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Relative Price Variability: The Case Of Turkey 1994-2002

Hande KÜÇÜK
Burç TUĞER

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The Central Bank of the Republic of Turkey

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ABSTRACT

In this study, the relation between inflation and relative price variability is investigated to shed light on the inflationary dynamics in Turkey. For this end, highly disaggregated Turkish CPI data, which helps to uncover some masked relations between the sub-items of CPI, is utilized. As a result, a significant positive association between inflation and relative price variability, which is robust to different specifications of these variables, is verified.

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(**) Research Department, The Central Bank of the Republic of Turkey,
E-mail:Hande.Kucuk@tcmb.gov.tr, Burc.Tuger@tcmb.gov.tr

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I. INTRODUCTION

Inflation has become a part of life for many economies throughout the world. The interest in dynamics of inflation and costs of inflation never vanished. In the previous studies (e.g. Fischer, 1981b), it is identified that one of the main channels over which inflation may inflict costs to the economy is by means of relative prices. Analytically, relative price variability does not necessarily reduce consumer welfare. However relative price variability leads to inefficiencies in the allocation of resources that reduce real income (Fischer, 1981b). Given the significance of the costs associated with relative price variability, the relation between inflation and relative price variability was extensively researched and a positive relation between the two was documented for many countries and for varying time periods[1]. Besides, one of the main sources of relative price variability being differential speeds of price adjustment in different sub-sectors renders the investigation of relative price variability valuable also in terms of understanding the inflationary dynamics.

Relative price variability basically measures the degree of disproportion in a given price distribution. The literature on relative price variability dates back to gold-standard era that is the reason why the measure is called relative *price* variability. With high inflation economies, more relevant and more common variability measure is relative *inflation* variability. Owing to the tradition, instead of calling this measure relative inflation variability, the term relative price variability is used throughout the study.

In our study, we investigate the relation between inflation and relative price variability to have a better understanding of inflationary dynamics in Turkey. For this end, we have utilized highly disaggregated Turkish CPI data[2] for our analysis, which helps to uncover some masked relations between the sub-items of CPI. As a result, we have found a significant positive association between inflation and relative price variability, which is robust to different specifications of these variables.

Our study proceeds with a short, selective literature survey of relative price variability, which tends to illuminate the concept from an analytical point of view and provides the motivation behind the study[3]. In the second section, the concept of relative price variability is explained in detail and various relative price variability measures based on different aspects of CPI are calculated and examined. In the third section, the significance of the relation between inflation and relative price variability is tested empirically. In the last section, our main findings are summarized and some further research agenda are suggested. The results of the unit root tests are presented in detail in the appendix section.

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[1] A survey of such studies can be found in Golob (1993).
[2] The period covered in the analysis is from January 1994 to December 2002.
[3] A more comprehensive literature survey can be found in Golob(1993), Fischer(1981) and Cukierman(1983).

II. LITERATURE SURVEY

"*A fundamental function of the price system is to transmit compactly, efficiently and at low cost the information that economic agents need in order to decide what to produce and how to produce it, or how to employ owned resources. The relevant information is about relative prices- of one product relative to another …- but the information in practice is transmitted in the form of absolute prices (e.g. Prices in USD). If the* <u>*price level*</u> *is on the average stable or changing at a steady rate, it is relatively easy to extract signal from the observed absolute prices. The more volatile the rate of inflation, the harder it becomes to extract the signal about the relative prices from the absolute prices*" (By Hayek, as reported in Friedman, 1977).

In 1970's with the advent of high and variable inflation in industrial economies, following the oil shocks, previous economic regularities were challenged. One example was the concept of downward sloping Phillips curve, which related inflation and unemployment in a non-linear fashion, being tested on analytical and empirical grounds (Friedman,1977). Furthermore, interest in the real costs of inflation surged. One of the main channels over which inflation may inflict problems upon the economy is, as quoted above, by means of relative prices.

However in the models, such as by Lucas (1973), it was assumed that relative price variability was independent from the variance of inflation. So analytically, it was not possible to show the cost of inflation through relative price variability. In Lucas' model, each sector prices consisted of a general trend component and a disturbance term (Vining, Elwertowski,1976) :

$$P_{it} = P_t + z_t$$

Where P_t distributed as $N\left(\overline{P}, \sigma^2\right)$

Note that,

P_{it}: logarithm of the price of i^{th} commodity at time t

P_t : logarithm of the general price level at time t

z_t : random variable, independent of P_t.

P_{it}-P_t=z_t where z_t is distributed as $N(0, \tau^2)$

Variance in individual prices around their mean τ^2 is therefore independent of the degree of variability σ^2 in the general price level. This fact implies that variance in relative prices is independent of variability in general price level. Furthermore, if the terms above are expressed in terms of rate of change of price, this is equivalent to:

$$E\left[\left(P_{i,t+1} - P_{i,t}\right) - \left(P_{t-1} - P_t\right)\right]^2 = E\left[z_{t+1} - z_t\right]^2$$

If the term on the right hand side is to be expanded, the cross terms will vanish:

$$\{E(z_{t-1} * z_t) = 0\} \Rightarrow Var(P_{it+1} - P_{it}) = 2\tau^2$$

That is, the variance in the one period change in P_{it} around their mean should be roughly constant and since constant unrelated to the degree of variability in the mean change.

In contrast to Lucas' model, empirically it was shown that there is a positive and significant relation between σ^2 and τ^2. In other words, as the general price level becomes more unstable, dispersion in relative prices increases (Vining, Elwertowski,1976).

II.1. A Suggested Taxonomy Of The Models That Predict A Relation Between Inflation And Relative Price Variability

Analytical models were modified to account for this regularity between relative price variability and inflation. There are roughly three main possibilities consistent with the positive correlation between relative price variability and inflation (Wozniak,1998): models that predict

- Inflation (Π) CAUSES relative price variability (RPV)
- A common third factor CAUSES both inflation (Π) and relative price variability (RPV).
- Relative price variability (RPV) CAUSES inflation (Π)[4].

II.1.a. Models That Predict $\Pi \Rightarrow RPV$

i.) Menu Cost Models

These models, mainly based on the work by Sheshinski and Weiss (1977), postulate that there is a lump sum cost of changing prices. These costs are associated with the transmission of price information to the consumers and the decision process itself. In the face of real cost of changing prices **(menu cost)**, the optimum pricing policy is to change the prices at discrete intervals. The price setters will adjust the prices once the real price, implied by the level of inflation, falls below a theoretical threshold '*s*'. And if real prices increase, the price setters will wait until the real price of the commodity they produce increase more than the upper bound *'S'*. The dispersion of the critical interval (s,S) across different products and the unsynchronized price setting behavior creates relative price dispersion. And as inflation is expected to increase, this band will get larger so that increased relative price variability will result. Therefore, from this model a positive relation between relative price variability and inflation results.

[4] Alternative classifications of the models can be found in Cukierman(1983), Golob(1993), Fischer(1981), Leiderman(1993) and in **Table II.1**.

ii.) Contract Models

Contract models, example for which are Bordo(1980), Taylor (1981), are based on overlapping contracts which create a positive relation between inflation and price dispersion.

The basic ingredient of this model is the **long-term contracts**. The long-term contracts may be desirable in the industries where it is important to minimize uncertainty and transaction costs. Uncertainties may arise due to unanticipated changes in the supply and demand conditions (Bordo, 1980). Transactions costs also arise because to search for and to gather information and measures taken to avoid hazards of opportunistic behavior are costly. The existence of such contracts creates price stickiness. For example, a positive monetary shock causes all prices to increase but there is temporary change in relative prices because some prices adjust more rapidly than others. Thereby with inflation, relative price variability will result due to the existence of long-term contracts. Moreover, this model also predicts that variance of relative prices, being regarded as a source of uncertainty, and contract length are inversely related.

II.1.b. Common Third Factor Affecting Both Π and RPV

i.) Limited Information Models[5]

This framework is mainly based on the 'equilibrium misconceptions model' by Lucas (1973) (Golob, 1993). As explained above Lucas' original model failed to contain the empirical regularity between relative price variability and inflation. This was partly due to the fact that Lucas' model was developed to explain the effect of inflation uncertainty on the output-inflation trade off. Later, Lucas' model was adapted to the issue of relative price variability by Barro (1976), Hercowitz(1981), Cukierman(1983) (Golob,1993).

The analytical model was basically based on an economy with a single commodity, large distinct markets with continuous market clearing also expectations are assumed to form rationally. The key idea behind the model is that agents confuse aggregate and relative price movements. This confusion, according to model, brings about the conclusion that 'money is not a veil' in the short run (Cukierman,1983).

Accordingly, one example for the common factor that influence both inflation and relative price variability is unanticipated changes in the money stock. If this change in the money stock is fully perceived, then the relative prices do not change. If there is misperception, changes in prices will be viewed as change in the relative prices. Under the condition that demand and supply elasticities differ across industries, economic agents will think that relative price change reflect actual price change (Fischer,1981). In fact, there is no

[5] The other names for this group of models are multi-market models and signal extraction models.

change in economic conditions, therefore agents acting upon misperception cause misallocation of resources. Therefore, unanticipated change in the money stock will both increase inflation and relative price variability.

ii.) Disturbances that have macroeconomic consequences

These kinds of explanations are not models actually. Major supply shocks that typically occur in specific industries, together with differential rate of price adjustment of distinct industries lead to both inflation and relative price variability. Examples for these shocks are oil shock, or shocks to food prices due to climate conditions.

