RELATIVE PRICE VARIABILITY, INFLATION AND STABILIZATION IN CROATIA[1]

Velimir Šonje

Introduction

During seventies and eighties economists observed strong and positive relationship between inflation and relative price variability (Vining and Elwertowski, 1976; Parks, 1978; Blejer and Leiderman, 1980, 1982; Domberger, 1987) leading to theoretical conclusion that in such conditions markets loose their informational value. Allocative power of markets in periods of high inflation decreases. This finding also supports conclusions about loss of growth due to persistent and high inflation. Real output is supposed to be a decreasing function of relative price variability (Lucas, 1973) due to miss-allocation of resources.

At the empirical level, however, no consensus is achieved regarding the shape of the relationship: if it's log-linear, is the regression coefficient between zero and one, or is it greater than one? Is inflation an independent variable, or is it the relative price variability?[2] Is there any evidence about causality? What prices do we have to take into account when we measure the variability of their ratios, etc.? No generalconclusion was found. Answers differed according to applied measurement techniques and countries that have been studied.

[1] I am grateful to my colleague, mr. Zoran Anušić. His helpful comments left a deep trace in this paper. However, the author is the only person who is responsible for everything that is written here.

[2] Some authors argue that simple regression models linking relative price variability and inflation are misspecified, without any underlying economic theory (Clare and Thomas, 1993).

Here I present the Croatian case study. In the first section I present brief comments on inflation and relative price variability in Croatia since 1980. In that section I also explain the measurement methods. In the second section of the paper I present some details about econometric estimates. In this section I show that the relationship between relative price variability and inflation exhibits a time dimension due to learning about inflation. In the third section I analyze variations of relative prices during stabilization period (after October 1993) when we observed increased relative price variability in the period of disinflation or, more precisely, deflation.

1. Brief History of Inflation and Relative Price Variability in Croatia

The variables present the monthly data for 1980:2 - 1993:12. The sample contains thirty-three prices, i.e. prices for thirty-three manufacturing industries. Among 33, there are six industries whose prices were heavily regulated during the period. These are production and distribution of electricity, oil and gas, and coal. For each of the 33 industries the official statistics publishes both base and chain price indices.

Relative price variability is measured by unweighted standard deviation of price changes around the mean price change (Vinning and Elwertowski, 1976; Domberger, 1987):

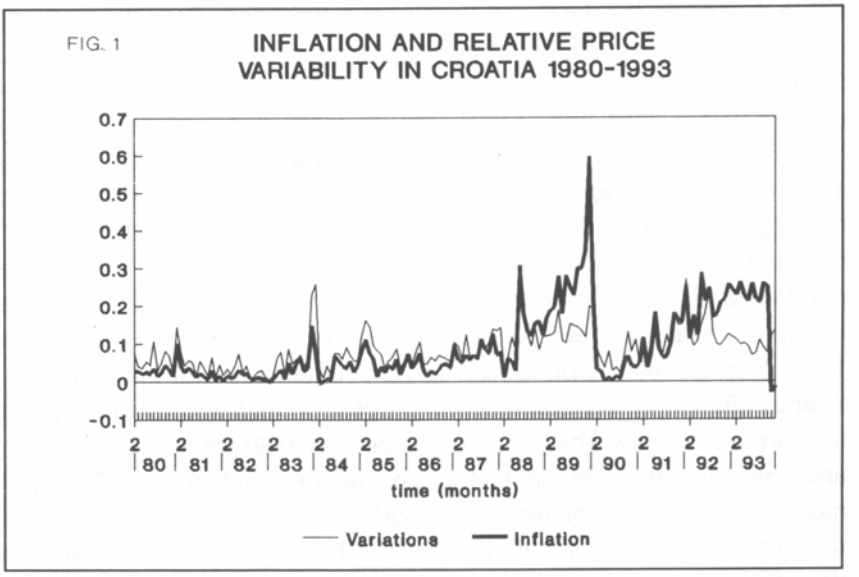
$$\lambda_t = \left[(1/m)\Sigma\Delta P_{it} - \Delta P_t)^2\right]^{1/2} \qquad (1)$$

where m denotes number of industry price indices in the sample, and t denotes time. Price changes are expressed in logs:

$$\Delta P_{it} = \log (P_{it}/P_{i,t-1}) \qquad (2)$$

$$\Delta P_t = (1/m)\Sigma\log (P_{it}/P_{i,t-1}) \qquad (3)$$

Figure 1 shows monthly time series of relative price variability and producer's prices inflation for the entire period.



