into account.

[29] The effect that the frequency of the inflation data has on the volatility of relative prices is discussed in Blejer [1983]

$$SK = \frac{n\sum_{i=1}^{n}(\pi_i - (\tilde{\pi}/n))^3}{(n-1)(n-2)\left[\frac{1}{n-1}\sum_{i=1}^{n}\pi_i - (\tilde{\pi}/n)^2\right]^{3/2}}$$

- conventional skewness of the weighted distribution

$$WSK = \frac{n\sum_{i=1}^{n}(w_i\pi_i - (\overline{\pi}/n))^3}{(n-1)(n-2)\left[\frac{1}{n-1}\sum_{i=1}^{n}(w_i\pi_i - (\overline{\pi}/n))^2\right]^{3/2}}$$

The above measures render different aspects of relative price changes. The mean of the weighted distribution is the aggregated inflation rate whereas the mean of the weighted distribution is the average inflation rate of commodities comprising the CPI basket. The unweighted variance assumes the value of zero when all individual inflation rates are equal and increases with higher dispersion of individual rates regardless of their share in the index. On the other hand, the variance of the weighted distribution measures the contribution of each group of commodities to overall variability on the basis of their weight in the basket and does not take on the zero value even if all rates are equal. Both measures seem to have considerable deficiencies with respect to describing the shape of the distribution in that they focus on one aspect of the variability neglecting the other. By contrast, the measure developed by Theil [30] takes account of several properties of the distribution thereby rendering a more comprehensive picture. The Theil variance is the weighted sum of squared deviations of unweighted individual rates from aggregate inflation rate:

$$TVAR = \sum_{i=1}^{n} w_i(\pi_i - \overline{\pi})^2$$

The Theil skewness is defined as:

$$TSK = \frac{\sum_{i=1}^{n} w_i(\pi_i - \overline{\pi})^3}{\left[\sum_{i=1}^{n} w_i(\pi_i - \overline{\pi})^2\right]^{3/2}}$$

Theil variance and skewness as defined above have been used extensively in empirical work. Their advantage over conventional and weighted measures in the analysis of relative price variability relies on the fact that they render a more accurate picture of relative price shifts. Specifically, unlike *wvar, Tvar* assumes the value of zero when all inflation rates are equal i.e. when no relative price changes take place.

[30] Theil [1967]

Moreover, unlike *var*, it does take account of the relative share of a sector in the index, giving more weight to the variation in "important" prices. As will be shown in section 5, Theil measures are also the ones most closely correlated with inflation.

For each quarter in the sample the distribution of individual inflation rates has been obtained. **Table 1** presents the set of descriptive statistics calculated for these distributions. The table shows that regardless of the statistic considered, on average the distributions were positively skewed and their variances varied substantially. To single out quarters with extraordinarily high and low levels of these statistics I sorted the data by the values of each statistic in an ascending order. **Table 2** presents top five and bottom five observations according to respective statistics.

The basic message that emerges from the tables is intuitionally obvious: the distribution of individual inflation rates is most heavily skewed and dispersed during initial stages of reform. In the case of all statistics but one, second and third quarter of 1989[31] turn out to be the periods during which the measures peak. By contrast, more recent observations (1994-1997) tend to be characterized by lowest variance and skewness. To give a better idea of these outlier distributions, **Figure 3** presents histograms of individual price changes for Sep-89 and Dec-89 (high positive skewness and variance) as well as Sep-95 and Sep-96 (high negative skewness).

*Table 1*

**Descriptive Statistics of the Distributions of Individual Inflation Rates**

| quarter | inflation | var | sk | wvar | wsk | Tvar | Tsk |
|---|---|---|---|---|---|---|---|
| 89Q1 | 0.295 | 0.275 | 6.523 | 0.342 | 1.345 | 9.481 | 0.721 |
| 89Q2 | 0.249 | 0.020 | 0.655 | 0.219 | 2.554 | 1.946 | 0.030 |
| 89Q3 | 1.053 | 1.615 | 2.510 | 17.433 | 3.943 | 243.370 | 0.277 |
| 89Q4 | 1.230 | 1.015 | 4.542 | 5.658 | 2.588 | 43.326 | 0.384 |
| 90Q1 | 1.319 | 0.980 | 0.889 | 4.740 | 1.955 | 55.905 | 0.125 |
| 90Q2 | 0.163 | 0.032 | 0.861 | 0.247 | 2.752 | 2.778 | 0.115 |
| 90Q3 | 0.103 | 0.035 | 2.127 | 0.064 | 0.151 | 1.527 | 0.050 |
| 90Q4 | 0.174 | 0.041 | 2.083 | 0.302 | 3.298 | 4.161 | 0.251 |
| 91Q1 | 0.257 | 0.039 | 0.991 | 0.216 | 1.459 | 7.068 | 0.367 |
| 91Q2 | 0.106 | 0.081 | 3.523 | 0.191 | 2.762 | 6.105 | 0.322 |
| 91Q3 | 0.050 | 0.029 | 0.679 | 0.119 | -2.203 | 2.550 | -0.107 |
| 91Q4 | 0.098 | 0.011 | 2.328 | 0.079 | 2.216 | 1.198 | 0.225 |
| 92Q1 | 0.116 | 0.005 | 0.632 | 0.084 | 3.273 | 1.241 | 0.652 |
| 92Q2 | 0.096 | 0.005 | 0.645 | 0.044 | 2.156 | 0.450 | 0.124 |
| 92Q3 | 0.097 | 0.011 | 1.481 | 0.091 | 1.799 | 1.195 | 0.027 |
| 92Q4 | 0.077 | 0.004 | 2.388 | 0.039 | 2.846 | 0.594 | 0.208 |
| 93Q1 | 0.099 | 0.003 | 2.250 | 0.033 | 2.031 | 0.431 | 0.184 |
| 93Q2 | 0.056 | 0.003 | -0.909 | 0.025 | 1.623 | 0.465 | -0.061 |
| 93Q3 | 0.060 | 0.012 | -1.497 | 0.122 | -1.790 | 1.968 | -0.227 |

[31] Liberalization of food prices took place in August 1989.

| quarter | inflation | var | sk | wvar | wsk | Tvar | Tsk |
|---|---|---|---|---|---|---|---|
| 93Q4 | 0.119 | 0.015 | 2.930 | 0.112 | 3.056 | 1.632 | 0.248 |
| 94Q1 | 0.050 | 0.019 | -5.071 | 0.036 | 4.340 | 1.638 | -0.399 |
| 94Q2 | 0.071 | 0.006 | 2.819 | 0.038 | 4.490 | 0.729 | 0.326 |
| 94Q3 | 0.079 | 0.012 | 3.616 | 0.019 | 0.971 | 0.726 | 0.334 |
| 94Q4 | 0.067 | 0.013 | 5.183 | 0.023 | 1.993 | 0.696 | 0.447 |
| 95Q1 | 0.081 | 0.005 | -0.598 | 0.030 | 2.490 | 0.541 | 0.040 |
| 95Q2 | 0.052 | 0.002 | -0.248 | 0.010 | 1.524 | 0.169 | 0.018 |
| 95Q3 | 0.025 | 0.006 | -4.429 | 0.043 | -3.863 | 0.988 | -0.349 |
| 95Q4 | 0.047 | 0.003 | 3.936 | 0.021 | 4.308 | 0.459 | 0.333 |
| 96Q1 | 0.065 | 0.002 | 1.257 | 0.020 | 2.117 | 0.265 | 0.104 |
| 96Q2 | 0.047 | 0.002 | -0.997 | 0.013 | 2.293 | 0.238 | 0.005 |
| 96Q3 | 0.023 | 0.007 | -4.009 | 0.073 | -2.641 | 1.259 | -0.297 |
| 96Q4 | 0.041 | 0.003 | 5.195 | 0.034 | 6.192 | 0.585 | 0.424 |
| 97Q1 | 0.049 | 0.001 | 0.696 | 0.013 | 2.215 | 0.198 | 0.072 |
| mean | 0.197 | 0.131 | 1.302 | 0.925 | 1.947 | 11.996 | 0.151 |
| st. dev. | 0.330 | 0.359 | 2.647 | 3.214 | 2.086 | 43.199 | 0.257 |

Source: author's calculations using GUS data

*Table 2*

**Quarters Ranked by Values of Descriptive Statistics**

| Ranking # | | **Inflation** | | **var** | | **sk** | | **wvar** | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 90Q1 | 1.319 | 89Q3 | 1.615 | 89Q1 | 6.523 | 89Q3 | 17.433 |
| five | 2 | 89Q4 | 1.230 | 89Q4 | 1.015 | 96Q4 | 5.195 | 89Q4 | 5.661 |
| highest | 3 | 89Q3 | 1.053 | 90Q1 | 0.980 | 94Q4 | 5.183 | 90Q1 | 4.740 |
| | 4 | 89Q1 | 0.295 | 89Q1 | 0.275 | 89Q4 | 4.542 | 89Q1 | 0.342 |
| | 5 | 91Q1 | 0.257 | 91Q2 | 0.081 | 95Q4 | 3.936 | 89Q2 | 0.219 |
| | 29 | 95Q4 | 0.047 | 93Q1 | 0.003 | 96Q2 | -0.997 | 95Q4 | 0.021 |
| five | 30 | 96Q2 | 0.047 | 96Q2 | 0.002 | 93Q3 | -1.497 | 96Q4 | 0.034 |
| lowest | 31 | 96Q4 | 0.041 | 96Q1 | 0.002 | 96Q3 | -4.009 | 96Q1 | 0.020 |
| | 32 | 95Q3 | 0.025 | 95Q2 | 0.002 | 95Q3 | -4.429 | 96Q2 | 0.013 |
| | 33 | 96Q3 | 0.023 | 97Q1 | 0.001 | 94Q1 | -5.071 | 97Q1 | 0.013 |

| Ranking # | | wsk | | Tvar | | Tsk | |
|---|---|---|---|---|---|---|---|
| | 1 | 96Q4 | 6.192 | 89Q3 | 243.370 | 89Q1 | 0.721 |
| | 2 | 94Q2 | 4.490 | 90Q1 | 55.905 | 92Q1 | 0.652 |
| five | 3 | 94Q1 | 4.340 | 89Q4 | 27.502 | 94Q4 | 0.447 |
| highest | 4 | 95Q4 | 4.308 | 89Q1 | 9.481 | 96Q4 | 0.424 |
| | 5 | 89Q3 | 3.943 | 91Q1 | 7.068 | 91Q1 | 0.367 |
| | 29 | 90Q3 | 0.151 | 93Q1 | 0.431 | 91Q3 | -0.107 |
| five | 30 | 93Q3 | -1.790 | 96Q1 | 0.265 | 93Q3 | -0.227 |
| lowest | 31 | 91Q3 | -2.203 | 96Q2 | 0.238 | 96Q3 | -0.297 |
| | 32 | 96Q3 | -2.641 | 97Q1 | 0.198 | 95Q3 | -0.349 |
| | 33 | 95Q3 | -3.863 | 95Q2 | 0.169 | 94Q1 | -0.399 |