Table II.1: Selected Models Which Predict A Relation Between RPV And Inflation

MODEL	**Multi- Market Models**	**Contract Models**	**Menu Cost Models**
Selected Studies	Lucas(1973), Barro(1976), Hercowitz(1981), Cukierman (1983)	Bordo(1980), Taylor(1981).	Sheskinski and Weiss (1977)
Key Aspect Of The Model	***Imperfect information*** ⇓ Aggregate/Local Confusion and Transitory/ Permanent Confusion	Uncertainty ⇓ ***Long Term Contracts*** ⇓ Price Stickiness	Real Costs associated with changing prices (**Menu Cost**) ⇓ (s,S) pricing
Alternative Taxonomy of The Models	Imperfect Information cum equilibrium (Leiderman,1993)	Imperfect Information cum disequilibrium (Leiderman,1993)	Perfect information cum equilibrium (Leiderman,1993)
	Information based (Taylor,1981)	Contract based (Taylor,1981)	
Transmission Channel	• Unexpected Nominal Shock • Variability of Inflation • Unexpected Inflation ⇓ Relative Price Variability	Nominal Shock (e.g. Positive monetary shock) ⇓ Some prices adjust more quickly than others ⇓ Relative Price Variability	Even under full information, the existence of cost of adjusting prices ⇓ Prices are adjusted discontinuously ⇓ Even expected inflation increases relative price variability.
Macro vs. Micro	Macro / Micro	Macro	Micro

II.1.c. Models That Predict $RPV \Rightarrow \Pi$

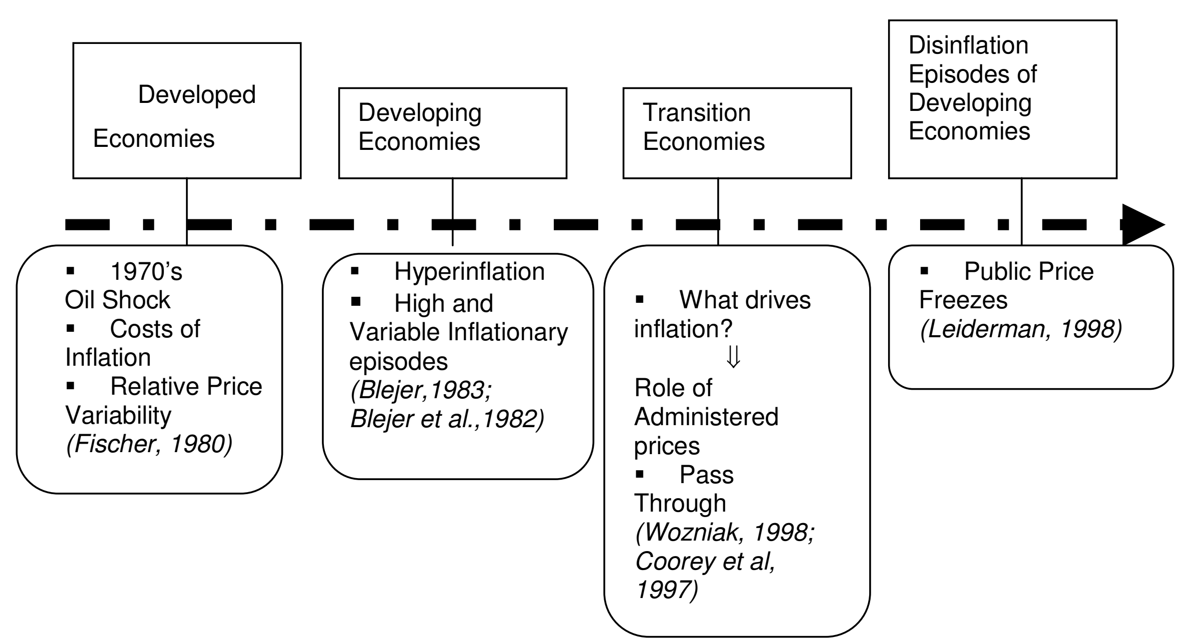
The last theoretical possibility that is consistent with a positive correlation between inflation and relative price variability is the case in which relative price variability is exogenous (Fischer, 1981). Assumption is that prices respond asymmetrically to the disturbances, thereby there is a positive relation between relative price variability and inflation. In this kind of model, goods markets are like Tobin type labor markets. In these markets, when there is excess demand, prices increase, whereas in case of excess supply prices do not fall. Therefore, the larger the variability of relative disturbances, the higher is the inflation (Fischer, 1981).

II.2. Implications of RPV Models and Previous Research on Turkey

II.2.a. Implications of RPV Models

As briefly summarized above, there are many theoretical models, which provide explanation for the positive association between relative price variability and inflation. Besides the theoretical model, relative price variability was investigated within the real world situations. In the 1970's relative price variability subject was studied within the developed economy experience for the real costs of inflation. Then, the interest in this subject in the industrial countries started to vane after the inflation was brought down to single digits.

Table II.2: The motivations behind the studies related to Relative Price Variability in Different Economies



Relative price variability subject was also taken up within the experiences of the developing economies. In Latin American economies which experienced high and variable inflation, the effect of inflation on the relative price variability was investigated from the perspective of traded and non-traded inflation (Blejer&Leiderman, 1982) and food inflation (Blejer,1983). Then the subject gained importance for the transition economies of the Eastern Europe. Economic structure being made up of public institutions, the issue of what pricing strategies public enterprises should pursue after privitization, naturally was important. If inflation was mostly determined by the relative price variability, clear implication was that public price adjustments should follow a smooth path instead of once in a year price hikes (Wozniak,1998). The subject was also studied for the *disinflation* episodes. In the Israeli case, the success of the stabilization program was also attributed to the price freezes. The studies about the Israeli disinflation revealed that public price freezes slowed down the relative price variability within the controlled prices, which facilitated the fight against inflation (Leiderman, 1993).

II.2.b. Previous Research on RPV in Turkey

Earlier studies on the Turkish inflation with reference to relative price variability are mentioned in this part:

- **Alper-Ucer(1998)**

In Alper and Ucer's study about inflation in Turkey, an empirical test about the relative price variability is conducted. A relative price variability measure based on 21 sub-components of private wholesale price index (WPI) is constructed and model-free regressions and Granger causality tests are performed to check the significance and the direction of the relation between inflation and relative price variability. The intuition behind these tests is that "in the economies where relative price variability is the driving force of inflation, inflation variability is expected to Granger cause inflation". However relative price variability is not found to be a driving force of inflation in Turkey. Also the Granger causality tests do not report a significant direction of 'causation'. However, a strong contemporaneous correlation between inflation and relative price variability is reported.

- **Karasulu (1998)**

Karasulu's study tries to approach the relative price variability concept from a micro perspective, where the motivation of the study is to find out real costs of inflation. Micro data utilized in the study are from 3 big provinces and span the period between 1991:1 and 1996:12. In contrast to the exercise that will be carried out in this study, Karasulu's calculations take the cross-section dimension, the provinces, into account (Figure III.1), which helps for formal testing of micro models' hypotheses and conclude about the costs of inflation.

It should be noted that when the cross-section dimension of price indices are taken into account, relative price variability measures are more than one. One relative price variability measure is 'within commodity group' relative price variability, which is called as intra-market relative price variability. While the other relative price variability measure will be relative price variability 'within provinces', which is called as inter-market relative price variability.

As a conclusion, it is pointed out that from the consumer's point of view, with inflation search costs within products increase. While from the producer's point of view, with inflation cost structure loses its significance as a determinant of pricing decisions. These findings are also in tune with the Alper and Ucer's remark that "inflation appears to have taken a life of its own".

- **Caglayan – Filiztekin (2001)**

Compared to Karasulu(1998), in Caglayan and Filiztekin's study, a more comprehensive data set which spans 1948 to 1997, is utilized. A total of 22 commodity group prices and 19 provinces are included in their calculation of relative price variability. A formal test of menu cost models vis-à-vis the signal extraction model (Barro,1976) is carried out[6].

In the empirical test of menu cost models, the direction of causality is expected from inflation to intra-market relative price variability whereas, in test of signal extraction models, the direction of causality is from unexpected inflation to inter-market relative price variability. In the study, it is concluded that the effect of inflation is non-neutral, i.e. there is a positive association between inflation and relative price variability, both inter and intra-market. Secondly, structural changes in the behavior of inflation are found to have a positive and important impact on the relationship. Finally, strong support for menu-cost models is found, however the data set does not support the signal extraction models.

[6] We have called the signal extraction model as limited information models and multi-markets model (Table II.1)

III. RELATIVE PRICE VARIABILITY: THE CASE OF TURKEY

III.1. Measures of Relative Price Variability

Consumer Price Index (CPI), which is basically a Laspayres price index, is based on 1994 base year weights. Except from some sub-items, which exhibit seasonal price variations, such as fresh fruits, vegetables and clothing, the weights of the commodities are fixed base year weights. Approximately 20 percent of CPI basket have time-varying weights while the remaining part have fixed weights (CBRT, 2001).

The consumption bundle, upon which the CPI is based, is revised periodically to account for the changes in the consumer preferences, quality in goods and introduction of new commodities. Given this fact, the price index utilized throughout this study is restricted to 1994 base CPI to ensure that the content of the sub-items is stable. Besides, monthly data spanning from February 1994 (94:02) to December 2002 (02:12), are utilized owing to the fact that with monthly data variability, will stand out more clearly.

Blejer (1983), postulates that the frequency distribution of individual rates of inflation approaches normality under the conditions of price stability or full price flexibility and simultaneous price adjustments, provided that the real shocks that have inflationary effects are distributed normally across commodities. However, in the presence of asymmetric price responses to nominal disturbances, the relative price probability distribution will be truncated or will tend to shift according to the nature of asymmetry (Blejer,1983). [7]

Following Blejer, distribution properties of month over month percentage change of unweighted sub-items of CPI-103 were investigated. Tests of normality, results of which are reported in the Appendix 1, revealed that the monthly inflation distribution has been non-normal throughout the sample period. Besides, right skewness and excess kurtosis dominated over the sample period. [8] Note that, the figures in the appendix table are based on unweighted measures, thus the mean given in the tables do not match up with the official consumer inflation figures.

After, conducting a preliminary analysis of CPI data, we focus on relative price distribution. Previously, various measures of relative price variability have been developed.

[7] The properties of price distribution for other countries are analyzed in detail in a study by Roger (2000).
[8] Please refer to the notes of Table A.1 in Appendix 1, for suggested definitions of **skewness** and **kurtosis**.

The measure often used by researchers is the one suggested by Theil (1967) which can be calculated in the following manner:

Rate of change of the price of i^{th} commodity is given by:

$$Dp_{it} = LN(P_{it}) - LN(P_{it-1}) \qquad (1)$$

Besides logarithmic difference of consumer price index (CPI) is also evaluated.

$$DP_t = LN(CPI_t) - LN(CPI_{t-1}) \qquad (2)$$

From these individual and general rate of inflation we can get the relative price variability measure :

$$VR_t = \sum_{i=1}^{n} w_{it} * (Dp_{it} - DP_t)^2 \qquad (3)$$

Strictly speaking, (3) is a relative *inflation* measure, as the literature on relative price variability dates back to gold-standard era, these measures are called as relative *price* variability rather than relative *inflation* variability. We will also follow the tradition and call this measure as relative price variability rather than relative inflation variability.