Series VART3 is series of unweighted standard deviation of price changes measured for the sample of 33 manufacturing industries. INFLA33 is unweighted average of price changes for industries in the sample.

There are two basic stylized facts that can be derived from this figure. First, in one of my earlier papers (Šonje, 1993) I showed that neither inclusion nor exclusion of six regulated energy prices changes the shape of series substantial.[3] Second, series of relative price variations

[3] *One explanation is that data are unweighted. Weighted data would put more emphasis on energy sectors. Another explanation is based on the speed of price adjustments. In high inflation countries (due to high level of indexation), all prices tend to react on local price changes within short time period and with almost the same magnitude.*

is flatter than the series of inflation. This observation requires further elaboration.

Table 1 reports the basic statistics for two series. Sample mean is displayed as the simple annual average of twelve monthly data. Sample standard deviation for each year is measured for twelve months within each year. From 1980 to 1986 standard deviations of price changes within a year are higher than average monthly inflation itself, despite the fact that average monthly inflation was pretty high, ranging from 1.4% in 1982 to 5.1 % in 1985. In this period, standard deviation of twelve months time series tends to be higher for relative price variations than for inflation itself (except in 1982). Sharp increase in inflation starts in 1987 and lasts till the end of 1989. In the year of 1989, average relative price variation is substantial lower than inflation. Year of 1990, after last stabilization program in ex-Yugoslavia, was just a short break. New sharp increase starts in 1991, lasts during 1992, and then, in 1993, inflation stabilizes at the level around 25% per month. During hyperinflationary period (1987-1993), annual standard deviations of monthly inflation tend to be higher than annual standard deviations of relative price variations, just contrary to the evidence for the first seven years of observations.

Conclusions based on descriptive statistics suggest that variations in relative prices tend to rise with inflation, but only up to a certain limit. When variations reach that limit, any increase in inflation, regardless of it's magnitude, does not pull the variations upwards. Variations remain stable at a certain level, or even start to decline.

Regression analysis supports this view. In one of my earlier papers (Šonje, 1993) I reported the results of the regressions with price variations as dependent and inflation as an independent variable. Estimated inflation elasticity of variations was about .45 in two different regressions (one contained energy prices, other did not).[4] The values

[4] *This finding supports the introductory remark that neither inclusion nor exclusion of energy prices changes the shape of the series substantial.*

Table 1

AVERAGE MONTHLY INFLATION (INFLA33) AND THE AVERAGE MONTHLY RELATIVE PRICE VARIABILITY (VART3) IN CROATIA 1980 - 1993.

YEAR	SAMPLE MEAN		STANDARD DEVIATION	
	INFLA33	VART3	INFLA33	VART3
1980	.0270	.0555	.0093	.0250
1981	.0287	.0518	.0260	.0351
1982	.0139	.0087	.0298	.0175
1983	.0391	.0645	.0391	.0573
1984	.0358	.0712	.0278	.0634
1985	.0509	.0846	.0287	.0396
1986	.0409	.0636	.0195	.0158
1987	.0775	.0951	.0235	.0288
1988	.1169	.1225	.0802	.0664
1989	.2758	.1385	.1151	.0299
1990	.0425	.0778	.0597	.0486
1991	.1057	.1068	.0525	.0399
1992	.2030	.1430	.0539	.0592
1993	.1927	.0988	.1022	.0199

of estimated coefficients supported the conclusion about the existence of some stable level of variations at very high levels of inflation. A test of structural stability of the specification was performed in that paper over two periods: a) inflationary period till December 1987, and b) hyperinflationary period starting from January 1988. The values of parameters differed substantial (β for hyperinflationary period was .3575 and 1.1877 for inflationary period, both highly significant), while the Chow test suggested significant structural differences in the two subperiods. At the same time, the explained part of variations was somewhat lower for the hyperinflationary period. (R squared was .406 for hyperinflationary and .6717 for inflationary period).[5]