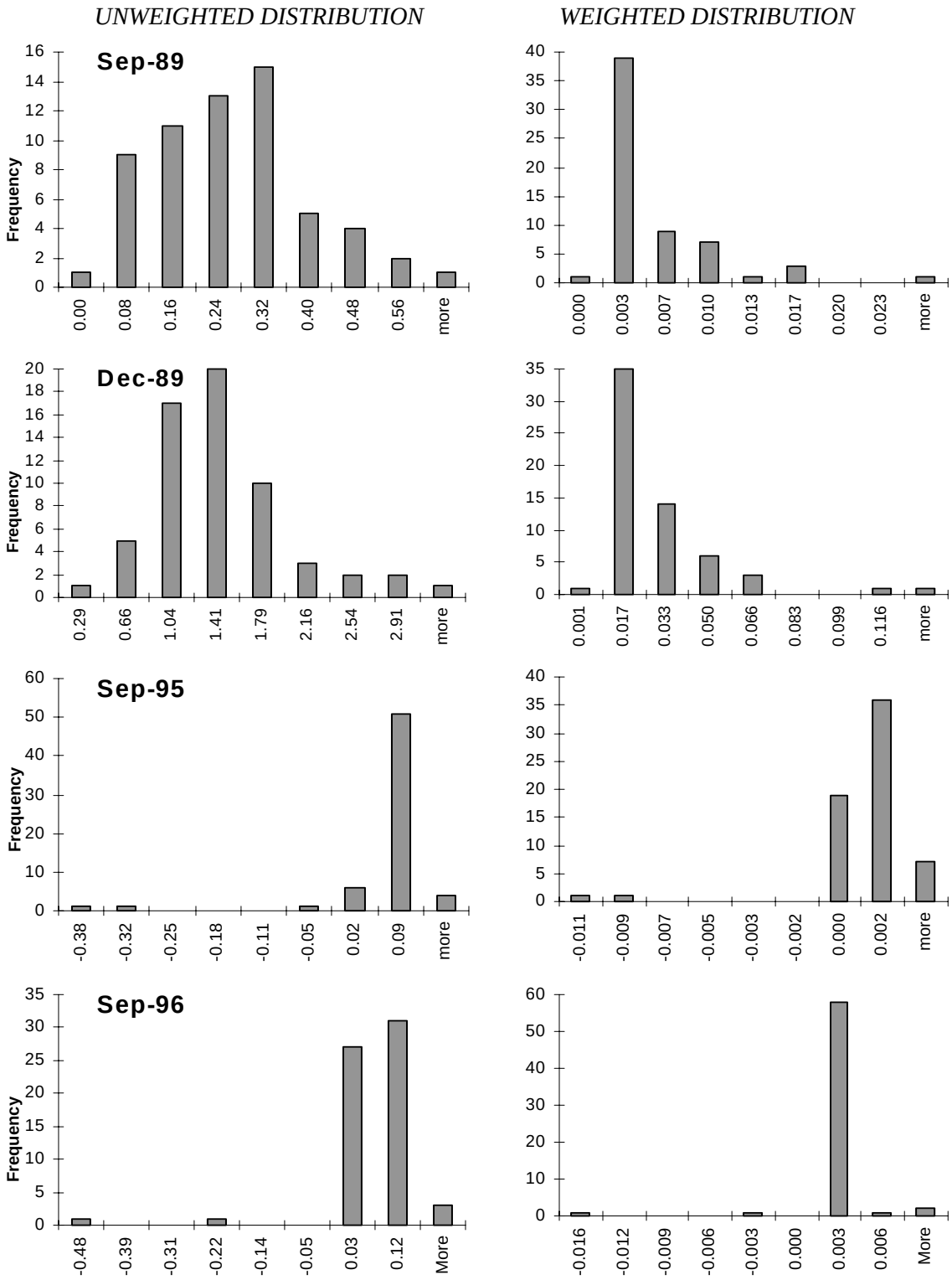
Source: author's calculations using GUS data

Initial inspection of **Tables 1** and **2** as well as **Fig. 3** allows easily to detect a positive link between aggregate inflation and relative price variability. **Fig. 4** depicts three different measures of standard deviation[32] used in the analysis along with the aggregate inflation. Because of disproportionately big values of these statistics for 4 initial observations (see **Table 1**), they have been dropped from the sample.[33] This enables to observe the relationship in a much more detailed scale.

[32] Standard deviation was used instead of variance because it is more closely correlated with inflation (see Table 3)

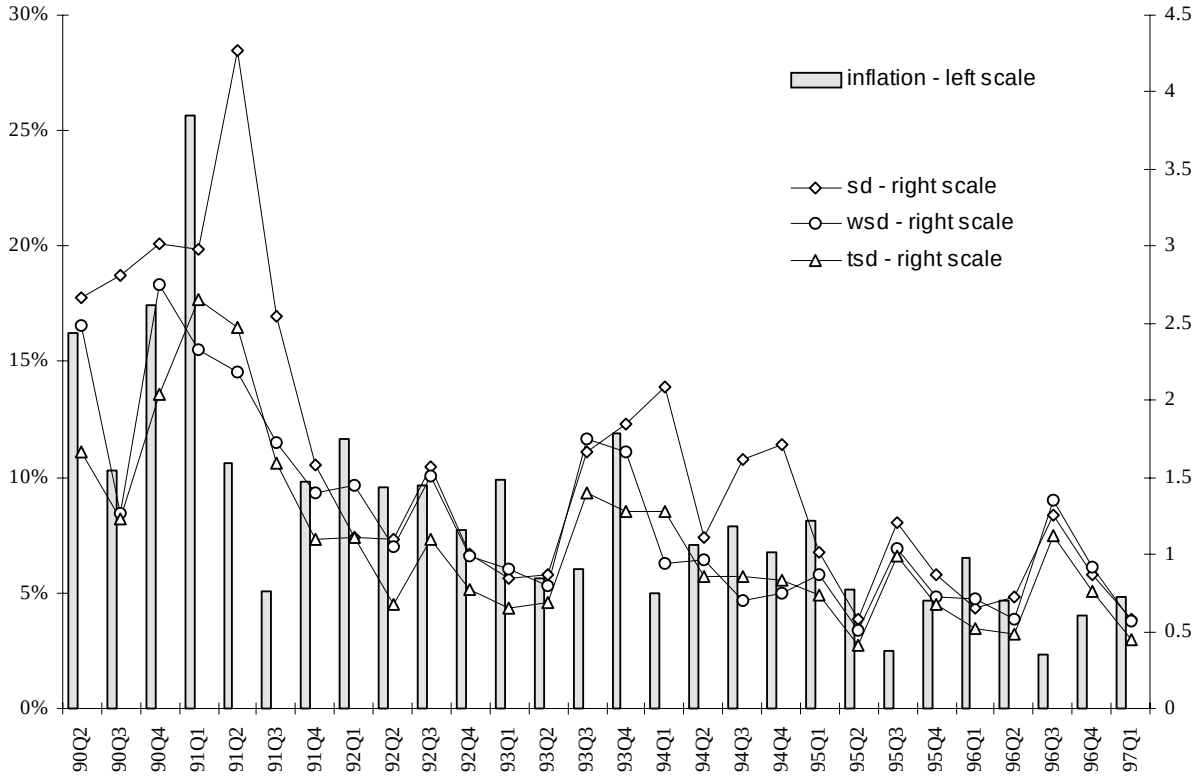
[33] For initial observations (1989-1990) inflation and variance move very closely together.

*Figure 3*
**Histograms for Individual Price Changes for Selected Quarters**




Source: author's calculations using GUS data

*Figure 4*
**Inflation and Various Measures of Variance**




Source: author's calculations using GUS data

# 5. ESTIMATION OF THE INFLATION MODEL

## 5.1. Derivation of the Model

To empirically verify the presumptions on the link between inflation and relative price variability built on the theory as well as visual inspection of graphs and tables, I chose the model which appears in the 1996 paper by Coorey, Mecagni and Offerdal.[34] It is a simple static model for a two-sector economy (tradables and non-tradables). The economy is small and open and therefore takes world tradable prices as given. Additionally, money market is assumed to clear at all times. Using this basic set of assumptions authors derive the following structural equations:

***Inflation***

(1) $\pi = \alpha_1 \pi_{nt} + \alpha_2 \pi_t + \alpha_3 V_\pi$ where $\pi_t = e + \pi^*$

[34] Coorey, Macagni, Offerdal [1996]

***Market for nontraded goods***

(2) $y_{nt}^{d} = -\beta_1 (\pi_{nt} - \pi_t) + \beta_2 y$ where $0 < \beta_2 < 1$

(3) $y_{nt}^{s} = -\delta_1 (w - \pi_{nt}) + \delta_2 (\pi_{nt} - \pi_t)$

(4) $y_{nt}^{d} = y_{nt}^{s}$

***Money Market Equilibrium***

(5) $m + v = \pi + y$ where $v = \chi \pi^{e}$

***Real Income Determination***

(6) $y_t^{s} = -\lambda_1 (w - \pi_t) + \lambda_2 (\pi_{nt} - \pi_t)$

(7) $y = y_n^{s} + y_{nt}^{s}$

where

$\pi$ — overall inflation
$\pi_{NT}$ — nontradables' inflation
$\pi_T$ — tradables' inflation
$w$ — nominal wages growth
$e$ — nominal exchange rate change
$\pi^{*}$ — foreign inflation (assumed constant)
$V_{\pi}$ — relative price variability
$y_{nt}^{d}$ — growth of demand for nontradables
$y_{nt}^{s}$ — growth of supply of nontradables
$y$ — real income growth
$w$ — nominal wage growth
$m$ — nominal money supply growth
$v$ — change in velocity
$\pi^{e}$ — expected inflation
$y_t^{s}$ — growth of supply of tradables

Four variables are assumed to be exogenous: $V_{\pi}$, $w$, $\pi^{e}$ and $m$; others are determined within the model. The equations have been structured so that they are true in economic sense when all coefficients: $\alpha$, $\beta$, $\chi$, (are positive. Substituting equations (1), (2), (3) (5), (6) and (7) in (4) and rearranging terms yields the following semi-reduced form equation for inflation:

$$\pi = \left[\frac{\beta_2(\alpha_1+\alpha_2)}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right]m - \left[\frac{(\alpha_1+\alpha_2)(\beta_2+\delta_2)+\alpha_2\delta_1}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right](\pi_{NT}-\pi_T) +$$
$$+\left[\frac{\alpha_3}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right]V_\Pi + \left[\frac{(\alpha_1+\alpha_2)\delta_1}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right]w + \left[\frac{\beta_2(\alpha_1+\alpha_2)\chi}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right]\pi^e$$

hence, because $\alpha, \beta, \chi, \delta > 0$

$$\frac{d\pi}{dm} > 0 \quad ; \quad \frac{d\pi}{d(\pi_{NT}+\pi_T)} < 0 \quad ; \quad \frac{d\pi}{dV_\Pi} > 0 \quad ; \quad \frac{d\pi}{dw} > 0 \quad ; \quad \frac{d\pi}{d\pi^e} > 0$$

In other words, according to the model, increased nominal money supply growth, wage growth, inflation expectations and relative price variability have a positive impact on inflation while appreciation of the real exchange rate based on relative inflation in tradable and non-tradable sectors tends to dampen it. For empirical analysis, the inflation expectation variable has been dropped from the model because of difficulties in capturing expectations due to lack of a reliable model for Poland as well as due to small sample size.[35] The final model takes the following form:

$$\pi = \gamma_1 + \gamma_2 m + \gamma_3 w + \gamma_4 (\pi_{NT} - \pi_T) + \gamma_5 V_\pi + seasonals$$

and takes account of:
- nominal money growth,
- nominal wage growth,
- real exchange rate based on relative inflation in tradable and non-tradable sector,
- relative price variability,
- quarterly seasonality.