This relative price variability measure is a divisia price index and the use of weights makes sense from the statistical point of view. If we were to draw n commodities at random in such a way that each TL spent of total expenditure has an equal chance of being selected, then the chance that commodity i will be selected is given by w_{it}. Hence w_{it} is the probability of finding the logarithmic price difference (Theil,1967, pp.136). Given the fact that $(Dp_{it} – DP_t)$ is the rate of change of i^{th} relative price –relative to the mean- and that the average of $(Dp_{it} – DP_t)$ approximates to zero, this measure can be viewed as variance of relative inflation (Parks,1978). In other words, VR_t can be interpreted as a measure of degree of non-proportionality of price movements (Theil, 1967).

Indeed, if all the prices in a given period increase at the same rate, the relative price variability measure will attain its minimum value, which is zero. As the degree of dispersion in the inflation rates increase, the *VR* measure will also increase. Besides, **(3)** does not depend on the general level of prices, however it depends on the rate of inflation.

On the other hand, this measure suffers from shortcomings: *VR* cannot distinguish between relative prices that are appropriate for optimal allocation of resources and the ones that are mistakes. Besides, *VR* doubly penalizes a change in the relative inflation rate that is subsequently reversed. If there is permanent decline in the relative price of a good, the measure will change only once (Fischer, 1981). Also, in the presence of non-normality of inflation measures, as in the case of Turkish CPI in our analysis, there are potential problems with the second-moment of non-normal distributions (Blejer, 1983). To account for non-normal distribution a robust measure, which is independent from the central values of the distribution, was proposed by Blejer (1983) :

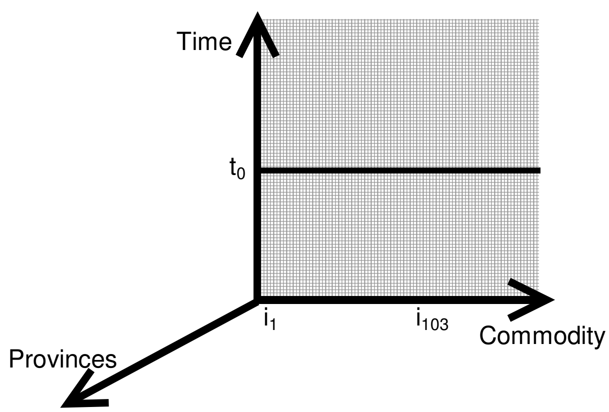
$$DR_t = \frac{1}{n-1}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}\left(w_i + w_j\right) * \left|\left(Dp_i - Dp_j\right)_t\right| \qquad (4)$$

The measure proposed by Blejer is a weighted average of the absolute values of all possible differences between the pair of observations. Given the complex formulation of the proposed measure, and difficulty in interpretation, this measure will not be calculated.

III.2. Relative Price Variability Based on Turkish CPI (103 Commodity Breakdown)

The approach to measuring relative price variability assumed different forms depending on the motivation of the particular studies. From the point of view of inflationary dynamics, it sufficed to restrict our study to commodity-time space of CPI. For more micro oriented models dealing with the price setting behavior, it would be necessary to take the 'province dimension' of CPI data into account (Table II.1). [9]

Figure III.1: Dimensions Of CPI-103



To calculate a relative price variability measure, first the rate of change of prices is calculated for each 103 sub-item:

$$Dp_{i,t} = LN(P_{i,t}) - LN(P_{i,t-1}) \qquad (1)$$

Also the weighted mean rate of change, or the rate of change of CPI is calculated:

$$DP_t = LN(CPI_t) - LN(CPI_{t-1}) \qquad (2)$$

[9] Micro analysis for relative price variability for Turkey was carried earlier by Karasulu(1998) , Caglayan and Filiztekin(2001), Filiztekin (2002).

Note that the logarithmic difference of i^{th} subcomponent from CPI is a *relative price* measure, expressed in logarithms:

$$LN(P_{i,t}) - LN(CPI_t) = LN\left(\frac{P_{i,t}}{CPI_t}\right) \quad (5)$$

Therefore the difference between Dp_{it} and DP_t will be a *relative inflation* measure.

$$Dp_{i,t} - DP_t = LN\left(\frac{P_{i,t}}{CPI_t}\right) - LN\left(\frac{P_{i,t-1}}{CPI_{t-1}}\right) \quad (6)$$

Where expected value of this relative inflation measure will approximate to zero. Therefore the variance of this relative inflation measure will be **(7)** which is nothing but the Theil's relative price variability measure.

$$VR_t = \sum_{i=1}^{n} w_i * (Dp_{i,t} - DP_t)^2 \quad (7)$$

Note that the weights used in the calculations are fixed base year weights. Given the fact that our data set has details up to four digit commodity classification, time varying weights are not utilized in the computations.

In the following sections, relative price variability measures based on monthly inflation data will be investigated. Then we would look into the properties of the relative price variability measures based on seasonally adjusted data. As a second step, the horizon over which the relative price variability measures are computed will be lengthened to see the degree of price adjustment in a quarter and a year. As a third step we will compute the VR measures based on three different classifications of CPI: goods/services, traded/non-traded, administered/non-administered. In all these exercises, we will compare relative price variability with corresponding inflation measures.

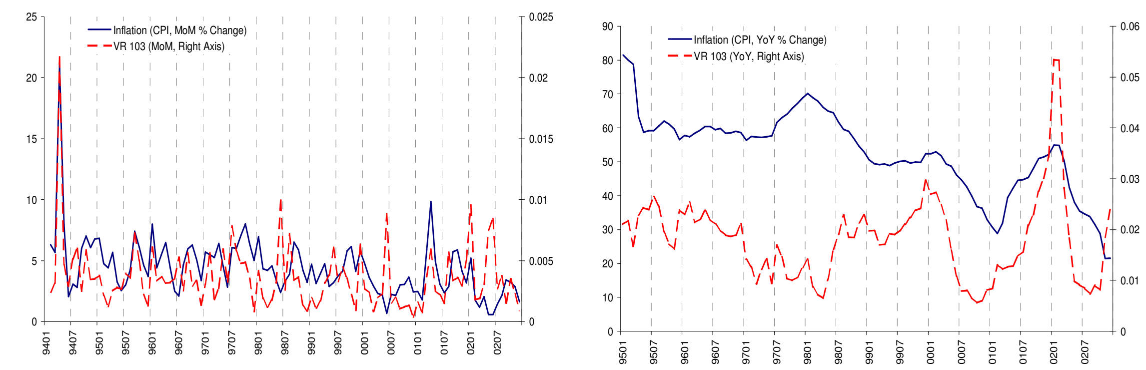
III.2.a. VR_t(103)

Relative price variability based on monthly inflation data, called as VR103 because it is based on 103 sub-items of CPI, mimics the behavior of monthly CPI inflation as can be seen from Graph III.1.a. The extreme values of CPI inflation are accompanied by high values of *VR103*. [10] Except from the coincidence of the peak values, it is difficult to analyze the relation with a visual inspection.

[10] The results of the outlier detection procedure, in Appendix 2, shows that both monthly inflation rate and VR103 have coincident outliers.

Graph III.1: Relative Price Variability And Inflation

a.) Monthly Inflation and VR103(mom) b.) Yearly Inflation and VR103(yoy)

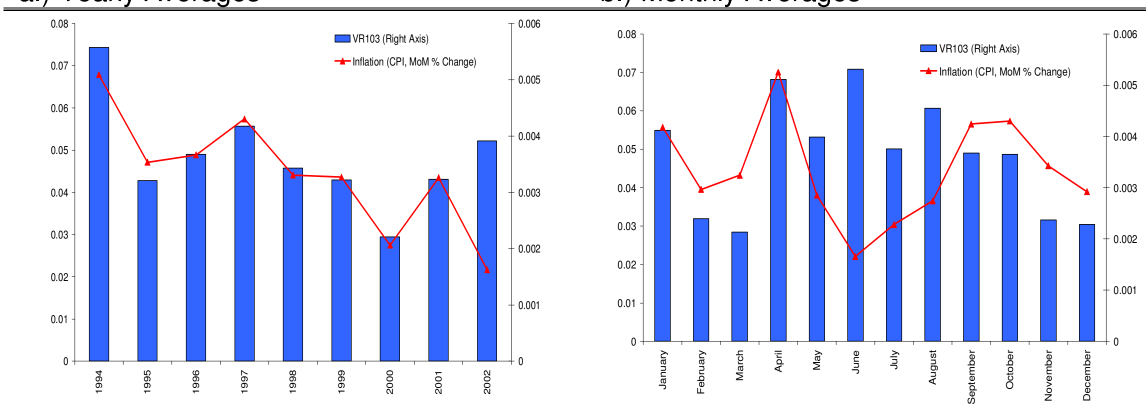


Source: SIS; Authors' Calculations

From Graph III.1.b, which displays annual CPI inflation and annual relative price variability together, we can see that the contemporaneous link between inflation and relative price variability is weaker compared to monthly measures. This is especially true for the period between 1995 and 1998. It can be clearly seen that the two series even moved in opposite directions during 1998. But, since 1999, it seems that the relationship between annual inflation and annual VR103 strengthened as they moved in the same direction throughout both inflationary and disinflation periods. The graphs above also reveal that, both the monthly and annual measures of VR103[11] increased more than the respective inflation rates in the post-crisis periods.

Graph III.2: Yearly and Monthly Averages of VR103(MoM) and Inflation

a.) Yearly Averages b.) Monthly Averages



Source: SIS; Authors' Calculations

[11] In this section, we derived VR103 based on annual inflation figures, from this point on, unless stated otherwise, VR103 stands for the relative price variability measure based on monthly inflation.

When we look at the yearly averages of VR103 we see that, except from 2002, when inflation increases so does the VR103. [12] Besides, the VR103 takes on its highest value at the crisis period of 1994 (Graph III.2a).