[5] *These results match the findings in the study of relative price variability in ex-Yugoslavia (Jurković, 1989).*

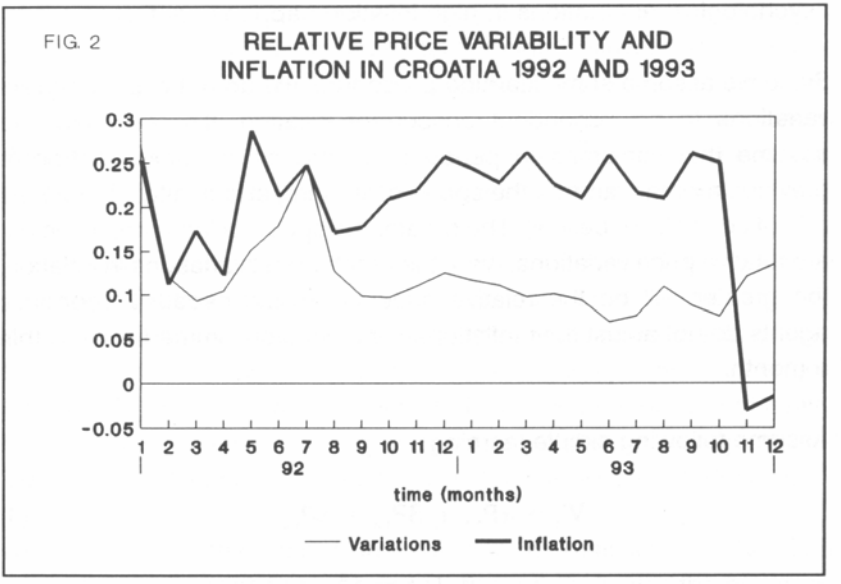
In all regressions Durbin-Watson test indicated a strong presence of the first-order autocorrelation of residuals. Since the specification did not account for autoregression or some learning process, all equations were reestimated according to generalized differential equation procedure. The results will be shown in the following section.

The figures, stylized facts and descriptive statistics suggest that Croatia is a country with long historical propensity toward inflation and with disordered markets because of the relative price variations. These variations exterminated any valuable information from the relative price signal.[6] Deterioration of informational content of prices is particularly obvious during hyperinflationary process, when the rates of inflation became higher than the unweighted standard deviations of price changes around the mean. In these times of high indexation, relative price variations tend to stabilize at a certain level of standard deviation. All prices tend to stick to some other current information which is published often enough to reflect changes in purchasing parity of domestic currency. In Croatia, it is Croatian Dinar/D-Mark exchange rate. Obviously, analyzing the link between relative price variability and inflation contributes to understanding the malfunctioning (or not functioning at all) of markets in Croatia.

2. Recent Relative Price Variability and Inflation in Croatia

Figure 2 shows the same series as figure 1, but for the shorter period of 1992:1 and 1993:12. The reasons for extracting just this period are straightforward. First, this is the period after introduction of the Croatian dinar in the circulation, and second, it is the period in which we see three types of price changes. Almost like in a laboratory.

[6] *Such as relative productivity or relative market competitiveness.*



The first type of price changes can be seen in first seven observations, from January to July 1992. It is the period of rising inflation. The second type of price changes can be seen in the next fifteen observations, from August 1992 to October 1993. This is the period of fluctuating inflation. Inflation in this period did not speed up significantly. It was moving around a stable level of the rate. The third type of price changes can be seen in November and December 1993. This is the stabilization period which was characterized by deflation. Finally, big changes in behavior of inflation were accompanied by small changes in behavior of relative price variations. This important observation calls for further investigation by regression analysis.