## 5.2. Description of the Data

The variables entering the model are based on the data from *Monthly Statistical Bulletins* and *Bulletins on Monthly Price Changes* of the *Polish Statistical Office* (GUS) as well as *Monthly Bulletins* of the *National Bank of Poland*. They are defined as follows:

1) $\pi$ — *CPI index*;
   percentage changes of end-of-quarter value of the index
2) *m — money supply*;
   percentage changes of end-of-quarter money stock

[35] Coorey (et al) use this reasoning to drop the variable from the model.

3) *w — nominal average monthly salary in the enterprise sector;*
percentage change of a quarter's last month average value vis-à-vis previous quarter's last month average value

4) $\pi_{NT} - \pi_T = rer$ *— inflation rates of tradable and non-tradable components of CPI index*
difference in percentage changes of end-of-quarter values

5) $V_{(}$ *— various measures of variance and skewness as well as their products*;
Definitions of variance and skewness measures used in regressions were slightly modified compared to those given in section 3. They are based on differences in log values of respective price indices instead of individual inflation rates. Using percentage change based measures would give rise to spurious regressions as the explanatory variables (variance, skewness) are based on differences of individual inflation rates and aggregate inflation (explained variable).

Before estimating the model it is worthwhile to take a look at the general correlation table (**Table 3**). It shows simple correlation coefficients for each pair of variables potentially to be included in the model. The table includes four different monetary aggregates as well as real exchange rate, wages, unweighted, weighted and Theil skewness, variance and standard deviation.

*Table 3*
**Correlation Table**

| | π | M1 | QM | M2 | DC | w | rer | Tvar | Tsd | Tsk | var | sd | sk | wvar | wsd | wsk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| π | 1.00 | | | | | | | | | | | | | | | |
| M1 | 0.84 | 1.00 | | | | | | | | | | | | | | |
| QM | 0.77 | 0.54 | 1.00 | | | | | | | | | | | | | |
| M2 | 0.85 | 0.72 | 0.97 | 1.00 | | | | | | | | | | | | |
| DC | 0.63 | 0.53 | 0.63 | 0.67 | 1.00 | | | | | | | | | | | |
| w | 0.92 | 0.75 | 0.83 | 0.89 | 0.68 | 1.00 | | | | | | | | | | |
| rer | -0.25 | 0.05 | -0.58 | -0.48 | -0.23 | -0.51 | 1.00 | | | | | | | | | |
| Tvar | 0.66 | 0.42 | 0.40 | 0.45 | 0.28 | 0.68 | -0.51 | 1.00 | | | | | | | | |
| Tsd | 0.82 | 0.59 | 0.54 | 0.60 | 0.46 | 0.80 | -0.40 | 0.96 | 1.00 | | | | | | | |
| Tsk | 0.17 | 0.02 | 0.11 | 0.09 | 0.26 | 0.11 | -0.03 | 0.11 | 0.15 | 1.00 | | | | | | |
| var | 0.82 | 0.63 | 0.44 | 0.53 | 0.38 | 0.75 | -0.30 | 0.94 | 0.98 | 0.14 | 1.00 | | | | | |
| sd | 0.79 | 0.61 | 0.42 | 0.50 | 0.31 | 0.73 | -0.31 | 0.94 | 0.96 | 0.10 | 0.99 | 1.00 | | | | |
| sk | 0.11 | 0.09 | 0.08 | 0.10 | 0.29 | 0.13 | -0.08 | 0.10 | 0.12 | 0.86 | 0.13 | 0.10 | 1.00 | | | |
| wvar | 0.76 | 0.52 | 0.57 | 0.61 | 0.38 | 0.80 | -0.57 | 0.98 | 0.97 | 0.10 | 0.94 | 0.94 | 0.09 | 1.00 | | |
| wsd | 0.82 | 0.64 | 0.44 | 0.53 | 0.38 | 0.75 | -0.30 | 0.94 | 0.98 | 0.14 | 1.00 | 0.99 | 0.13 | 0.94 | 1.00 | |
| wsk | 0.15 | 0.08 | 0.13 | 0.12 | 0.09 | 0.25 | -0.20 | 0.17 | 0.14 | 0.53 | 0.15 | 0.14 | 0.47 | 0.18 | 0.15 | 1.00 |

Source: author's calculations using GUS and IFS data
*M1* — the sum of currency outside banks and demand deposits other than those of the central government; *QM* — quasi-money, the sum of time, savings, and foreign currency deposits other than those of the central government; *M2* — the sum of M1 and QM; *DC* — domestic credit includes net claims on general government, nonfinancial public enterprises and public sector; *rer* = $\pi_{NT} - \pi_T$ real exchange rate

There are several important messages that emerge from the correlation table:

- Inflation seems to be more closely correlated with standard deviation than with variance.
- Of all measures of relative price variability, Theil statistics yield highest correlation coefficients with inflation.
- Of three different monetary aggregates: M1, M2 and Domestic Credit (DC), M2 is the most closely correlated with inflation.
- All monetary aggregates are highly correlated with wages (between 0.66 and 0.85). As the two variables appear both on the left side of the model equation, the resulting multicollinearity would increase standard errors of the estimates and would render the t-statistics invalid.
- Domestic credit has the lowest correlation coefficient with inflation and as such will minimize the problem of multicollinearity if put into the model.

## 5.3. Estimation of the Model

**Table 4** presents estimates of a full semi-reduced model with seasonals. Domestic credit has been used instead of M2 to reduce the danger of multicollinearity and Theil statistics were chosen because of high correlation coefficients with overall inflation. (see **Table 3**). The resulting model has been obtained using the "General to Specific" procedure. Beginning with a fully unrestricted model with all explanatory variables lagged up to two periods, one variable with the lowest (insignificant) t-statistic has been dropped at a time. The procedure continued until all variables were significant at 10% significance level.[36]

[36] Seasonals were not eliminated even if their t-statistics fell below the level of significance.

*Table 4*

**Modeling Inflation by OLS (Model I)**

| Variable | Coefficient | Std. Error | t-value | t-prob | Partial $R^2$ |
|---|---|---|---|---|---|
| Constant | -0.067*** [37] | 0.011 | -6.185 | 0.000 | 0.680 |
| DC | 0.069* | 0.039 | 1.761 | 0.095 | 0.147 |
| DC_2 | 0.226** | 0.091 | 2.493 | 0.023 | 0.257 |
| w | 0.450*** | 0.105 | 4.265 | 0.001 | 0.503 |
| rer_1 | -0.643*** | 0.073 | -8.810 | 0.000 | 0.812 |
| rer_2 | -0.240*** | 0.054 | -4.449 | 0.000 | 0.524 |
| Tsd | 0.029*** | 0.007 | 4.148 | 0.001 | 0.489 |
| Tsd_1 | 0.012** | 0.005 | 2.290 | 0.034 | 0.226 |
| Tsd_2 | 0.016*** | 0.003 | 5.252 | 0.000 | 0.605 |
| Tsk | 0.070** | 0.031 | 2.250 | 0.037 | 0.220 |
| CSeason | 0.040 | 0.026 | 1.515 | 0.147 | 0.113 |
| CSeason_1 | 0.030 | 0.026 | 1.177 | 0.254 | 0.072 |
| CSeason_2 | 0.067** | 0.029 | 2.326 | 0.032 | 0.231 |

***Regression evaluation and tests***

$R^2 = 0.995$

WALD Test of Overall Significance $Chi^2(6) = 3130.7$ [0.0000] ***

The F Test of Overall Significance F(12, 18) = 248 [0.0000]***

DW = 2.05

Normality Test of Residuals $\chi^2(2) = 0.0092849$ [0.9954]

*Tests on the significance of each variable*

| variable | F(num,denom) | Value | Probability |
|---|---|---|---|
| *Constant* | F(1, 18) = | 38.256 | [0.0000] *** |
| *DC* | F(2, 18) = | 4.4713 | [0.0265] ** |
| *w* | F(1, 18) = | 18.188 | [0.0005] *** |
| *rer* | F(2, 18) = | 44.779 | [0.0000] *** |
| *Tsd* | F(3, 18) = | 14.293 | [0.0001] *** |
| *Tsk* | F(1, 18) = | 5.0635 | [0.0372] ** |
| *CSeason* | F(3, 18) = | 1.8298 | [0.1779] |

Even though of all monetary aggregates DC is the least closely correlated with wages, its correlation coefficient is still relatively high and equals 0.68. Therefore, there is a high risk that the estimates of the coefficients' standard errors will be distorted by the presence of multicollinearity. Considering this the author decided to run two additional regressions each including only one of the two correlated variables. **Table 5** and **Table 6** present the output of regressing inflation on the set of explanatory variables including money[38] and wages, respectively.[39]

[37] Number of stars beside a coefficient or a statistic indicates the level of significance: no stars - insignificant at up to 10% level, * - significant at 10%, ** - significant at 5% and *** - significant at 1%.

[38] M2 was preferred over credit because of its high correlation with inflation

*Table 5*

**Modeling Inflation by OLS (Model II)**

| Variable | Coefficient | Std.Error | t-value | t-prob | Partial $R^2$ |
|---|---|---|---|---|---|
| Constant | -0.055*** | 0.007 | -8.059 | 0.000 | 0.765 |
| M2_1 | 0.548*** | 0.054 | 10.106 | 0.000 | 0.836 |
| rer | -0.193*** | 0.065 | -2.968 | 0.008 | 0.306 |
| rer_1 | -0.575*** | 0.038 | -15.244 | 0.000 | 0.921 |
| rer_2 | 0.114** | 0.044 | 2.616 | 0.017 | 0.255 |
| Tsd | 0.046*** | 0.004 | 12.472 | 0.000 | 0.886 |
| Tsd_1 | 0.020*** | 0.003 | 7.146 | 0.000 | 0.719 |
| Tsk | 0.113*** | 0.025 | 4.495 | 0.000 | 0.503 |
| CSeason | 0.019 | 0.016 | 1.174 | 0.254 | 0.065 |
| CSeason_1 | 0.056*** | 0.017 | 3.247 | 0.004 | 0.345 |

***Regression evaluation and tests***

$R^2 = 0.996$

The F Test of Overall Significance F(10, 20) = 498 [0.0000]***

WALD Test of Overall Significance $Chi^2(5) = 4731.1$ [0.0000] ***

DW = 1.53

Normality Test for Residuals $\chi^2(2) =$ 0.45765 [0.7955]

*Tests on the significance of each variable*

| variable | F(num,denom) | Value | Probability |
|---|---|---|---|
| *Constant* | F(1, 20) = | 64.953 | [0.0000] *** |
| *M2* | F(1, 20) = | 102.13 | [0.0000] ** |
| *rer* | F(3, 20) = | 99.978 | [0.0000] *** |
| *Tsd* | F(2, 20) = | 77.890 | [0.0000] *** |
| *Tsk* | F(1, 20) = | 20.205 | [0.0002] *** |
| *CSeason* | F(3, 20) = | 3.7858 | [0.0267] ** |

[39] As in model I "General to Specific" procedure was used in regressions II and III to find appropriate specification.