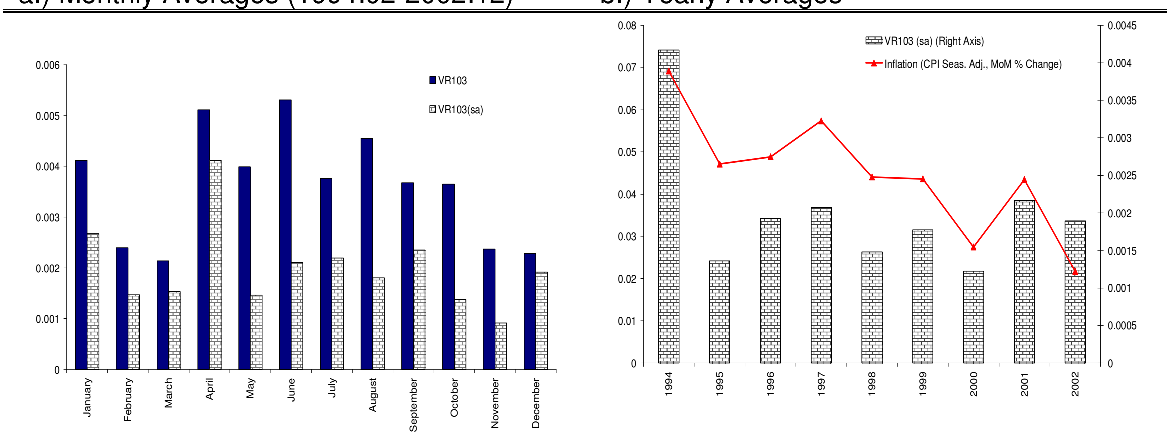
As a next step, we investigate the monthly distribution of VR103 to see if the relative price variability is due to differential seasonal patterns of each sub-group price. Contrary to our preliminary finding of year averages, we see that in the summer season, when the rate of change of prices is low, the VR103 increases. This might indicate that relative price variability may result from different seasonal patterns of each sub-item (Graph III.2b).

III.2.b. $VR_t(103)$ Based on Seasonally Adjusted Data

The relative inflation measures based on raw data might exhibit patterns pertaining to the seasonality of some sub-items in CPI and the price adjustments carried out by the public sector enterprises. To account for seasonality in some price indices, we used TRAMO-SEATS methodology by utilizing Demetra program. Each price sub-component was investigated for seasonality. While 65 out of 103 sub-items which showed clear seasonal patterns were seasonally adjusted, in 38 items, no seasonality was found. Notably, seasonal adjustment failed for most of the sectors in which the prices are adjusted periodically.

Graph III.3: Yearly and Monthly Averages Of Seasonally Adjusted VR103

a.) Monthly Averages (1994:02-2002:12) b.) Yearly Averages



Source: SIS; Authors' Calculations

When the series are seasonally adjusted, the relative price variability averages decrease to a great extent (Graph III.3a). This finding does support the view that one of the main sources of relative price variability are different patterns of seasonality in the sub items of CPI. However in April, even seasonally adjusted measure of VR103 is high, which points

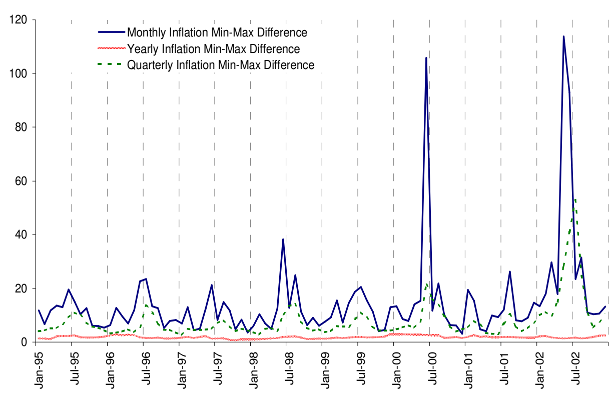
[12] We will try to explain this exception in 2002 when we discuss the relative price variability within different subgroups of CPI.

out to a factor, that increases relative price variability, other than seasonality. According to the yearly averages, positive association between relative price variability and inflation holds also for the seasonally adjusted figures, 2002 still being an exception (Graph III.3b).

III.2.c. VR_t(103) Based on Different Time Horizons

Secondly, we calculate relative price variability measures over different time horizons. With this exercise, the degree of price adjustment over different time horizons will be analyzed. Previously, it was noted that if the period of observation was extended, both the magnitude and the degree of fluctuations of differences over time would be substantially reduced (Blejer,1983). Graph III.4, which shows the differences between maximum and minimum rates of inflation for the 103 sub-items in the CPI on monthly, quarterly and annual bases, supports this view. While, the gap between the minimum and the maximum rates of change on a month-on-month basis is the highest, the gap narrows as we increase the period over which inflation is calculated.

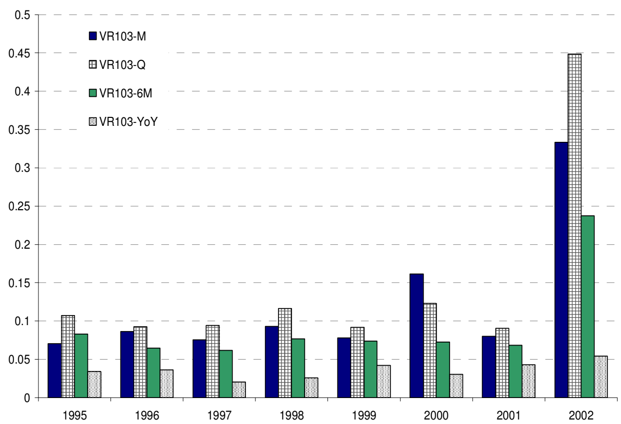
Graph III.4: Percentage Difference between Minimum and Maximum Inflation Rate(*)



Source: SIS, Authors' calculations
Note: a.) Over different time horizons, percentage difference is calculated by (max.-min.)/max. rate of inflation in CPI-103 in a given month , **b.)**Calculations are based on unweighted percentage changes

To see the degree of price adjustment over different time horizons, quarterly, semi-annual and annual measures of relative price variability were also calculated. Graph III.5 reveals that relative price variability measured over three months is higher than that of measured over a month. This rather unexpected pattern shows that in a high inflationary environment, price signals are not clear for price setters even in three months. Interestingly, in 2000, when a crawling peg exchange rate regime was adopted, the pattern is in tune with our expectations, in the sense that relative price variability decreased monotonically as the time horizon is expanded. In turn, this provides an evidence for the significance of exchange rate movements as a price signal. Another implication of Graph III.5 is that, even over a year, real inflation differential persists, implying an income transfer from one sector to the other due to inflation.

Graph III.5: Relative Price Variability Measures Based On Different Time Horizons(*)



Source: SIS, Authors' calculations
Note: VR measures are clearly affected by the rate of Inflation, which implies that relative price variability measure based on month over month differences will be smaller. Therefore all the measures were adjusted by the corresponding average rate of inflation. E.g., VR103(mom) at 1994:1 is 'standardized' with the mean of 1994:1 monthly inflation figures.

III.2.d. $VR_t(103)$ Based on Different Classifications of CPI

As a next step, we construct relative price variability measures based on different classification of CPI-103. We divide the items in CPI depending on following groups:

- Food, Beverages and Tobacco (FBT), Goods excluding FBT and Services

-Traded vs. Non-traded[13]

- Administered vs. Non-administered classifications.

The last two groups are based on the CBRT's traded and administered price classification while we generated the first classification based on CPI-103 data. From each classification, we would like to see whether the relative price variability differs across subgroups. From the first group we would like to control for the most volatile part of the price indices, namely the food. With the second group we would like to investigate the relation between traded sector prices, relative price variability and exchange rate. With the third classification we would like to see the dynamics of the public price adjustments. The findings will shed light on the inflation dynamics in Turkey. The subgroups of each classification can be seen from the table below.

[13] The items in the CPI-103 list that match with the exported and imported items in the Input-Output Table of 1996 announced by the SIS are classified as traded and remaining as non-traded.

In contrast to the ungrouped data, relative price variability formula for the grouped data is more complicated. As it would be remembered, the first step is to calculate monthly rate of change of prices (Blejer, 1983):

$$DP_t = LN(CPI_t) - LN(CPI_{t-1}) \qquad (2)$$

Then for each subgroup, we calculate the corresponding sub-group price index.

$$P_t(g_j) = \sum_{i \in g_j} \frac{w_i * p_i}{\lambda_{g_j}} \qquad (8) \qquad \text{Where} \qquad \lambda_{g_j} = \sum_{i \in g_j} w_i$$

After calculating the rate of change of price for each subgroup,

$$Dp_t(g_j) = LN\lfloor p_t(g_j) \rfloor - LN\lfloor p_{t-1}(g_j) \rfloor \qquad (9)$$

We calculate first **within group** relative price variability:

$$V_t(g_j) = \sum_{i=1}^{n} \frac{w_i * \left[Dp_i - Dp(g_j)\right]_t^2}{\lambda_{g_j}} \qquad (10)$$

As relative price variability measure is a quadratic, there is a cross-term; this cross term is called **between group** relative price variability:

$$VB_t(G) = \sum_{j=1}^{m} \lambda_{g_j} * \left[Dp(g_j) - DP\right]_t^2 \qquad (11)$$

Total relative price variability for each group is,

$$VR_t(G) = VB_t(G) + \sum_{j=1}^{m} \lambda_{g_j} * V_t(g_j) \qquad (12) \qquad \text{Where} \qquad \sum_{j=1}^{m} \lambda_{g_j} = 1$$

Note that from each classification of CPI-103 we have a different measure of total relative price variability -VR103, VR(GO), VR(T), VR(Ad) (Table III.1)- these measures are approximately equal to each other.