Assume that the economic agents have to learn about the inflation. If all of the agents formed their inflationary expectations according to some current information, such as the exchange rate depreciation, we wouldn't be in a position to observe fluctuations like those in the figure 2. So, we assume some adaptive form of learning, although

psychological adaptations in high inflation happen very fast.[7]

Since we assume some learning procedure, we do not expect current variations to be dependent on current inflation. It's reasonable to assume that variations in period t depend on monthly inflation in previous months, and on the speed of learning about inflation (see the role of coefficients bellow). The greater the speed of learning, the lower are relative price variations. Also, the greater past variations in inflation, the greater will be the relative price variability, because economic agents do not adjust their inflationary expectations immediately, within a month.

Assume following simple learning:

$$V^e_t = \alpha P_{t-1} + \beta P_{t-2} + \phi P_{t-3} \qquad (4)$$

$$\alpha + \beta + \phi = 1^8$$

where P, is inflation in period t and V^e_t is expected inflation in period t. Because of hyperinflationary nature of the economy, we assume that relevant information for learning extend only three months in the past.

Furthermore, it is assumed that the relevant independent variable is the absolute value of the difference between the current inflation and the expected inflation: DIFFA=abs(P_t-V^et). Assumption is: the greater the difference between actual and expected inflation is, the greater are relative price variations. In construction of this variable, I have used several assumptions about learning parameters. The best performance

[7] *Assuming adaptive expectations pattern is rather reasonable when dealing with monthly data, even in case of high inflation.*

[8] *It is a matter of convenience to assume a linear combination of coefficients in equation (4). The value of estimated regression coefficient (see bellow) does not change if we multiply these coefficient by any positive constant.*

of the variable was achieved with α = 0.3, β = 0.5, ϕ = 0.2. This parameter combination suggests that learning is slower than it can be expected for the hyperinflationary process. Economic agents probably still allow monthly increases in the rate of inflation to be due to fluctuations and not due to some longer term trend. The conclusion holds only for months, but not for longer observation periods.

The second explanatory variable in the model (ENRGIN) is the simple average of price changes in electricity distribution and final oil products. These prices, which affect the whole price system, were heavily regulated. The policy makers tended to keep them unchanged for some periods, but when they were faced with the burden of heavy losses in these industries, they allowed for relative price adjustment. Such price behavior affected price variations in all other industries.

As it was expected, the Durbin-Watson d statistics for the OLS estimation of the specification in levels, strongly indicated the presence of the first order positive autocorrelation. Furthermore, relative price variations is the process which exhibits time inertia due to technological input-output links and staggered price contracts in the system. Having in mind the need for autoregressive form of the estimation model suggested by economic theory, and also having in mind strong and positive autocorrelation, the model was reestimated in the autoregressive form by the maximum likelihood method.

The rationale for including the first explanatory variable (DIFFA) is found in learning process which underlies the formation of inflationary expectations. This variable can be regarded as psychological variable. The presence of the second explanatory variable (ENRGIN) tracks the periods when some basic prices in the system were regulated. This variable can be named the regulatory variable. The presence of the third explanatory variable (VART3 lagged one period) is due to technical and contractual inertia in the price system. This variable can be addressed as the technical variable. The model was estimated for the latest "hyperinflationary period" - 1991:1 1993:12.

Durbin's h test in this equation still indicated the presence of autocorrelation. Furthermore, the inspection of residuals revealed two huge outliers in months of major political events. The first outlier was in January 1992. That was the month when Croatia gained full monetary sovereignty with Croatian Dinar under the full control of the Croatian National Bank. The second outlier was in July 1992, the preelection month. Final estimation included these two political dummies.

Estimation results are given bellow. The equation is estimated by OLS method in the first differences form because of high estimate of autoregression coefficient in the previous equation. That is why all explanatory variables have prefix DIF.