*Table 6*

**Modeling Inflation by OLS (Model III)**

| Variable | Coefficient | Std.Error | t-value | t-prob | PartR$^2$ |
|---|---|---|---|---|---|
| Constant | -0.054*** | 0.009 | -5.988 | 0.000 | 0.678 |
| w | 0.431** | 0.104 | 4.149 | 0.001 | 0.503 |
| w_1 | 0.217* | 0.109 | 1.993 | 0.063 | 0.189 |
| w_2 | -0.162* | 0.083 | -1.949 | 0.068 | 0.183 |
| rer_1 | -0.425*** | 0.078 | -5.469 | 0.000 | 0.638 |
| rer_2 | -0.128** | 0.059 | -2.176 | 0.044 | 0.218 |
| Tsd | 0.031*** | 0.007 | 4.519 | 0.000 | 0.546 |
| Tsd_1 | 0.013* | 0.007 | 1.751 | 0.098 | 0.153 |
| Tsd_2 | 0.026** | 0.006 | 4.160 | 0.001 | 0.505 |
| Tsk | 0.081** | 0.031 | 2.642 | 0.017 | 0.291 |
| Tsk_1 | 0.058* | 0.031 | 1.889 | 0.076 | 0.174 |
| CSeason | 0.004 | 0.032 | 0.122 | 0.904 | 0.001 |
| CSeason_1 | 0.056* | 0.027 | 2.072 | 0.054 | 0.202 |
| CSeason_2 | 0.046 | 0.028 | 1.617 | 0.124 | 0.133 |

***Regression evaluation and diagnostic tests***

$R^2 = 0.995$

The F Test of Overall Significance F(13, 17) = 235 [0.0000]***

WALD Test of Overall Significance $Chi^2(5) = 2127.5$ [0.0000] ***

DW = 2.11

Normality Test for Residuals $\chi^2(2) = 2.8375$ [0.2420]

*Tests on the significance of each variable*

| variable | F(num,denom) | Value | Probability |
|---|---|---|---|
| *Constant* | F(1, 17) = | 35.861 | [0.0000] *** |
| *w* | F(3, 17) = | 7.9094 | [0.0016] *** |
| *rer* | F(2, 17) = | 18.243 | [0.0001] *** |
| *Tsd* | F(3, 17) = | 18.766 | [0.0000] *** |
| *Tsk* | F(2, 17) = | 5.2678 | [0.0166] ** |
| *CSeason* | F(3, 17) = | 2.2897 | [0.1151] |

Specification search in all three regressions (I, II and III) yielded statistically significant estimates in high explanatory power equations. Both F and Wald tests strongly confirm the overall significance of the postulated models. Tests performed yield the following description of the data and the regressions:

– The stability of the modeled relationships was tested by Chow tests. Values of the 1-step Chow statistics[40] were calculated for each regression beginning with the first observation for which the denominator degrees of freedom are positive. They were

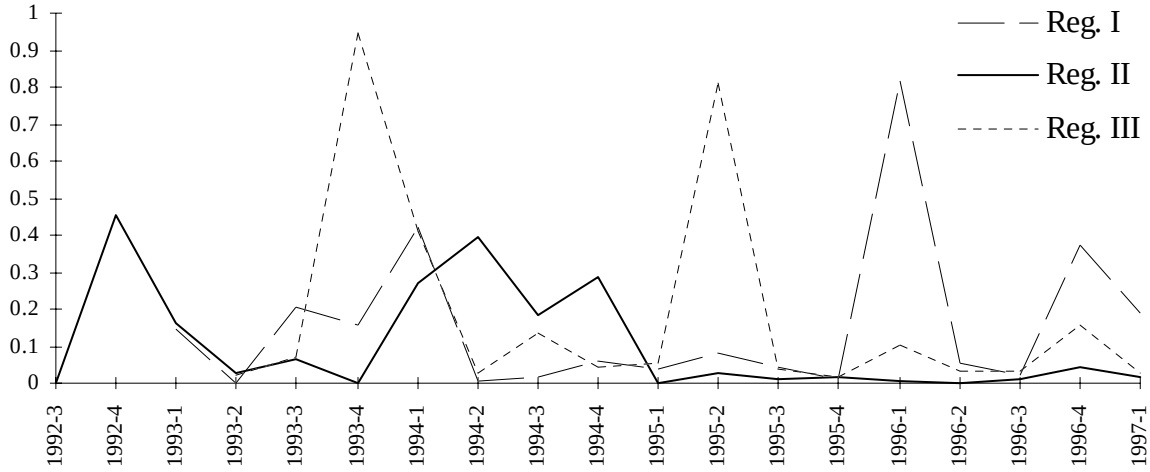
[40] 1-step Chow tests are performed by consecutively adding one observation at a time and calculating F statistic based on differences in residual sum of squares. Additionally a number of other various Chow tests were performed none of which indicated the danger of instability at the 5% significance level.

then scaled (divided) by their 5% critical values and graphed in **Figure 5**. The regressions are confirmed to be stable as the graph in the **Figure 5** contains no values greater than unity.

- Residuals were checked for normality by $\chi^2$ tests which reported no significant departures from normality in any case.
- Visual inspection of residual plots did not indicate the presence of heteroscedasticity. No formal tests for heteroscedasticity were available because of the scarcity of observations.
- Even though some seasonal coefficients in the above regressions turned out significant[41], on average, F-tests on the significance of explanatory variables did not confirm joint significance of seasonal factors in all but second regression.[42]

*Figure 5*

**1-Step Chow Test Values Scaled by the Critical Values**




To give a better idea of relative contributions of particular variables to inflation, **Table 7** presents inflation decomposition at the sample mean for three versions of the model. The decomposition was obtained by taking sample means of all regression variables (including inflation — in the first row of the table) and multiplying them by respective coefficients from regressions I, II and III.[43] Because equations were evaluated at sample mean, residuals by definition are equal to zero and inflation is decomposed into a set of factors whose contributions all add up to the value of inflation mean: 19.25%.

[41] *CSeason_2* in Reg. I, *CSeason_1* in Reg. II and *CSeason_1* in Reg. III have t-statistics significant at 5%, 1% and 10% significance level, respectively.

[42] However, seasonal variables were not removed from the regressions because of the general notion (and author's strong belief) that inflation in Poland is a highly seasonal phenomenon.

[43] Seasonals were omitted. All numbers in the table were additionally multiplied by 100%.

*Table 7*
**Inflation Decomposition at Sample Mean**

| | Regression I (table 4) | Regression II (table 5) | Regression III (table 6) |
|---|---|---|---|
| inflation | 19.25 = | 19.25 = | 19.25 = |
| Constant | -6.70 | -5.50 | -5.40 |
| DC | 1.25 | - | - |
| DC_2 | 3.76 | - | - |
| M2_1 | - | 9.89 | - |
| w | 7.80 | - | 7.47 |
| w_1 | - | - | 3.97 |
| w_2 | - | - | -2.90 |
| rer | - | -0.24 | - |
| rer_1 | -1.03 | -0.92 | -0.68 |
| rer_2 | -0.34 | 0.16 | -0.18 |
| Tsd | 5.49 | 8.71 | 5.87 |
| Tsd_1 | 2.31 | 3.85 | 2.50 |
| Tsd_2 | 3.20 | - | 5.20 |
| Tsk | 0.90 | 1.46 | 1.05 |
| Tsk_1 | - | - | 0.74 |

Because the models were estimated in a framework controlling for different shocks, it is possible to make statements about relative importance of factors fueling inflation. The main messages that emerge from the empirical analysis can be summarized as follows:

- **Wages appear to be the most significant source of inflationary pressures**. If both monetary (*DC*) and wage (*w*) variables are included in the analysis (model I) the wage elasticity of inflation reaches 0.45, whereas that of credit growth (combined contemporaneous and lagged) about 0.3. If only wages are considered (model III), the elasticity rises to about 0.49. [44]
- **Real exchange appreciation substantially lowers inflation**. All regressions reveal significant dampening effect of real exchange appreciation on inflation. Coefficients of *rer* have all very large t-statistics (in absolute value) and add up to extremely high elasticities ranging from -.0648 (model III) to -0.883 (model I).
- **Relative price variability exerts considerable upward pressure on inflation.** In all regressions relative price variability is confirmed to raise overall inflation. The fact that the analysis was carried out in the framework controlling for wage/monetary and real exchange shocks adds more credibility to the result as the detected correlation is econometrically proven to be an autonomous macroeconomic phenomenon significant even in the absence of exogenous shocks. [45] Coefficients of Theil standard deviation and skewness are significantly positive suggesting that

[44] The elasticity of *w_2* is negative suggesting some rebound effects of wage growth. The overall elasticity of 0.49 has been obtained by adding up the elasticities of *w, w_1* and *w_2*

[45] The correlation may however be enhanced by monetary shocks as suggested by Fischer (1982) and Coorey et al (1996)

increased relative price variability fuels inflation. The influence of higher dispersion of relative price changes (higher *Tsd*) seem to be persisting over time more than that of larger asymmetry (higher *Tsk*) which is reflected in the significance of both contemporaneous and lagged coefficients of *Tsd* as opposed to insignificance (with one exception) of lagged *Tsk* coefficients in the regressions. On the other hand, pooled elasticity of the variables seems to give more weight to skewness than to variance: skewness has the elasticity of 7%, 11.3 % and 13.9% whereas variance — 5.7%, 6.6% and 7% in the first, second and third model respectively.

The significance of skewness and variance variables in the equation explaining inflation has serious implications. It means that, other things equal, any measures taken to reduce the volatility and disproportionality of individual inflation rates of various CPI components can depress overall inflation in the short run. Of course, policy makers have a limited control over a majority of factors that determine the shape of the distributions of relative price changes. Most of the shifts result from seasonal supply shocks (food) and the volatility of world prices which Poland as a typical small economy takes as given.[46] However, in Poland still there is a substantial niche of the economy in which the government reserves itself the right to influence pricing policy in a number of ways. Administered price increases set price levels of most Polish utilities, drugs or vodka.[47] Putting aside the issues of political feasibility which will be taken up later on, it is the government that decides on the frequency and pace of those increases. In terms of the analysis presented above this means that the policy makers can influence the shape of the distribution of individual price changes to some extent by choosing the path of administered price adjustments. It is obvious that the policy of big and rare, one-time increases will magnify both skewness and variance of the distribution whereas the pattern of gradual and continuos adjustments will result in smaller values of these statistics. Therefore, big, outlier price hikes that make the distribution of relative price changes wide and heavily skewed and cause dramatic relative price shifts to take place rapidly do not facilitate fighting inflation. Rather, the main policy related recommendation emerging from this section is that the gradual pattern of administered price adjustment that favors frequent and moderate increases is preferred as it does not introduce excess distortions to the economy.