Table III.1: Different Classifications of Relative Price Variability(RPV) Measures

GROUP Name (G)	Subgroups (g_j)	Table Representation	RPV Measures		
			Within RPV	Between Group RPV	Total RPV
Goods		**GO**		$VB_t(GO)$	$VR_t(GO)$
	Food, Beverages and Tobacco	FBT	$V_t(FBT)$		
	Services	Ser	$V_t(Ser)$		
	Goods exc. Food, Beverage and Tobacco	GO	$V_t(GO)$		
Traded		**T**		$VB_t(T)$	$VR_t(T)$
	Traded	T	$V_t(T)$		
	Non-Traded	NT	$V_t(NT)$		
Administered		**Ad**		$VB_t(Ad)$	$VR_t(Ad)$
	Administered	Ad	$V_t(Ad)$		
	Non-Administered	N-Ad	$V_t(N\text{-}Ad)$		

III.2.d.1. RPV In Food, Services, and Goods Excluding Food Sectors

Food, beverages and tobacco (FBT), which constitute nearly 31 percent of the total CPI, is one of the most volatile sub-group in CPI. This is mainly due to the fact that food prices are mostly affected by supply conditions or exogenous factors like weather. Inflation in the services sector, which, mainly consists of rent, transportation, health, education and communication services, exhibits a more stable pattern over time compared to FBT sector. While, goods prices are more sensitive to exchange rate shocks or financial crises as the recent experience of Turkey shows; services sector prices are sticky compared to goods prices.

Table III.2: Inflation and Relative Price Variability Within FBT, Services and Goods Excluding FBT Sectors (averages of the monthly rates)

	Food, Beverages and Tobacco		Services		Goods Excluding Food, Beverages and Tobacco	
	V_t(FBT)	π_{FBT}(%)	V_t(Ser)	π_{Ser}(%)	V_t (Go)	π_{Go}(%)
1994	0.0081	7.5	0.0033	5.7	0.0037	7.1
1995	0.0050	4.4	0.0024	4.9	0.0021	4.8
1996	0.0051	4.3	0.0029	5.0	0.0024	5.2
1997	0.0076	6.5	0.0022	5.7	0.0023	5.1
1998	0.0058	3.9	0.0022	5.3	0.0019	4.0
1999	0.0057	3.7	0.0018	5.1	0.0018	4.2
2000	0.0044	2.4	0.0007	3.2	0.0011	2.5
2001	0.0046	4.9	0.0014	3.3	0.0024	5.0
2002	0.0088	1.8	0.0010	2.2	0.0017	2.4

Source: SIS, Authors' calculations
Notes: Monthly inflation rates (%) for each group are calculated as the logarithmic difference of the respective weighted indices times 100.

It can be seen from Table III.2 that except for a few observations, i.e. FBT in 2002, Services in 1998, relative price variability moves in the same direction as the inflation rate for all the subgroups. The fact that the average relative price variability within the FBT sector was at its maximum in 2002, when the average monthly inflation rate in FBT sector was at its historical minimum is quite controversial. What is even more interesting is that, the same pattern remains even when beverages and tobacco-which are known to be much less affected by the positive supply shock in 2002 compared to food– are excluded. When the food item is analyzed down to its basic sub-indices, it was observed that this huge rise in the relative price variability in FBT in 2002 was mainly due to the fresh vegetable and fruit items, which exhibited very low-even negative in the summer months- inflation rates compared to the other sub-indices of food that are less affected by the favorable supply conditions.

The average monthly relative price variability within the goods excluding FBT sector was highest in the economic crisis years of 1994 and 2001 and lowest in the distinct disinflationary episodes of 2000 and 2002. This observation shows that goods prices are quite sensitive to economic developments and that they are flexible. On the contrary, as implied by the relative price variability measures, services sector prices show some rigidity. In the disinflationary episode of 2000, the average monthly inflation rate in the services sector was 3.2 percent, which was well above the 2.5 percent average inflation rate in the goods excluding FBT sector. On the other hand, while average inflation rate in the goods sector doubled to become 5 percent in the following year of crisis, the one in the services sector increased by only 0.1 points to become 3.3 percent. The fact that the within group variability in the services sector did not rise as much as the one in the goods excluding FBT sector in 2001 also supports this view. In 2002, in both groups, relative price variability measures declined relative to 2001 levels, but the fastest convergence to 2000 levels was in goods excluding FBT sector.

The fact that relative price variability measures were higher in 2002 than in 2000, although the average monthly inflation rate was lower in 2002, can be attributed to the drastic fall in domestic demand following the big recession in 2001, which in turn increased the cost of adjusting (increasing) prices. What is more, in 2002, floating exchange rate regime brought in an increased volatility in the exchange rates, which in turn led to further divergence in the speeds of adjustment of different sectors to the changes in the exchange rate. On the other hand, as the firms faced a pre-announced exchange rate-which is the most important determinant of input prices in Turkey- and a strong demand in 2000, the cost of adjusting prices were much lower than in 2002.

Table III.3: Average Proportion of Total Relative Price Variability ($VR_t(Go)$) Accounted for by Each Component (%)

	$\lambda_1 * V_t(FBT)/VR_t(Go)$	$\lambda_2 * V_t(Ser)/VR_t(Go)$	$\lambda_3 * V_t(Go)/VR_t(Go)$	$VB_t(Go)/VR_t(Go)$
1994	51.3	16.5	22.4	9.8
1995	51.7	20.1	24.2	4.0
1996	44.1	23.3	24.4	8.1
1997	55.0	16.8	20.1	8.1
1998	44.4	21.2	28.3	6.1
1999	49.6	18.0	24.9	7.6
2000	52.5	15.8	24.2	7.5
2001	42.1	13.9	30.6	13.5
2002*	64.9	8.7	18.0	8.5

Source: Authors' calculations

Notes: a. λ_1, λ_2 and λ_3 are respectively the shares of FBT, Services and Goods Excluding FBT in total CPI, $\lambda_1+\lambda_2+\lambda_3=1$

b. The within and between group variability measures are calculated according to the formulas given in the previous section (Equations 9-13).

In order to see what the sources of the fluctuations in the total relative price variability, $VR_t(Go)$, are, we decomposed $VR_t(Go)$ to its components by multiplying the within-group variability by the weight of that group in CPI (λ_i) and dividing it by total variability ($VR_t(Go)$).

Table III.3 shows that within variability in FBT, despite having the smallest weight, contributed the most to the relative price variability. The between-group variability *$VB_t(T)$* has the smallest share. Accordingly, except for 2001, nearly %90 of the variability in relative inflation rates is due to within-group variability. There is a substantial increase in the share of between-group variability in 2001, which implies that the pricing behavior across FBT, services, and goods excluding FBT diverged considerably in 2001 and 2002. The share of $\lambda_2 * V_t(Ser)$, which has been declining since 1999, has reached its minimum in 2002, while the share of $\lambda_1 * V_t(FBT)$ has reached a record high because of the reasons discussed above.

III.2.d.2. RPV In Traded and Non-Traded Goods and Services Sectors

To see whether there is a positive association between inflation and relative price variability within traded and non-traded sectors, we calculated the monthly averages of $V_t(T)$, $V_t(NT)$ and respective inflation rates. Table III.4 shows that there is indeed a positive association between relative price variability and inflation for the traded/non-traded classification notwithstanding a few exceptions, e.g. 1997 for non-traded, 2002 for traded[14].

Table III.4: Inflation and Relative Price Variability Within Traded and Non-traded Sectors (averages of the monthly rates)

	Traded		**NonTraded**		**Exchange Rate (USD)**	
	$V_t(T)$	**π_T**	**$V_t(NT)$**	**π_{NT}**	**Volatility**	**Δe_t**
1994	0.0046	7.3	0.0049	6.0	3.5	9.4
1995	0.0023	4.5	0.0029	5.0	1.3	3.5
1996	0.0026	4.7	0.0035	5.1	1.5	5.2
1997	0.0037	5.7	0.0028	5.8	1.6	5.5
1998	0.0024	4.1	0.0025	4.8	1.1	3.7
1999	0.0022	3.7	0.0030	5.1	1.4	4.6
2000	0.0020	2.5	0.0010	3.0	0.8	2.1
2001	0.0027	4.8	0.0023	3.9	4.1	7.1
2002*	0.0033	2.2	0.0012	2.1	2.1	0.8

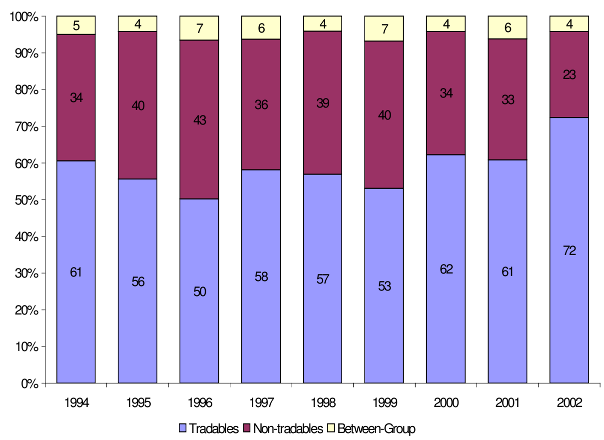
Source: CBRT,SIS, Authors' calculations
Notes: **a**. Monthly inflation rates (%) for each group are calculated as the logarithmic difference of the respective weighted indices times 100. /**b.** Monthly volatility is calculated by dividing the standard deviation of monthly exchange rate distribution by the mean of monthly exchange rate

It is a widely accepted fact that in Turkey, not only the traded sector inflation, but also the non-traded sector inflation is affected by the developments in the exchange rates[15] since foreign inputs are used in the production of non-traded goods and services, and exchange rate is one of the main determinants of the foreign input prices. In this context, it is not surprising to note that $V_t(T)$ and $V_t(NT)$ were at their minimum levels in 2000, in which, a crawling peg exchange rate regime with pre-announced daily exchange rates was being

[14] The negative relation between $V_t(T)$ and π_T in 2002 is due to the fact that traded sector includes the food item, which was analyzed in the previous section.
[15] The contemporaneous simple correlation of the change in the US dollar with the traded sector inflation is 0.60, whereas the one with the non-traded inflation is 0.57 for the period between January 1994 and December 2002.

implemented. As a natural consequence of the fixed exchange rate regime, the volatility in the exchange rates was at its historical minimum in 2000 and the average monthly change in the US dollar was also at its lowest level up to that date. The association between $V_t(T)$, $V_t(NT)$ and the exchange rate is stronger for exchange rate volatility rather than the average monthly depreciation rate. Although the average monthly depreciation rate was lower in 2002 compared to 2000, the exchange rate was more volatile, possibly leading to a different degree of pass-through behavior for different sectors, which in turn increased relative price variability.