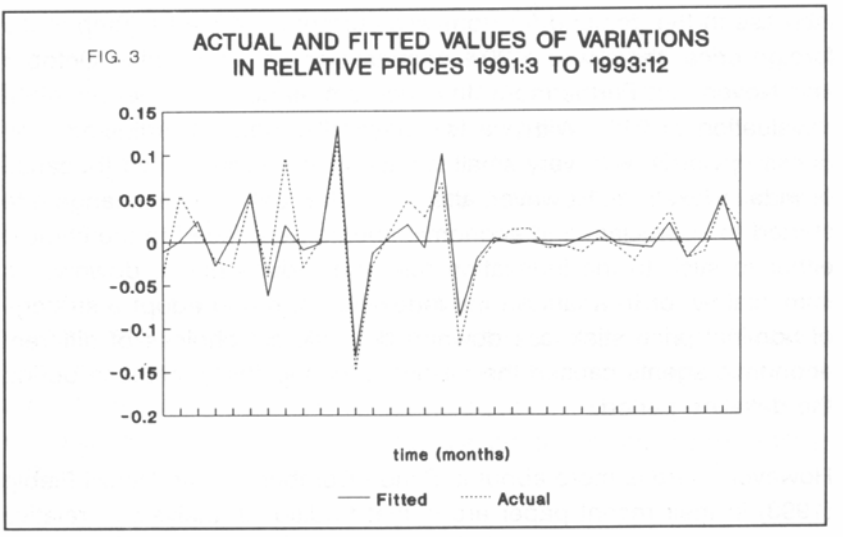
$$DIFVART3_t = \underset{(-.066)}{-.0003} + \underset{(5.66609)}{.1117}\ DIFDUM1_t + \underset{(5.88605)}{.1117}\ DIFDUM2_t$$

$$+ \underset{(2.22307)}{.1541}\ DIFDIFFA_t + \underset{(3.62929)}{.3877}\ DIFENRGIN_t$$

$R^2 = .7479$ adj $R^2 = .7154$ DW = 2.0404 F = 22.995

This equation helps to determine psychological, technical and regulatory factors that contribute to relative price variations. It also helps to explain why relative price variations tend to stabilize when inflation rate reaches a certain level. In such a situation, which occurred in Croatia from the middle of 1992 till October 1993, psychological variable DIFFA has small values. Since the differences between actual and expected inflation tend to be small, the impact of not-yet-learned inflation tends to be small too. Still, in such a situation, variations do not fall to zero or constant value, because of the impacts of technical and regulatory factors which are still present.

Figure 3 concludes this section. It shows actual and fitted values of series VART3 for 1991, 1992 and 1993. This figure serves as a basis for judgments about explanatory power of the equation. The reader should draw conclusions on his or her own.



3. Price Relationships during Deflation

The concluding model in the previous section can also explain the case of deflation at the beginning of the stabilization program which was announced in October 1993. A reader should keep in mind some basic features of the program.

First, the program was initiated at the high level of monthly inflation accompanied by the relatively low level of relative price variations. The low level of relative price variations was due to indexation rule: prices were widely indexed to the exchange rate, and there were no significant inflation surprises during 1993. Second, the program was theoretically founded, well prepared and generally credible. Credibility arised from two sources: government's pre-commitments toward low inflation, and from the internal consistency of the program itself. High credibility was the prime reason for tremendous shift in the demand for money which occurred at the very beginning of the program.

Increase in the demand for domestic currency induced a jump in it's foreign price: there was a 20% nominal appreciation during October and November. Furthermore, the program started with the overnight devaluation of 21 %. Within a few days all producers adjusted their prices upwards, with very small variations in relative prices (because of wide indexation). However, after only a few days, the exchange rate started to appreciate and economic agents were faced to the choice: either to stick to the indexation rule and reduce prices downwards immediately, or to abandon the indexation rule and adopt a strategy of nominal price stickness downwards. Different choices of different economic agents caused the relative price variability increase during the deflation period.

However, there is more about it. Simon Domberger and Denzil Fiebig (1993) in their recent paper argue that traditional analysis of relative price variations tells nothing about staggerness and synchronization of price movements. It is therefore necessary to look at different choices of different economic agents because they are important in two respects. First, the skewness of price change distributions gives information about price staggerness. And second, differences in skewness during inflationary and deflationary periods give information about the degree of nominal price rigidity upwards and downwards.