# 6. CUMULATIVE RELATIVE PRICE CHANGES

The econometric analysis performed in section 5 gives some indication of the magnitude of the relative price movements on inflation in the short run. It does not however give any insights into the factors behind those movements. This section examines more closely the sources of relative price variability as well as provides a more disaggregated analysis of relative price shifts.

[46] In practice, most governments exercise some sort of policy aiming to „smooth out" seasonal volatility of prices of numerous agricultural products.

[47] The issue will taken up in more detail in Section 6 and 7

Estimating the relative price variability on the basis of differences in individual inflation rates of groups of commodities comprising the price index need not indicate whether any actual relative price shifts take place in the economy. It is possible that even during periods of persisting high relative price variability, relative prices measured at the end of the sample period did not change and the variability as detected by variance and skewness resulted from different paths of catching up with inflation among sectors. Therefore it is necessary to examine relative price changes on a cumulative basis. In the case of transition economies there is little doubt that high relative price variability was indeed accompanied by significant permanent relative price changes. A number of shocks that those economies were subjected to triggered higher price variability to produce a new price structure with price relations closer to those of market economies. While the market reforms implemented in the early stages of transition and their openness to international trade ensure that most absolute as well as relative prices gradually adjust and converge towards world levels, pricing of a certain number of goods and services still remains in the hand of the governments. Magnitude, pace and frequency of adjustments in these prices have all been the subjects of fierce debates as economically optimal outcomes have to be reconciled with political feasibility.

Citrin and Lahiri [1995] argue that these administered price increases have been the main factors fueling inflation in the FSU countries. While this may be true for Poland as well, it is important to look at those increases on a cumulative basis. Administered increases can only be considered a fundamental determinant of inflation if their purpose is to establish new and higher relative prices of controlled goods. Pujol and Griffiths [1996] employ simple regression technique to show that in Poland there has been strong correlation between a long lasting improvement in a particular sector's relative price and the number of times its price increases were distribution outliers.[48] In other words, exceptionally high price increases in some sectors may not just be the infrequent way of catching up with inflation[49] but should rather be considered an ongoing process of establishing a new higher relative price.

To give more insight into the outlier price increases, **Table 8** presents all CPI categories of products or services whose price rose more than 3 standard deviations of the unweighted distribution of price changes for a particular quarter.

[48] Pujol [1996] regresses the change in a sector's relative price between Dec-89 and Jun-95 ($\Delta$RCPI) on the number of times that sector registered an outlier price increase (NSK) and obtains statistically significant coefficients in an equation with a rather low explanatory power: $\Delta RCPI_i = 0.211\ NSK_i + 0.94$, $R^2 = 0.39$. The author uses this result to support the hypothesis that skewed relative price changes are causing Polish inflation.

[49] The low frequency of price adjustments may also suggest an attempt to avoid menu costs.

*Table 8*

**Outlier Price Increases**

| quarter | Outlier Price Changes | 3*Std. deviation |
|---|---|---|
| 89Q1 | drugs 413 % | 1.56% |
| 89Q2 | transport fuels & lubricants 64%; vegetables 54%; furniture 54%; rents 46%; edible fats 46%; tea and coffee 45%; fish products 43% | 42% |
| 89Q3 | meat 660%; meat products I 567%; butter 429%; meat products II 429% | 378% |
| 89Q4 | sugar 329%; vehicles 256%; bread 232%; grains, cereals & their products 221%; publications 196%; confectionery & honey products 189%; furniture 181%; vehicle maintenance & repairs 173% | 166% |
| 90Q1 | drugs 452%; furnace fuels 405%; c/heating & hot water supply 398%; electricity 369%; gas 338%; detergents 333% | 295% |
| 90Q2 | postal and telecom services 71%; fruits 64%; toys 54%; national transport 54% | 53% |
| 90Q3 | c/heating & hot water supply 100%; electricity 79%; gas 58% | 56% |
| 90Q4 | butter 103%; vegetables 90%; eggs 77% | 60% |
| 91Q1 | c/heating & hot water supply 100%; gas 78%; vegetables 66%; postal & telecom services 64%; rents 60%; furnace fuels 59% | 59% |
| 91Q2 | gas 163%; electricity 129% | 85% |
| 91Q3 | postal and telecom services 82%; c/heating & hot water supply 61% | 51% |
| 91Q4 | vegetables 50%; eggs 50%; butter 36%; fruits 33% | 31% |
| 92Q1 | c/heating & hot water supply 100%; gas 70% | 48% |
| 92Q2 | rents 38%; drugs 29% | 22% |
| 92Q3 | eggs 49%; sugar 44%; cookies and pastries 38%; bread 33% | 31% |
| 92Q4 | vegetables 39%; fruits 27%; furnace fuels 26%; national transport 24% | 20% |
| 93Q1 | vegetables 38%; c/heating & hot water supply 26%; local transport 18% | 17% |
| 93Q2 | national transport 25%; fruits 25% | 17% |
| 93Q3 | eggs 55% | 33% |
| 93Q4 | edible fats 63%; eggs 56%; fruits 51%; vegetables 44% | 36% |
| 94Q1 | other food products 38 % | 21% |
| 94Q2 | fruits 49% | 22% |
| 94Q3 | tea and coffee 47% | 31% |
| 94Q4 | fish 86% | 34% |
| 95Q1 | rents 30%; vegetables 22%; fruits 22% | 20% |
| 95Q2 | vegetables 15%; fruits 15%; tobacco 15%; cheeses 13% | 12% |
| 95Q4 | fruits 31%; vegetables 31%; eggs 27% | 17% |
| 96Q1 | fruits 20%; vegetables 20%; bread 16%; gas 13%; culture & arts 13% | 13% |
| 96Q2 | tobacco 16%; bread 16% | 14% |
| 96Q4 | fruits 42%; vegetables 20% | 17% |
| 97Q1 | electricity 17%; rents 13%; vegetables 13%; culture & arts 12%; gas 12% | 11% |

Source: author's calculations using GUS data

The most striking pattern that emerges from the table is that of high seasonality. With the exception of 1989 and 1990 when most prices have undergone significant adjustments, on average first quarters seem to be highly dominated by increases of

controlled prices such as energy, gas or water supply. Sometimes these administered increases are extended into the second quarter as well (1991 and 1992). Seasonal foods increases account for biggest hikes in the fourth and second quarter as the reduced supply of fruits and vegetables combined with protectionist food market policies drive prices up. Third quarter emerges as the period with relatively small price increases with no clear pattern (with the exception of eggs) and no increases exceeding 3 standard deviation in both 1995 and 1996.[50] This is certainly the result of food price decreases brought about by positive seasonal supply shocks.

Big price increases need not cause significant shift in a sector's relative price if unless they are regular and frequent. Establishing higher relative prices requires continuos increases well in excess of inflation rates. To trace those continuos relative price shifts the author calculated the relative price index $RP_i$ for all individual CPI categories throughout the sample period.[51] It is defined as follows:

$$RP_t^i = \frac{P_t^i}{CPI_t} \quad \text{for } i = 1,\ldots,65 \quad \text{and t = 0 (88Q4), } \ldots, \text{ 33 (91Q1)}$$

$$\sum_{i=1}^{65} w_t^i = 1 \text{ for all t, where } w_t^i - CPI \text{ weights}$$

In the calculations I set t = 0 (88Q4) to be my basis period so that:

$$P_0^i = CPI_0 = RP_0^i = 1$$

Therefore, the initial relative price for all goods at the end of 1988 is 1. If in any sample period RP of a good drops below 1 this means that the upward adjustments in its nominal price have fallen short of overall inflation and that the relative price of this good has deteriorated. By contrast, RP bigger than 1 indicates relative improvement in the product's price.[52] Values of RP were calculated for each quarter in the sample using the formula above. For the purpose of graphical presentation RPs were sorted in descending order and middle 51 categories are skipped. **Figure 6** presents values of RP at the end of the first quarter of all sample years with the exception of 1989 for which the time distance from basis period is too short. The graph bars represent five highest downward and upward relative price shifts (five top and bottom bars, respectively) in relation to the price structure of end 1988. Dotted vertical line shows aggregate CPI whose relative price is always equal to 1 by definition.

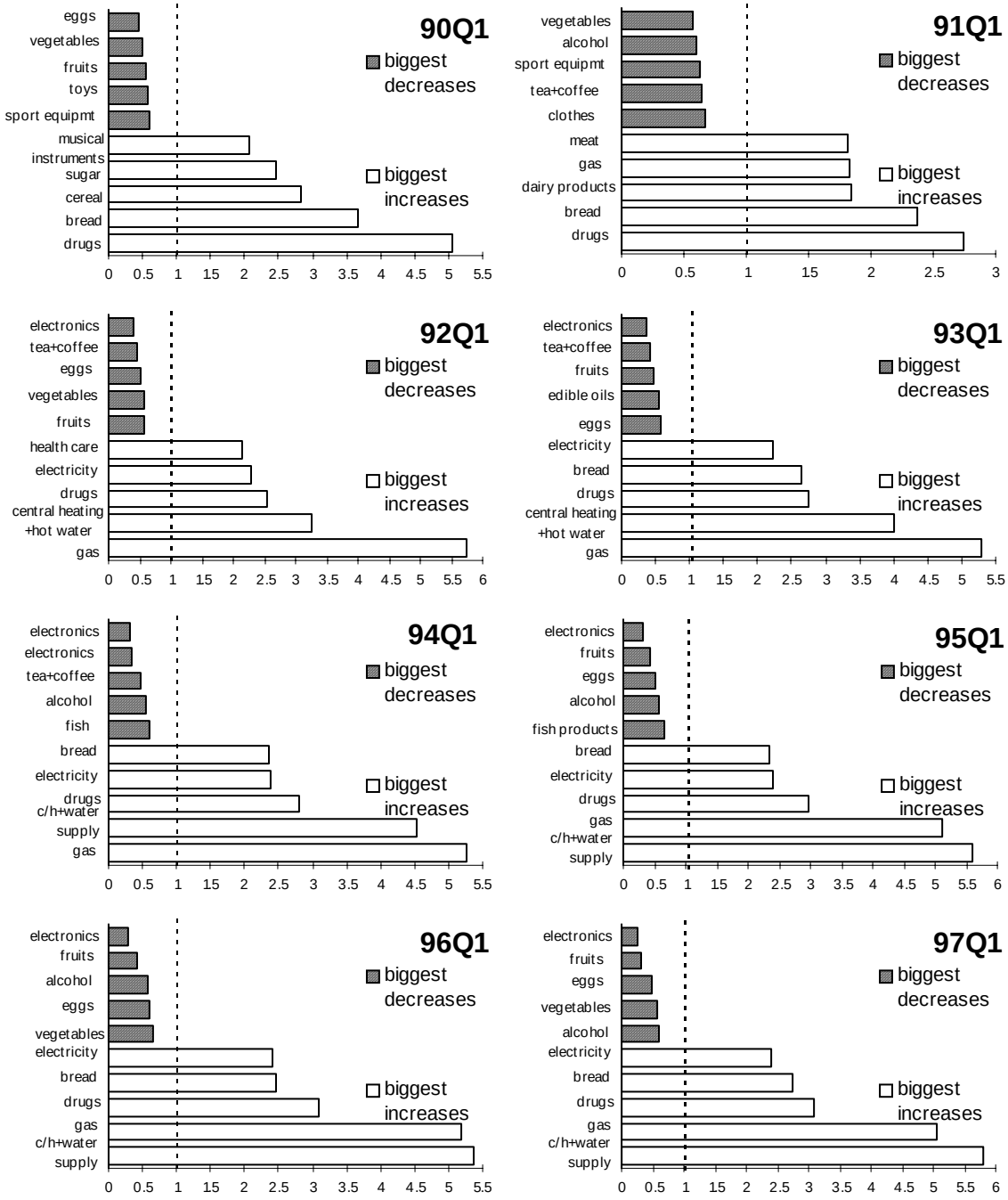
[50] This finding can be linked to negative skewness of third quarters for 1995 and 1996 as well as for most other years (see **Table2**)

[51] Since the number of categories differs across years due to data availability, the categories for which the data coverage was incomplete throughout the sample had to be dropped, leaving the total number at 61 for the entire sample period.