Graph III.6: Average Proportion of Total Relative Price Variability ($VR_t(T)$) Accounted for by Each Component (%)



Source: Authors' calculations
Notes: Traded and Non-traded shares are calculated as $\lambda_1 * V_t(T)/VR_t(T)$ and $\lambda_2 * V_t(NT)/VR_t(T)$ respectively, where $\lambda_1+\lambda_2=1$.

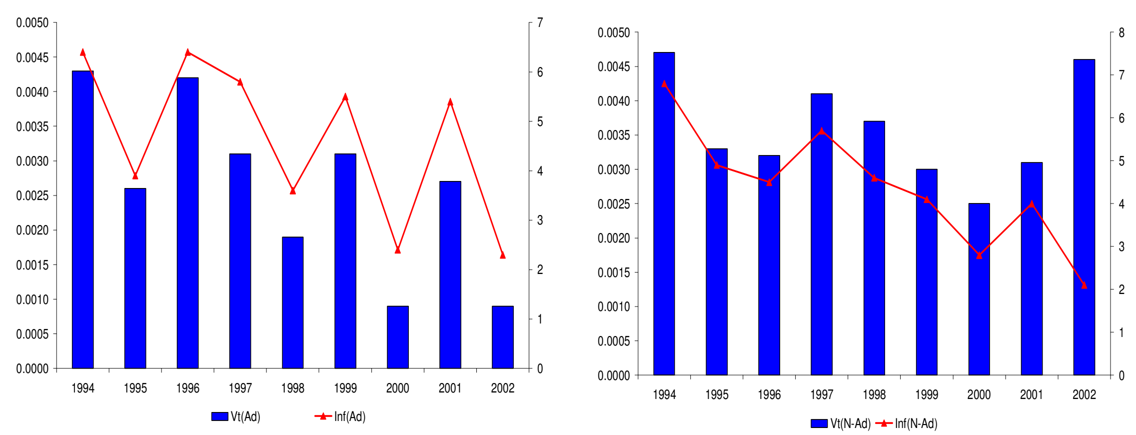
It can be observed from Graph III.6 above that the share of between-group variability ($VB_t(T)$) is for the most part negligible. Thus, most of the $VR_t(T)$ can be attributed to the dispersion of relative price changes within each set. In all cases, the variability within the traded sector accounts for a much larger fraction of the total than the variability within non-traded sector. One may argue that this is the natural result as the traded sector has a larger weight in total CPI than the non-traded sector, but the fact that $\lambda_1 * V_t(T)/VR_t(T)$ is for the most of the time larger than the weight of the traded sector in CPI, supports the result stated above. The same result was found by Blejer and Leiderman (1981) for the traded/non-traded classification for Mexico between 1951-76. According to their analysis, this implies that, in case of an open economy, a large share of relative price variability is attributable to variables that are beyond the control of the domestic authorities; because traded good prices are not only affected by domestic economic variables, but also by foreign (exogenous) factors, that have a weaker effect on non-traded goods prices. In our opinion, since in the case of Turkey non-traded goods prices are also affected by the exchange rates, an even larger part of the total relative price variability is affected by foreign (exogenous) factors.

III.2.d.3. RPV In Administered and Non-Administered Goods and Services Sectors

Administered prices, which are the prices mainly under the control of the government have in fact been used as a policy variable for the most of the time. In some periods, administered goods prices were determined in line with the budgetary needs of the State Owned Enterprises (SOE), while in others they were deliberately kept low to supply cheap input to various sectors and they were used as a nominal anchor in the fight against inflation as was the case in 2000 and 2002. In periods during which, administered goods and services inflation were artificially kept high or low relative to non-administered or free goods and services, the relative inflation rates fluctuated.

Graph III.7: Inflation and Relative Price Variability Within Administered and Non-administered Goods and Services (averages of the monthly rates)

a.) Administered Sector b.) Non-administered Sector

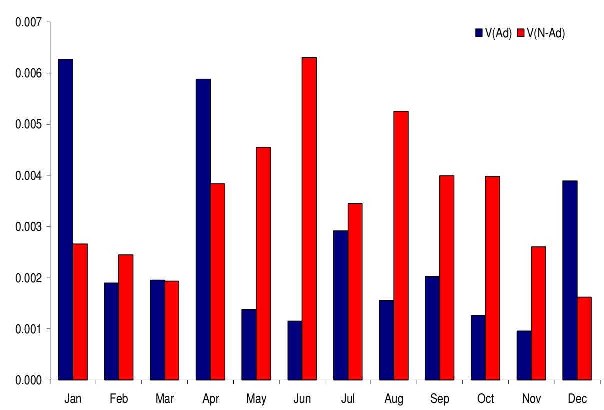


Source: SIS; Authors' Calculations
Notes: Monthly inflation rates (%) for each group are calculated as the logarithmic difference of the respective weighted indices times 100.

As presented in the Graph III.7 above, both the average relative price variability and the average rate of inflation in the administered goods and services sector are quite volatile compared to the non-administered sector. The fact that governments adjust some prices for some economic or political considerations at a given time, leads to an increase in the relative price variability within the administered sector at that time. On the other hand, there is also variability across the years: generally low values of average inflation rates and relative price variability are followed by high rates of both.

Relative price variability within the administered sector reached its lowest levels in 2000 and 2002, in which inflation rates in the administered sector were used as an additional nominal anchor in disinflation efforts and were also realized at their minimum levels on average. On the other hand, during these two disinflation periods, the relative price variability within the free goods and services sector was quite high compared to the one within the administered sector. In this kind of a situation, where $V_t(Ad)$ was much lower than $V_t(N\text{-}Ad)$, we would expect the between-group variability to increase. But, interestingly this was not the case; even was the opposite as $VB_t(Ad)$ was zero in 2000.

Graph III.8: Monthly Averages of $V_t(Ad)$ and $V_t(N\text{-}Ad)$ (1994-2002)



Source: Authors' calculations

When the monthly distribution of the relative price variability in the administered goods sector is analyzed, it can be seen that, the highest averages are for January and April respectively, in which the average monthly inflation rates are also the highest (Graph III.8)[16]. In other words, it can be said that in the months, in which the price adjustments are made, both the inflation and the relative price variability within the administered sector increase, since not all of the prices are adjusted at the same time and at the same rate.

[16] This explains why the April averages for both seasonally unadjusted and adjusted VR103 measures are so high.

IV. EMPIRICAL FINDINGS ON THE RELATION BETWEEN INFLATION AND RELATIVE PRICE VARIABILITY

The theoretical discussion presented above and the examination of the Turkish data suggest a link between relative prive variability and inflation. This section reports empirical evidence on the relationship between relative price variability and variables related to inflation such as the the rate of inflation, the acceleration of inflation, the variance of inflation and the variance of the unexpected rate of inflation, using model-free ordinary least squares equations. Although these equations are good enough to test the significance of the relationship between relative price variability and various measures of inflation, they essentially do not test one theoretical model against the other.

Table IV.1: Pair wise Simple Correlation Coefficients Between Relative Price Variability and Inflation Measures (1995:01-2002:12)

	VR103	**VR10**
Monthly Inflation Rate (π)	0.53*	0.48*
Acceleration in Monthly Inflation Rate ($\Delta\pi$)	0.49*	0.43*
Expected Inflation[17] (π^F)	0.04	0.29*
Unexpected Inflation[18] ($\pi - \pi^F$)	0.28*	0.16
6-month Variance of the Monthly Inflation Rate (σ^2_π)	0.16	0.14
6-month Variance of the Expected Inflation Rate ($\sigma^2_{\pi^F}$)	-0.07	-0.09
6-month Variance of the Unexpected Inflation Rate ($\sigma^2_{\pi-\pi^F}$)	0.10	0.04

Source: SIS, authors' calculations
Note: (*) indicates that the correlation coefficients are statistically significant.

As a first step, we calculated the pairwise simple correlation coefficients for monthly relative price variability measures and variables related to inflation. The relative price variability measures are calculated at two different levels of aggregation-103 and 10[19]- considering the earlier studies by Balk (1983) and Goel and Kam (1993), which suggest that the level of commodity aggregation may have a nontrivial effect on the relationship that is being tested. However, the main measure is the one based on 103 commodity breakdown.

[17] This series is obtained by using the insample dynamic forecasts of a monthly inflation model which is specified as follows: $\pi_t = f(\pi_{t-1}, \pi^s_{t,t+1}, cur_{t-1}, \Delta e^*_t, S_i)$ where π :monthly percentage change in CPI, π^s : quantitative inflation expectations of the *manufacturing industry* taken from SIS Monthly Manufacturing Industry Tendency Survey, cur :capacity utilization rate in the total manufacturing industry, Δe^* : percentage change in the weighted average of the current and lagged values (-1 to –4) of the nominal exchange rate and S_i : seasonal dummy for the ith month.

[18] This series is obtained by subtracting the expected rate of inflation from the realized monthly rate of inflation (the residual series of the monthly inflation model described in the previous note).

[19] VR10 is calculated by using the 10 major sub-groups of CPI.

The data used is at monthly frequency and is based on Consumer Price Index, CPI, (SIS, 1994=100) in Turkey for the period between 1994 and 2002.

Table IV.1 shows that, relative price variability measured at both levels of aggregation are closely related to the monthly inflation rate and the acceleration in the monthly inflation rate with high and significant pair-wise correlation coefficients. While the correlation coefficient between VR103 is and expected inflation is insignificant, the one between VR103 and unexpected inflation is positive and significant. On the other hand, the vice versa is true for VR10. Thus, the preliminary analysis presented by the correlation coefficients imply that relative price variability measured at the lowest degree of commodity aggregation is more closely related to unexpected inflation rather than expected inflation.

As a second step, we investigate the direction of association between relative price variability and inflation related variables before going on with the regression analysis. For this purpose, Granger causality tests, which essentially test whether *temporally* there is a consistent lead and lag relationship between the variables of interest, were ran. In the context of relative price variability and inflation, Granger causality tests indicate whether changes in the former typically precede changes in the latter or vice versa.