Their argument can be summarized in a few hypothesis, out of which I emphasize the following two (Domberger and Fiebig, 1993, p.299):

Hyp. 1: The skew will be positive when the mean of the price change distribution is positive and conversely when the mean is negative.

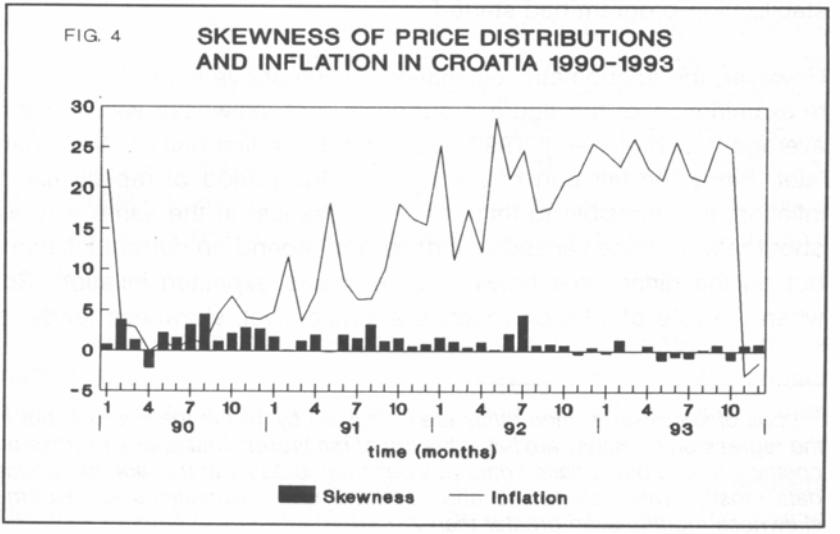
Hyp. 2: The skewness of the distribution is inversely related to the absolute magnitude of the mean rate of price change: we expect less skewness when inflation is stable and the time interval between price changes is reduced.

These propositions are formed having in mind intramarket price variations. Primary aim was to explain skewness by microeconomic

explanatory variables such as the degree of market concentration and the like. However, hypotheses can be examined at the higher level of aggregation, namely, at the intermarket level. Only explanations can be slightly different. At lower levels of aggregation, skewness can be explained by real variables such as market structure. At the intermarket level, however, skewness can be explained only by expectational variables.

Skewness is measured as usual, with α_3. It is the ratio of the third moment around the mean and the third power of the standard deviation. Figure 4 shows series of skewness and inflation for the period 1990 - 1993.[9]. Estimation equation bellow shows the relationship between skewness and inflation for the whole period 1980 - 1993.

$$SKEW_t = 2.316 - 6.95493\ INFLA33_t \qquad R^2 = .2113$$
$$(-6.65004)$$



[9] *Note that the observation marked with (+4) is an extreme outlier. It's real value is 5.914. Here it is drawn as ii is 1.914. The reason is graphical convenience.*

There is a link between two variables, although not so strong.[10] But, what is more important, the link is negative. This violates the working hypothesis about the positive link between skewness and inflation. According to the results of estimation, in periods of growing inflation we would expect to see negative skewness, and in periods of deflation, we would expect to see positive skewness. Indeed, figure 4 shows positive skewness in deflationary period at the end of 1993. What is the economic interpretation of it?

Deflationary reaction of Croatian manufacturers was pretty homogenous. Most of the producers concentrated in the lower part of the price distribution. It means that most of producers decided, more or less, to stick to the indexation rule even in the period of deflation.[11]There were only a few exceptions who decided to break the rule and to freeze their prices at the nominal level (some industries as beverages even tried to increase prices substantial) Credibility of the program was high, and most of the economic agents believed in it. This fact explains deflation which occurred only one month after stabilization program had started.