[52] All the statements about price changes are relative to the basis period i.e. to the end of 1988.

*Figure 6*

**Extreme Relative Price Changes (Basis Period — end 1988)**

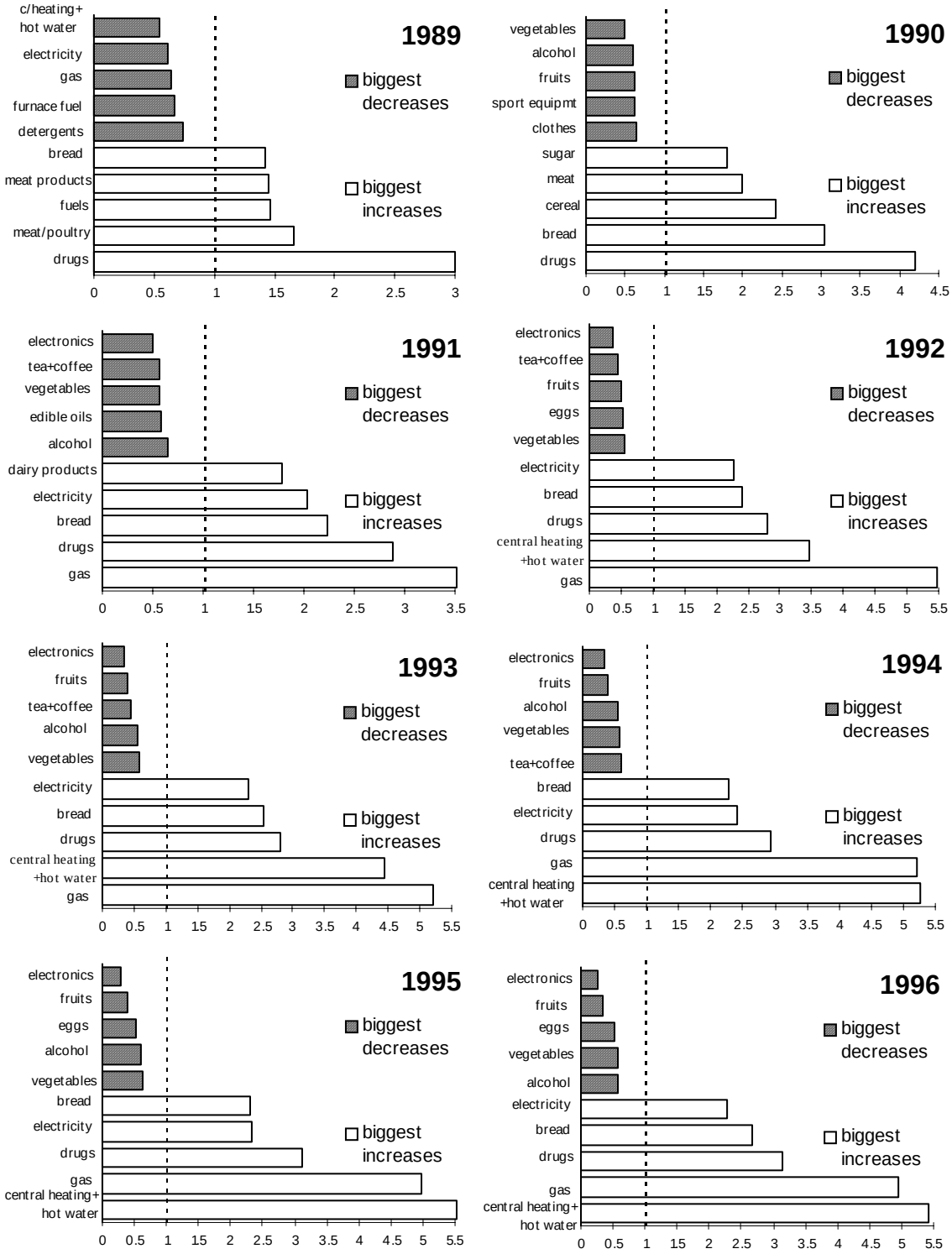



Source: author's calculations using GUS data

Comparing relative prices of goods at the end of the particular quarter for consecutive years can be very informative in terms of providing insight into systematic shifts taking place within equal (annual) time intervals. However, it also suffers a great deal from high seasonality of the data making it impossible to discriminate against permanent price shifts that take place due to continuos permanent changes and temporary ones resulting from seasonality. Therefore, an alternative way of capturing relative price shifts had to be developed. In order to get rid of seasonality the value of the RP index was averaged over four quarters for each full sample year (1989-1996)

for all categories. While resulting annual averages do not provide the same systematic information on RP changes based on same-frequency observations, they are free from seasonal supply distortions and reflect actual ongoing changes in relative price structure. **Figure 7** presents extreme average values of RP for the period 1989-1996.

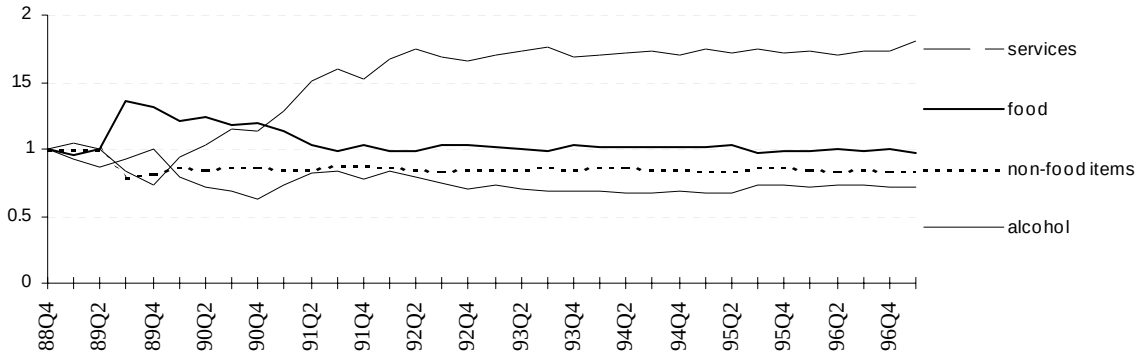
*Figure 7*
**Extreme Relative Price Changes (Basis Period — end 88)**



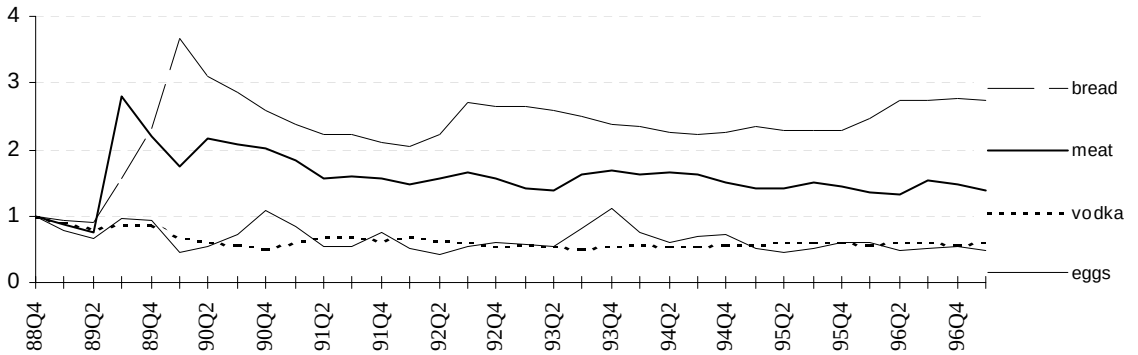

Source: author's calculations using GUS data

*Figure 8*
**Cumulative Relative Price Changes**

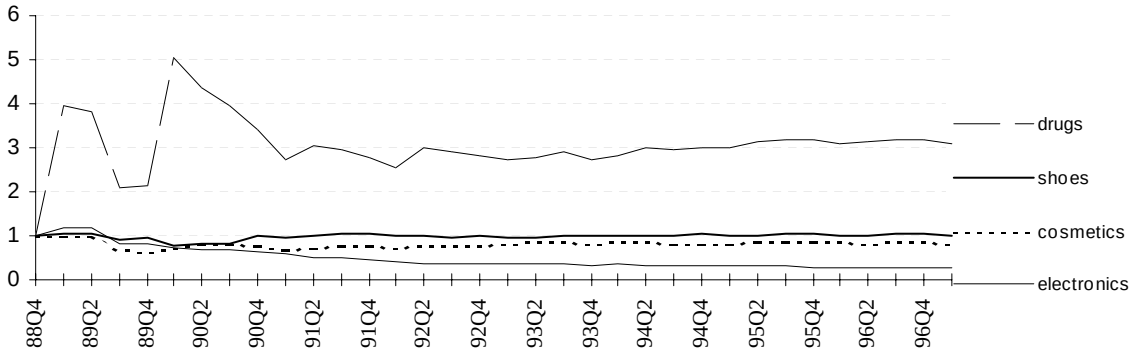
A: MAIN CATEGORIES



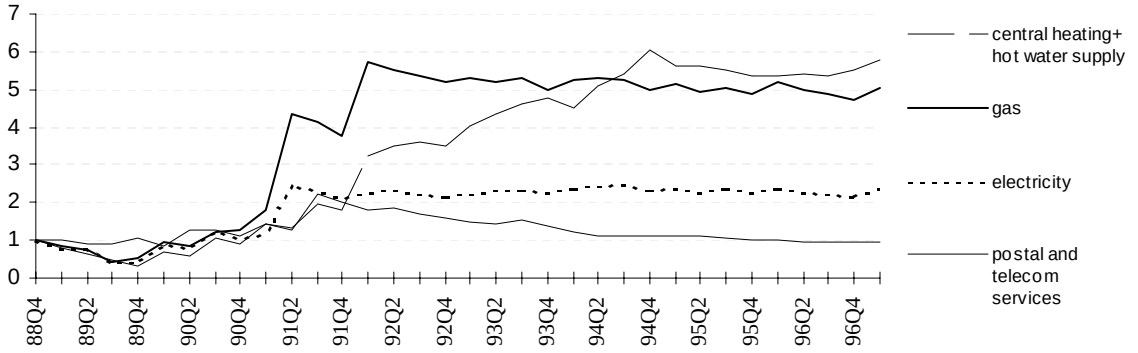

B: SELECTED FOODSTUFFS




C: SELECTED NON-FOOD ITEMS




D: SELECTED SERVICES




Source: author's calculations using GUS data

To give a better idea of the path of relative price changes over time, **Figure 8** presents cumulative relative price changes (as indicated by RP values) for main CPI categories as well as selected items from these categories.