In the literature, there is no unanimity as to the direction of causality between inflation and relative price variability on both empirical and theoretical grounds. For the case of Turkey, Alper and Ucer (1998) found that there is no Granger causation between relative price variability and inflation by using 21 commodity breakdown of WPI to measure variability. We held the Granger tests for the monthly rates of inflation and relative price variability at both levels of aggregation[20].

Table IV.2 : Results of the Selected Granger Causality Tests (1994:02-2002:12)

Relative Price Variability Measure	*Inflation Measure*	*Lag Length*	**Hypothesis and Significance Level (p-value)** *Relative price variability does not cause inflation*	*Inflation does not cause relative price variability*
vr103	π	4	0.54	0.13
		6	0.45	0.09
		8	0.67	0.00
vr10	π	4	0.69	0.55
		6	0.54	0.14
		8	0.71	0.05

Source: Monthly CPI (SIS, 1994=100) and authors' calculations using 103 and 10 commodity breakdown of the CPI between 1994:01 and 2002:12, SIS Manufacturing Industry Monthly Tendency Survey.
Notes: a. The procedure is to regress each variable on p lagged values of the other. If the right hand side variables are jointly significant, they Granger cause the left-hand side variable. The tests were done taking lag length p as 4, 6 and 8, keeping in mind that the results of the tests may depend critically on the number of lagged terms included.

[20] Since lead and lag relationships are considered in these tests, we found it more appropriate to focus on monthly measures of variability and inflation, as the lags of annual measures which are obtained essentially by twelve order differencing do not seem to make economic sense.

Table IV.2 presents the results of the Granger causality tests for the monthly measures of relative price variability and inflation. Taking into account the fact that the direction of causality may be significantly affected by the choice of the lag length, we report the test results for three different lag lengths: 4, 6 and 8. We know that in Turkey, the adjustment in prices, is generally completed in 3-4 months, i.e. the monthly inflationary inertia is found to be significant up to 4 lags, the passthrough is found to be completed in 4 months[21]. But, keeping in mind the presence of different supply and demand elasticities in different sectors and costs associated with changing prices, we also allowed for the possibility of a longer period of adjustment - 6 and 8 lags[22].

For VR103 and monthly inflation, when 4 and 6 lags involved, we see that the hypothesis 'monthly inflation does not cause VR103' is rejected at 13% and 9% significance levels whereas the alternative hypothesis is not rejected with very high p-values. What is more, when 8 lags are involved, monthly inflation is found to Granger cause VR103 at a high significance level. Thus, combining the results for all lags, **we can conclude that there is a one way causality running from the monthly inflation rate to the monthly relative price variability measured at the lowest degree of aggregation.** This result is also supported by the tests held on VR10 but more strongly when 8 lags are included.

If we repeat the Granger causality tests for the different classifications of CPI, to test whether the same direction of association between inflation and relative price variability holds for the different classifications of CPI, we see that for 4 different subgroups out of 7, i.e. non-administered, food, services and non-traded sectors, the *group* inflation *Granger causes* the *within* group relative price variability, whereas the vice versa is not true[23].

Having obtained some evidence supporting the view that there is a one-way causality from inflation to relative price variability, we go on with the regression analysis[24], where we apply Fischer (1981) and Leiderman (1993) studies to test the significance of the relationship between relative price variability and inflation in Turkey, taking relative price variability as the dependent variable. While we preserve the basic structure of their regressions, we extend the analysis to control for the effect of degree of commodity aggregation on the relationship

[21] See Alper and Ucer (1998) for the former, Leigh and Rossi (2002) for the latter.
[22] We did not rely on the information criteria for choosing lag length because we thought economic considerations outweigh econometric ones in this case.
[23] There is no Granger causality between the administered sector inflation and the relative price variability within this sector, while for goods excluding food and traded sectors there is a feedback mechanism between the inflation rates and the within variability measures of the respective groups.
[24] See Appendix 2 for the unit root tests.

being tested. For this purpose, as discussed above, we use two measures of relative price variability -one based on 10, the other based on 103 commodity breakdown of CPI[25].

Thus, the dependent variable that we use in the regressions differs according to CPI commodity breakdown, while the explanatory variables do not since the relative price variability measures based on both levels of aggregation are related to the same consumer price inflation.

Table IV.3 present the results of the regressions linking measures of relative price variability to the inflation rate and the rate of change of the inflation rate. The absolute value of the rate of change in the inflation rate is also included among the explanatory variables in order to test whether relative price variability responds to the acceleration and deceleration in the inflation rate asymmetrically.

Table IV.3 : Regressions Explaining the Relative Price Variability with Inflation Rates, CPI (1994=100)

			Independent Variables			Summary Statistics			
R-No.	*Period*	*Dependent Variable*	*Inflation rate*[c]	*Change in the inflation rate*	*Absolute value of the change in inflation rate*	*Joint F-stat (pvalue)*	*R^2*	*DW*	*RESET (pvalue)*
3-1-1	94:02-02:12	VR103[a]	0.0558 (5.65)	0.0001 (0.19)	0.0020 (2.93)	0.00	0.34	1.88	0.00
3-1-2	94:02-02:12	VR103	0.0566 (6.45)	-	0.0020 (2.93)	0.00	0.34	1.87	0.00
3-2-1	94:02-02:12	VR10	0.0159 (4.19)	0.0003 (1.68)	0.0002 (0.78)	0.00	0.25	2.23	0.15
3-2-2	94:02-02:12	VR10	0.0162 (4.29)	0.0003 (1.65)	-	0.00	0.25	2.19	0.07

Source: Monthly CPI (SIS, 1994=100) and authors' calculations using 103 and 10 commodity breakdown of the CPI between 1994:01 and 2002:12.
Notes: a. Relative price variability measure calculated using month over month rate of inflation.
b. Values in parenthesis are t-ratios

The regression results presented in Table IV.3 verify the significance of the relationship between the relative price variability and the rate of inflation on a monthly basis for both levels of aggregation. The coefficient of the monthly inflation rate is larger in case of the relative price variability measure based on the 103 commodity breakdown (VR103). The fact that the change in the inflation rate is not statistically significant in explaining VR103 while its absolute value is, indicates that relative price variability *does not* respond to the acceleration

[25] We also wanted to control for the effect of "time" on the relationship by including the year-over-year relative price variability and inflation measures following the argument of Blejer (1983), which considered the possibility that relative price variability is mainly affected by differential speeds of price adjustment across different commodities. However, since the year-over-year change in CPI is found to have a unit root, while the relative

or decceleration in the inflation rate asymmetrically. On the other hand, the relative price variability measure based on the 10 commodity breakdown VR10 is found to be unrelated to either the change in the inflation rate or its absolute value.

Having shown the significance of the relationship between relative price variability and inflation for all variability measures, we go on with testing whether the positive association between the two is due only to the effect of unexpected inflation or also to the direct effect of expected inflation on relative price variability (Table IV.4). The first effect is implied by the Lucas-type confusion[26] between aggregate and relative shocks. Under rational expectations with market clearing and misperceptions, unanticipated changes in the money stock lead to unanticipated changes in the price level and increased relative price variability. According to this approach, while fully perceived change in the money stock has no effect on relative prices, a misperceived change in the money stock, leads to changes in prices in individual markets. Market participants, who view these changes as changes in relative prices, adjust their own prices accordingly. This in turn leads to *actual* relative price changes given that the demand and supply elasticities in individual markets differ[27]. The second effect-expected inflation having an effect on relative price variability-is implied by the existence of costs of price adjustment (Menu Cost Models). Taking the inflation rate as exogeneous and assuming that there is a lump-sum cost of changing prices, prices change only at discrete intervals. When there is a rise in the inflation rate, prices are changed more frequently, but generally this is not enough to maintain the previous dispersion of relative prices, which now widens. This menu-cost approach implies that relative price variability increases with inflation whether it is anticipated or not[28].

To test these hypothesis, an expected inflation series was needed. We used two alternative expected inflation series in our regressions. The first one is the quantitative inflation expectations of the manufacturing industry taken from SIS Monthly Manufacturing Industry Tendency Survey- denoted by π^S . Although, this series reflects the expectations about the manufacturing industry inflation, rather than CPI inflation, it is used as a proxy for CPI inflation expectations since it was the only quantitative expectation data available for the whole sample[29]. Alternatively, we constructed an expected inflation series by taking the in-

price variability measures did not, the results of the OLS regressions did not seem to be reliable (see Appendix 2). Thus, the results are not reported in this paper.

[26] These models are explained in Table III.1 as multi-market models.

[27] See Hercowitz (1981) and Fischer (1981) for a detailed explanation.

[28] See Sheshinski and Weiss (1977) for an analysis focusing on the effect of the expected rate of inflation on relative price variability.

[29] The simple correlation coefficient between manufacturing sector expected inflation and CPI inflation is 0.79 for 1994:01-2002:12

sample forecasts from a reduced form single equation monthly model, denoted by π^F [30]. Two different unexpected inflation series in turn were obtained as the difference between monthly inflation rates and respective “expected inflation” series. The absolute value of unexpected inflation was also added to the regressions[31], to test whether relative price variability responds asymmetrically to upward or downward bias in the inflation expectations (forecasts) of economic agents. If the effect of unexpected inflation on relative price variability is *symmetrical*, the coefficient of the absolute value term should be nonzero whereas the coefficient of the original term should be zero. In the presence of *asymmetry* both coefficients should differ significantly from zero.