However, the econometric estimation shown above is pretty crude. A re-examination of the figure 4 suggests that skewness was, on the average, much higher in 1990, 1991 and in the first half of 1992, than later. Since the left part of the figure is the period of rapidly rising inflation, it is possible to think of skewness just in the same way as about relative price variability: it does not depend on current inflation, but on the differences between current and expected inflation. So, when the rate of inflation reaches a stable level, skewness tends to

---

[10] Logs of successive price ratios are multiplied by 100 in the figure 4, but in fhe regression form they are left in the log of ratio form. That is why regression coefficient is so big; inflation data vary between -0.035 and 0.3, and skewness data mostly vary between -2 and 2, with a few observations for extreme skewness months even greater than 2.

[11] The decision to stick to the rule was the decision about the sign of the price change. Certain level of nominal rigidities is still present in the system because the magnitude of the price decrease is still smaller than the magnitude of the appreciation.

stabilize near the normal shape of the price changes distribution. However, a regression with differences between actual and expected inflation as explanatory variable did not perform well, indicating that this issue needs some further examination by use of alternative econometric techniques such as the time varying coefficient method of estimation, which is beyond the scope of this paper.

Conclusions

Croatia is a country with long history of inflation and disordered markets because of long tradition in relative price variations. But, relative price variations tend to stabilize at the high levels of inflation. When inflation reaches a certain level, relative price variability tends to stabilize at the level. This suggests the following: First, at the high level of inflation all prices tend to stick to some other current information which is published often enough to reflect changes in purchasing parity of domestic currency. In Croatia, it is the Croatian Dinar/D-Mark exchange rate. Second, relative price variability in high inflations depends on differences between actual and expected inflation, not on the current inflation itself. Econometric estimates support this conclusion. Variations stabilize because differences between actual and expected inflation tend to be small in the periods of relatively stable inflation rate, but they do not fall to zero because of variations in basic prices of energy and because of impacts of major political events.

The Croatian stabilization program started in October 1993 from the relatively low level of relative price variability. There was widely spread indexation rule in the price contracts, and the differences between actual and expected inflation in months before stabilization were not big. Credibility of the program was high, and most of the producers decided to stick to the exchange rate indexation rule even in the period of appreciation. That is why skewness was positive in both months of deflation. Such behavior of the price distribution confirms the empirical finding of negative relationship between inflation and skewness of the price distribution, which violates working hypothesis.

REFERENCES

Blejer, Mario I. and Leonardo Leiderman, 1980. "On the real effects of inflation and relative price variability: Some empirical evidence." **The Review of Economics and Statistics,** 42 (4): pp.439-545.

Blejer, Mario I. and Leonardo Leiderman, 1982. "Inflation and Relative Price Variability in the Open Economy." **European Economic Review,** 18: pp.387-402.

Clare, A.D. and S.H.Thomas, 1993. "Relative price variability and inflation in an equilibrium price misperceptions' model: Evidenceforthe UK." **Economics Letters,** 42: pp.51-57.

Domberger, Simon, 1987. "Relative Price Variability and Inflation: A Disaggregated Analysis." **Journal of Political Economy,** 95 (3): pp.547-566.

Domberger, Simon and Denzil G. Fiebig, 1993. "The Distribution of Price Changes in Oligopoly." **The Journal of Industrial Economics,** 41 (3): pp.295-313.

Jurković, Lidija, 1989. "Inflation and Relative Price Variability in Yugoslavia." **Economics Letters,** 29: pp.135-139.

Lucas, Robert E., 1973. "Some international evidence on output-inflation trade-offs." **American Economic Rewiev,** 63: pp.526-534.

Parks, Richard W., 1978. "Inflation and relative price variability." **Journal of Political Economy,** 86 **(1):** pp.79-96.

Šonje, Velimir, 1993. "Varijacije relativnih cijena i količina u Hrvatskoj industriji u uvjetima visoke inflacije." **Privredna kretanja i ekonomska politika,** 25: pp.45-69.

Vining, Daniel R. and Thomas C.Elwertowski, 1976. "The relationship between relative prices and the general price level." **American Economic Review,** 69: PP.699-708.