The main messages from **Fig. 6 - 8** can be summarized as follows:

**The biggest relative price shifts took place between 1989-1991.**

As **Fig. 6** and **Fig. 7** suggest after 1991 no significant changes in the top and bottom relative price shifts occurred. Graphs confirm the notion that following the period of profound changes prior to 1992, most prices have stabilized and the process of adjustments that is still going on in some cases[53] is by far less abrupt than in the initial stages of transition.

**Increases in the prices of utilities have undoubtedly led the inflationary process.**

Out of 5 biggest relative price increases, 3 took place in the sector of utilities. Prices of utilities rose by as much as 5 (gas) to 5.4 (central heating and water supply) times more than the CPI index. Pricing of most utilities are up till now controlled by the government which sets the pace of upward adjustments. (The issue of controlled prices will be taken up in more detail in the next section.)

**Relative prices of staple foods have risen significantly.**

Prices of bread and dairy products (see **Table 9** below) have outpaced inflation more than twice. This substantial relative price increase may be partially due to extraordinarily low prices of these foods before 1989 reflecting high subsidies which were part of the government's social safety net at that time.

**Commodities from the category *electronics* experienced by far the largest and most permanent decline[54] in its relative price.**

This certainly reflected a strong positive supply shock as the market with relatively scarce supply of electronics before 1989, got suddenly saturated with a large number of suppliers following market reforms in 1990.

It should be clear by now that administered price increases have indeed dominated the inflation performance in Poland during 1989-1997. To shed more light on the magnitude of that influence **Table 9** presents names of 15 sectors that managed to raise their prices the most along with their RP averaged over four quarters of 1996. The table additionally presents three sectors subject to government price controls which registered RP changes below 15 top increases. Sectors whose prices are strictly set by the government have been typed bold. Sectors that have been underlined are partly controlled by the government. This can take the form of:

- controlling a small number of items within the sector comprised of numerous categories (like *TV and radio subscription fee* in the sector: *culture and arts* and *fuels* or *railway tickets* in *national transport*),
- influencing the pricing policy at the industry level (like *coal* in the sector: *furnace*),

[53] Slow gradual upward adjustments continue in the case of for example: *central heating and hot water supply*.

[54] The relative price of the category *electronics* continues to decline systematically and reached the lowest value of RP=0.25 at the end of 97Q1

– setting the prices (or approving the planned price increases) by the local government *(non-private local transport*).

*Table 9*

**15 Biggest Relative Price Increases 1989-1996**

(controlled prices — underlined, administrative prices — bold)

| # | sector | $RP^{i}_{1996}$ | # | sector | $RP^{i}_{1996}$ |
|---|---|---|---|---|---|
| **1** | **central heating and hot water supply** | **5.419** | **11** | **rents** | **1.709** |
| **2** | **gas** | **4.939** | 12 | hairdresser's and cosmetic care | 1.651 |
| **3** | **drugs** | **3.151** | 13 | publications | 1.556 |
| 4 | bread | 2.68 | 14 | furnace fuels | 1.545 |
| **5** | **electricity** | **2.274** | 15 | grains, cereals and their products | 1.527 |
| 6 | local transport | 2.18 | | — | |
| 7 | health | 2.067 | 26 | culture and arts | 1.152 |
| 8 | dairy products | 2.036 | **38** | **postal and telecom services** | **0.969** |
| 9 | dry-cleaning, dyeing and other | 1.793 | **55** | **vodka** | **0.587** |
| 10 | national transport | 1.785 | | | |

Source: author's calculations using GUS data

As **Table 9** suggests, there are 12 sectors in the economy in which the government reserves the right of either strict price setting (bold) or influencing prices in some parts of the sector leaving others be determined by market clearing (underlined). Of the total of 12 such sectors, 9 are listed in the table (i.e. are among 15 sectors with highest increases) and all but three have experienced relative price increase. The average (unweighted) relative price of all government controlled goods increased more than twofold since 1989 or almost threefold when only direct price setting items (in bold) are considered. The same figure for all other goods with free prices equals 1.034 suggesting that on average, market-determined prices were rising at the pace of overall price level.

# 7. ADMINISTERED PRICE INCREASES: CUKIERMAN-LEIDERMAN MODEL

Having acknowledged the special role of administered price increases in the process of establishing the new relative price structure, I now turn to the final topic of this paper which links those increases to the overall relative price variability.

Even though the evidence clearly points to utility prices as the ones that outpaced inflation the most, it is remarkable that after a dramatic upward shift that occurred during 1989-1992, their relative prices remained fairly stable afterwards. This suggests that the process of adjustments came to a halt in 1992 and administered increases just make up for inflation since then. However, as Pujol and Griffiths (1996) point out, the

process is still very far from being complete and there is a strong need to continue the adjustments. The authors calculate their own relative cost of living index comparing prices of the same consumption basket in a couple of Eastern European countries including Poland and Austria. The results are striking : the overall index for Poland in percent of the Austrian index equals 60.4%, the food index — 67.3% and the index for utilities — just 22.6%![55] While the calculations were made using data from March 1994, the size of undervaluation of utilities as compared to other CPI categories should not differ significantly as the relative prices of Polish utilities have hardly risen since 1994 (see **Fig. 6** and **Fig. 7**). Pujol and Griffiths also calculate the coefficient of variation that captures the extent to which individual ratios of commodity prices in both countries deviate from the overall index. The relatively high value of that coefficient for Poland suggests that undervaluation varies enormously for different goods. In particular, authors note that much of this variation comes from relatively high undervaluation of utilities. They conclude that while the low value of the overall cost-of-living index points to significant undervaluation of the Polish currency, the desired appreciation[56] will not eliminate the existing disparities within the index. Therefore, it is important to continue corrective adjustments of prices of utilities (which seem to be most undervalued) to bring the relative price structure closer to world levels. Upward adjustments in these prices are also important if the sectors are to be provided with full cost recovery as well as funds for necessary investments. Finally, bringing these prices up to the real levels would induce their proper economical use and discourage overconsumption.

The need for further adjustments entails the question of the optimal path of the process. Putting aside the implications of such adjustments in the sphere of political economy, what is the least distorting way of establishing higher relative prices? Is the big-bang approach of large one-time increases more desirable than continuos gradual adjustments that take longer to achieve the same effect? The results of the model estimated in Section 5 suggested that gradual adjustment is clearly preferred on the grounds that it does not contribute to wide and skewed relative price distributions which were proven to raise aggregate inflation. Cukierman and Leiderman's paper "Price Controls and the Variability of Relative Prices"[57] sheds some light on the same policy dilemma. Authors observe that most literature on relative price variability has implicitly assumed that prices are determined by market clearing in all markets. However, this is a serious oversimplification in the case of many economies where the government is involved in setting the prices of a certain number of goods.[58]

In their analysis, Cukierman and Leiderman consider an economy composed of two sectors: a market sector where prices are determined by demand and supply and a controlled sector where prices are set by the government. They lump all the goods of the latter sector into one composite aggregate "controlled good" whose price is

[55] The utilities index equals 73.6 % in Slovenia, 35% in Hungary, 29.6% in the Czech Rep. and 10.9% in Slovakia

[56] Real appreciation has indeed been taking place systematically during the entire period 1989-1997, in particular since 1994 (Pujol and Griffiths' data) up to date

[57] Cukierman A. and L. Leiderman (1984)

[58] Authors focus on the Israeli economy which had a sizable controlled sector in 1984 and perform empirical analysis using Israel data.

determined administratively. The model is developed by equating supply and demand in the free sector, adding the market for controlled goods and the money market. The rate of change of nominal money stock $x_t$ is assumed to obey:

$$\Delta x_t = x_t - x_{t-1} = E_{t-1}\Delta x_t + \varepsilon_t = \delta_t + \varepsilon_t$$

where $\delta_t = E_{t-1}\Delta x_t$ is a perfectly predictable (on the basis of all information up to t-1) part of the money supply increase and $\varepsilon_t$ is the random normally distributed innovation unknown in period t.

The main findings of the model are captured in the following equation[59] :

$$p_t(v) - Q_{ft} = ((x_{t-1} + \delta_t - p_t(c)) + \beta\varepsilon_t + \rho w_t(v),$$

where $p_t(v)$ — price of the good in market v (free market), $Q_{ft}$ — price level within the group of free goods, $p_t(c)$ — price of the "controlled good", $w_t$ — relative excess demand shock in market v; $w_t(v)$ ($w_t^d(v) - w_t^s(v)$ and is normally distributed over time and across markets.

$\alpha$, $\beta$, $\rho$ — positive coefficients constant over time and involving values of demand and supply elasticities

The equation implies that in addition to factors traditionally assumed to have positive influence on relative price variability like demand shocks ($w_t$) and unexpected movements in the money stock ($\varepsilon_t$), price dispersion in the free market is also affected by the term $(x_{t-1} + \delta_t - p_t(c))$. This term reflects the lack of synchronization between the certain component of money growth ($x_{t-1} + \delta_t$) and the level of controlled prices as set by the authorities. In other words, if the increase of the price level of the "controlled good" does not go in line with the expected money increase (i.e. the term is different from 0), relative prices **within the sector of free goods** are likely to be affected.[60] Depending on the sum of demand and supply elasticities for a particular market, the disparity will either increase or decrease the relative price in that market.[61] However, for the economy as a whole, greater gap between $\delta_t$ and $\Delta p_t(c)$ means greater relative price variability among free goods and thus greater overall relative price variability.

Cukierman and Leiderman's analysis has serious implications for the optimal path of administered price increases. The theory presented in section 3 as well as its empirical support in sections 4 and 5 clearly suggest the positive impact that relative price variability has on overall inflation. Therefore, **efforts to minimize relative price**

[59] The equation has been slightly simplified compared to that appearing in the paper. For the full expression see Cukierman and Leiderman (1984) p. 276

[60] It is obvious that a change in the price of the controlled good will increase the overall relative price varaibility by changing the ratios of controlled to free prices. The novelty of Cukierman and Leiderman's finding is that the change in the price of the controlled good will independently increase the relative price variability within the sector of free goods.

[61] The coefficient (involves values of demand and supply elasticities which determine the sign of $\alpha$.

**variability should be considered an important part of anti-inflationary policy**. As shown by the authors the variability of free prices can be substantially increased if the administered price increases diverge from the money growth path. By contrast, if the pace of those increases resembles that of money expansion, the resulting relative price variability in the free goods sector is minimized.

The main message from Cukierman and Leiderman's paper may not be directly applicable in Poland. Using the paper's main finding as a policy recommendation would amount to increasing administered prices at the pace of general inflation and hence preserving existing undervaluation in a number of sectors[62]. This is clearly not an option considering that relative prices of utilities and other undervalued commodities have to be substantially increased. However, the theory also predicts that any reduction of the gap between the pace of adjustment and money growth will decrease the magnitude of the impact. Therefore, if the government wants to take measures to curb inflation while at the same time making necessary administered increases it should adopt a rather gradual approach. Frequent increases slightly above the inflation rate are recommended in the light of the analysis as they are not causing the relative price variability to increase by as much as would be the case with occasional big changes.

This pace of price adjustments may not be, however, optimal for policy makers. The same issue analyzed in the context of political economy yields a different outcome: from the point of view of the government it might be better to avoid frequent price increases. Any decision to raise prices is likely to be costly for the authorities in terms of the loss of popularity and the cost is clearly minimized by lowering the frequency of adjustments. These political costs may be thought of as an important part of menu costs introduced earlier in the paper. Just like standard menu costs, they make (administered) prices more sticky in that they discourage the government from making frequent inflation-driven adjustments. Keeping in mind that all governments whether populist or not are subject to those same constraints, it may turn out that the economically rational option of small repeated adjustments is not politically feasible. Therefore, with only limited frequency of administered increases available, the revised policy recommendation could suggest bigger adjustments because only they can ensure that necessary relative price realignments take place. In other words, when political economy rules out the feasibility of regularly repeated increases, sizable adjustments might be preferred to small ones.

[62] Assumption is being made that money growth translates fairly accurately into inflation.

# 8. SUMMARY AND CONCLUSIONS

This paper has been designed as an attempt to estimate the magnitude of the influence of relative price shifts on the overall price level in Poland during the transition period 1989-1997. For that purpose, the theoretical model has been found that builds on menu costs and trend inflation to derive a positive relationship between variance and skewness of the distribution of relative price changes and the general inflation. The model allowed to estimate the effect of relative price shifts within the framework controlling for nominal and real shocks. Using Polish data, a set of three versions of the model were estimated. All of them yielded high explanatory power and statistically significant coefficients on most variance and skewness variables thus giving a strong empirical support to the theoretical relationship. Larger shifts in relative prices accompanying the adjustment process and detected by higher variance in the equation were proven to exert substantial upward pressure on inflation that persists over time. On the other hand, high positive skewness reflecting the domination of the adjustment process by few large increases was confirmed to produce contemporaneous upward impulse that tends to wear off after one quarter but is stronger in magnitude than that coming from higher variance. Including other explanatory variables like real exchange rate, wages and/or money allowed for observing the relative importance of inflationary factors. The analysis revealed that money and wages remain to be the main factors fueling inflation and can jointly account for almost three quarters of quarterly inflation. If their impact is evaluated separately, wages contribute about one half of inflation and domestic credit almost one third. On the other hand, real exchange rate appreciation was confirmed to significantly lower inflation. The measure based on different paces of inflation between tradables and non-tradables has proven to be a substantial dampening factor with an average elasticity of about minus three quarters.

Additionally, a closer look has been cast at the distributions of individual inflation rates of CPI components. High variance and positive skewness have been the typical features of these distributions. This suggests that some profound relative price shifts were taking place (variance) and that a small number of large price increases have led the inflationary process (skewness). Individual inflation rates have also been looked at on a cumulative basis. This analysis revealed that prices in the sector of controlled utilities have experienced the highest relative increases with some services (central heating and hot water supply, gas) outpacing the aggregate inflation 5 times and more. In general, sectors controlled by the government have registered biggest relative price increases: 8 of them are among 15 sectors with top relative price increases and their average relative price in 1996 has more than doubled since the end of 1988.

It is remarkable, however, that on average most of those dramatic relative price shifts occurred during initial years of reform: 1989-1991. Since 1992 relative prices for most goods controlled by the government have remained fairly stable. This suggests that the process of upward adjustments was seriously slowed down or even stopped in recent years and administered price increases just make up for inflation.

Even though the data clearly show that significant increases in some relative prices have indeed taken place, the adjustment process should not be considered complete. As evidenced in the literature, prices in most of the sectors controlled by the government are still substantially undervalued and need further upward adjustments if Polish economy is to successfully integrate with the world economy. According to the Cukierman-Leiderman's model presented in the paper, the optimal path of controlled price increases is the one that follows money expansion. The overall relative price variability induced by those administered increases will then be minimized which according to the paper's earlier findings can contribute to lower overall inflation. Therefore, the main policy recommendation for conducting anti-inflationary policy should be frequent increases slightly in excess of overall inflation so that upward adjustments can take place without inducing large price variability. However, when one considers the same issue in the context of political economy, this recommendation may not turn out optimal for policy makers. Less frequent adjustments are clearly more preferred by the government who has to bear the brunt of its unpopular decisions. Therefore, when frequent adjustments are not feasible, sizable increases have to be recommended as they ensure that the existing undervaluation of numerous services will diminish more quickly.

# References

Ball, L. and N. G. Mankiw, *Asymmetric Price Adjustment and Economic Fluctuations,* Economic Journal, Vol. 104 (March 1994 No.), 423, pp.247-261

Ball, L. and N. G. Mankiw, *Relative Price Changes as Aggregate Supply Shocks,* The Quarterly Journal of Economics, Vol CX, Issue 1

Blejer, Mario I. *On the Anatomy of Inflation. The Variability of Relative Commodity Prices in Argentina,* Journal of Money, Credit and Banking Vol. 15 No 4, 1983, pp. 470-482

Blinder, A. (1982). *Inventories and Sticky Prices: More on the Microfoundations of Macroeconomics,* American Economic Review, Vol. 72 No. 3 pp. 334-348

Bordo, M.D. *The Effects of Monetary Change on Relative Commodity Prices and the Role of Long-Term Contracts,* Journal of Political Economy, 88, pp.1088-1109

Citrin, D.A. and A.K. Lahiri *Policy Experiences and Issues in the Baltics, Russia and Other Countries of the Former Soviet Union,* IMF Occasional Paper No. 133, (Washington, International Monetary Fund December 1995)

Coorey, S., Mauro Mecagni, and Erik Offerdal, *Disinflation in Transition Economies: The Role of Relative Price Adjustment,* WP/96/138, (Washington: International Monetary Fund, December 1996)

Coorey, S., Mauro Mecagni, and Erik Offerdal, *Disinflation in Transition Economies: The Implications of Relative P.rice Adjustment,* PPAA/97/1, (Washington: International Monetary Fund, February, 1997)

Cukierman, Alex *Relative Price Variability and Inflation: A Survey and Further Results,* Carnegie-Rochester Conference Series on Public Policy, 19 (1983), pp. 103-158

Cukierman, A. and L. Leiderman (1982) *Price Controls and the Variability of Relative Prices* Journal of Money, Credit and Banking, Vol.16, No. 3 (August 1984)

___, *The Relationship between Relative Prices and the General Price Level: A Suggested Interpretation,* The American Economic Review, Vol. 69 (June 1979), No. 3, pp. 443-447

___, *Relative Price Variability and Inflation in the Israeli Economy,* Bank of Israel Economic Review, 59 (1987), pp. 47-63

Domberger, Simon *Relative Price Variability and Inflation: A Disaggregated Analysis,* Journal of Political Economy95:3 (1987), pp. 547-566

Fischer S. (1981) *Relative Shocks, Relative Price Variability, and Inflation* Brookings Papers on Economic Activity No. 2, pp.381-441

Fischer S. *Relative Price Variability and Inflation in the United States and Germany* European Economic Review 18 (1982)

Friedman M. (1975) *Perspectives on Inflation* Newsweek, June 24, p. 73

Glejser, H. *Inflation, Productivity and Relative Prices - A Statistical Study,* Review of Economics and Statistics, 47 (1965), pp. 761-780

Greenspan A. (1974) *A general view of Inflation in the United States* in *Inflation in the United States: Causes and Consequences,* Proceedings from the Conference Board Economic Forum, New York, May 21, 1974

GUS - G³ówny Urz¹d Statystyczny (Polish Main Statistical Office), *Monthly Statistical Bulletins* and *Bulletins on Monthly Price Changes,* various issues 1989-1997

Hercovitz, A. *Money and the Dispersion of Relative Prices,* Journal of Political Economy 89 (1981), pp. 328-356

____, *Money and the Dispersion of Relative Prices in the United States,* Journal of Monetary Economics 10 (1982), pp. 25-38

Lach, Saul, and Daniel Tsiddon, *The Behavior of Prices and Inflation: An Empirical Analysis of Disaggregated Price Data,* Journal of Political Economy 100:2 (1992), pp. 349-389

Lucas R. (1973) *Some International Evidence on Output-Inflation Trade-offs* American Economic Review Vol. 63 No. 3

NBP - Narodowy Bank Polski (National Bank of Poland), *Monthly Bulletins,* various issues 1989-1997

Marquez, J. And D. Vining, *Inflationand Relative Price Behavior: A Survey of the Literature,* Economic Perspectives, edited by Maurice B. Ballabon Vol.3 (Harwood Academic Publishers: New York, 1984)

Mussa M., *The Welfare Cost of Inflation and the Role of Money as a Unit of Account,* Journal of Monay, Credit and Banking 1977: 9, pp. 276-286

Parks, W. Richard, *Inflation and Relative Price Variability,* Journal of Political Economy, 1978, vol.86, No 1, pp. 79-95

Parsley, David C. *Inflation and Relative Price Variability in the Short and Long Run: New Evidence from the United States,* Journal of Money, Credit, and Banking, Vol. 28, No. 3 (August 1996, Part I), pp.323-342

Pujol, T., and M. Griffiths, *Moderate Inflation in Poland: A Real Story* IMF Working Paper, WP/96/57 (Washington: International Monetary Fund, June 1996)

Romer David (1996) *Advanced Macroeconomics* (New York: The McGraw-Hill Companies), 1996

Sheshinski, E., and Y. Weiss, *Inflation and Costs of Price Adjustment,* Review of Economic Studies, Vol. 54, 1977, pp. 287-303

Sollow, R. *The Intelligent Citizen's Guide to Inflation* Public Interest No. 38, 1974

Theil, H. *Economics and Information Theory,* (Amsterdam: North Holland), 1967

Tobin, J. *Inflation and Unempolyment,* American Economic Review 62: pp.1-18

Vining, Daniel and Thomas C. Elwertowski, *The Relationship Between Relative Prices and The General Price Level*, The American Economic Review, Vol. 66, No. 4, 1976, pp. 699-709

Wellisz, Stanis³aw *Inflation and Stabilization in Poland, 1990-1995*, in *Macroeconomic Stabilization in Transition Economies* edited by Mario I. Blejer and Marko Skreb, (Cambridge University Press, 1997), pp. 157-171