Table IV.4: Regressions Explaining the Relative Price Variability with Expected and Unexpected Inflation, CPI (1994=100)

			Independent Variables						**Summary Statistics**			
Reg. No.	*Period*	*Dependent Variable*	*Expected Inflation*		*Unexpected Inflation*		*Absolute value of Unexpected Inflation*		*Joint F-stat (pvalue)*	R^2	*DW*	*RESET (pvalue)*
			π^S	π^F	π^S	π^F	π^S	π^F				
4-1-1	94:02-02:12	VR103[a]	0.069 (6.72)		0.010 (0.35)		0.012 (0.33)		0.00	0.37	1.68	0.00
4-1-2	95:01-02:12	VR103		0.008 (0.64)		0.067 (2.87)		0.016 (0.42)	0.04	0.08	1.62	0.19
4-2-1	94:02-02:12	VR10	0.018 (4.39)		0.016 (1.47)		0.005 (0.36)		0.00	0.23	2.11	0.01
4-2-2	95:01-02:12	VR10		0.017 (2.81)		0.019 (1.92)		0.006 (0.39)	0.01	0.13	2.13	0.09

Source: Monthly CPI (SIS, 1994=100) and authors’ calculations using 103 and 10 commodity breakdown of the CPI between 1994:01 and 2002:12, SIS Manufacturing Industry Monthly Tendency Survey.
Notes: a. Relative price variability measure calculated by using month over month rate of inflation.
b. π^S is the expected inflation rate taken from SIS Manufacturing Industry Monthly Tendency Survey.
c. π^F is the in-sample dynamic forecasts of monthly inflation rates taken from the monthly inflation equation described in footnote 14.
d. Values in paranthesis are t-ratios

According to the regression results presented in Table IV.4, π^S, expected inflation of the manufacturing industry is highly significant in explaining monthly relative price variability for both levels of aggregation while unexpected inflation (neither itself nor its absolute value) is not. However, the results are reversed for VR103, when insample forecasts from the monthly inflation model, π^F**,** are used as expected inflation. In this case, expected inflation is found to have no effect on relative price variability, whereas unexpected inflation is found to have a significant effect. On the other hand, in explaining VR10, expected inflation, π^F, is more significant than unexpected inflation.

[30] The simple correlation coefficient between expected inflation obtained from monthly inflation model and CPI inflation is 0.87 for 1995:01-2002:12. (See footnote 14 for a brief information about the monthly model)
[31] Since the expected inflation series are nonnegative their absolute values were not added to the regressions.

In sum, the regressions presented in Table IV.4 could not answer whether expected or unexpected inflation is more effective in explaining relative price variability in Turkey. The results depend on what we use as expected inflation. But, since expectations taken from the manufacturing industry monthly tendency survey are only a *proxy* for CPI expectations, the unexpected inflation series obtained in this way not only includes “the expectation error” but also the structural difference between the CPI inflation and the manufacturing sector inflation. Therefore, taking insample forecasts as expected inflation seems more reliable, suggesting evidence in favor of the Lucas-type aggregate-relative confusion approach for Turkey.

Additional regressions were held for monthly relative price variability as a function of alternative measures of inflation variability following Leiderman (1993): the moving (12-month) variances of the inflation rate, of the expected inflation rate (manufacturing industry inflation expectations) and of the unexpected inflation rate. Interestingly, inflation variability- as we measure it- is found to have no significant effect on relative price variability.

V. SUMMARY AND CONCLUSION

This paper aimed to measure the relative price dispersion in the Turkish Consumer Price Index (CPI) and verify the relationship between relative price variability and inflation in Turkey for the period between January 1994 and December 2002 from various aspects. Although, in doing so no theoretical alternative was tested against another, the results of the empirical analysis were interpreted in line with the theories discussed briefly at the beginning.

In computing the relative price variability in Turkey, measures based on seasonally adjusted data were also calculated in addition to the measures based on raw data in order to control for the effect of seasonal variation on the measure of relative price variability. Even though the monthly measure of relative price variability decreases to a great extent when seasonality is taken into account, it does not totally dissappear, implying that there are factors other than seasonality that lead to dispersion in relative inflation rates.

What is more, to control the effect of the *time span* on relative price variability, quarterly semi-annual and annual relative price variability measures were also calculated in addition to the monthly measures. It was found that, in contrast to what one would expect, as the time horizon is expanded, relative price variability measure first increases, then declines. Although relative price variability is substantially reduced after six months, the relative price adjustment is not completed even in one year’s time, which is the longest time horizon we have considered.

As a next step, relative price variability measures based on different classifications of CPI were calculated, to obtain inferences about relative price variability across different classifications. To sum up briefly: It was found that food is the sub-group that contributes the most to the total relative price variability measured over food, goods excluding food and services. In case of traded and non-traded sectors, the former is found to account for the most part of the total relative price variability based on this classification. Another striking point is that, the within variability in these sub-groups were shown to be significantly affected by the volatility in the exchange rate. When the administered vs. non-administered goods and services classification was considered, it was found that the bulk of the public price adjustments are generally realised in certain months, such as January and April, leading to higher relative price variability in these months, whereas the relative price dispersion is more evenly distributed across months in case of the non-administered group.

The relationship between relative price variability and inflation was verified both by the examination of the statistical properties of the data and carrying out simple regressions. The results show that **there is in fact a positive contemporaneous association between relative price variability and inflation in Turkey.** This conclusion is shown to be robust to the *degree of commodity aggregation* since there is a significant positive relationship between monthly measures of relative price variability and inflation no matter if the former is measured by 103 or 10 commodity breakdown of the CPI. In addition, empirical findings verified that, monthly measures of relative price variability are found to respond symmetrically to acceleration or deceleration in the inflation rates.

When, inflation was decomposed into expected and unexpected components to see which part of inflation is indeed effective on relative price variability, it was found that the results depend on what is used as expected inflation.

In our opinion, relative price variability reveals valuable information about the inflation dynamics in Turkey. Differential speeds of adjustment in different sectors and thus the role of relative prices will gain more importance as inflation is targeted down to single digit levels.

High levels of relative price variability within some sub-sectors imply that underlying inflation trend is masked by some extreme price hikes in a given period. Therefore, following an inflation measure that excludes these kinds of extreme values may be more informative than following a general measure of inflation based on CPI, in terms of policy making. A further research agenda, with these findings, can be investigating core inflation measures, which would take the findings about relative price variability into account, for policy making.

Another practical implication of excessive relative price variability is related to forecasting inflation. With a high relative price variability, treating sub-groups of CPI seperately may enhance the performance of inflation forecasts. However this is an emprical problem which should be tested against alternative methods of forecasting.

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APPENDIX 1

Table A.1 : Selected Statistics of the Distiribution of Monthly Inflation Rates based on CPI-103 Series

Obs.	Mean[(1)]	Median	Maximum	Minimum	Std. Dev.	Skewness[(2)]	Kurtosis[(3)]	Jarque-Berra	P-Value
9402	4.7	4.3	23.7	-2.3	4.6	1.3	5.4	53.0	0.0
9403	5.2	4.4	39.4	0.0	5.7	3.2	17.7	1097.3	0.0
9404	28.3	24.4	88.9	0.0	20.2	1.1	4.2	28.7	0.0
9405	9.0	9.3	41.1	-7.4	8.1	0.6	4.1	11.9	0.0
9406	2.7	2.5	16.1	-18.8	4.6	-1.4	10.1	253.7	0.0
9407	4.4	2.5	72.7	-12.9	10.5	5.0	32.3	4108.8	0.0
9408	4.4	2.7	58.0	-21.0	9.4	3.1	19.4	1321.3	0.0
9409	5.6	4.4	53.8	0.0	6.9	3.7	25.2	2352.2	0.0
9410	5.6	3.6	46.5	0.0	6.9	2.7	14.1	659.2	0.0
9411	4.7	4.0	34.7	0.0	5.5	2.9	15.1	779.0	0.0
9412	6.5	4.4	40.6	-5.2	7.5	2.0	7.7	163.7	0.0
9501	9.4	6.6	123.0	-0.5	13.6	5.9	48.9	9665.0	0.0
9502	4.4	3.8	24.6	-9.4	5.2	1.3	5.7	60.9	0.0
9503	4.3	3.6	49.9	-11.0	6.0	4.6	35.1	4795.8	0.0
9504	6.2	4.1	96.5	-8.8	10.7	6.2	50.7	10427.3	0.0
9505	3.7	3.5	24.3	-18.6	4.4	0.1	12.7	402.2	0.0
9506	2.7	2.6	31.8	-19.8	5.0	0.6	18.3	1016.8	0.0
9507	3.3	2.5	24.7	-20.8	5.4	0.3	9.3	171.4	0.0
9508	5.3	4.1	32.1	-14.9	6.8	1.4	7.5	121.0	0.0
9509	8.5	4.2	133.0	-8.5	17.6	4.9	30.4	3637.0	0.0
9510	5.2	3.6	40.8	-3.3	6.5	2.3	10.7	341.5	0.0
9511	3.6	2.6	24.8	-5.5	4.2	2.0	9.6	260.1	0.0
9512	3.3	2.7	19.5	-2.2	3.7	2.1	8.9	223.3	0.0
9601	8.7	6.6	53.2	-7.4	8.8	1.9	8.7	201.6	0.0
9602	5.3	4.3	53.2	-12.7	7.4	3.3	20.6	1506.9	0.0
9603	6.6	4.0	66.1	-1.3	9.6	3.7	20.0	1478.6	0.0
9604	6.2	4.7	42.8	-8.6	6.7	2.2	11.4	382.2	0.0
9605	5.6	4.3	47.1	-13.2	7.2	2.5	13.9	617.2	0.0
9606	3.3	2.8	46.1	-17.3	6.1	3.0	26.7	2559.7	0.0
9607	3.6	2.9	23.0	-25.2	6.2	-0.1	9.2	164.7	0.0
9608	5.9	3.7	81.5	-2.6	9.6	5.3	39.1	6076.1	0.0
9609	6.2	3.8	100.0	-5.7	12.3	5.4	37.1	5489.4	0.0
9610	5.4	4.7	23.0	-11.9	5.6	1.0	4.8	29.9	0.0
9611	3.6	2.9	33.5	-10.4	5.0	2.9	17.3	1015.0	0.0
9612	3.6	3.3	23.3	-6.4	4.0	2.1	10.5	319.9	0.0
9701	7.2	5.0	43.8	-3.3	8.5	2.3	8.8	232.0	0.0
9702	6.4	4.3	96.6	-4.0	11.4	5.6	41.7	6958.4	0.0
9703	5.3	4.2	25.5	-0.6	5.0	1.6	6.3	93.1	0.0
9704	5.3	4.0	37.9	0.0	6.1	2.7	12.4	503.5	0.0
9705	5.8	4.7	43.5	-18.9	7.8	2.1	11.3	373.1	0.0
9706	3.2	2.8	49.7	-17.9	6.5	3.2	28.9	3053.8	0.0
9707	6.6	5.5	42.0	-14.0	8.7	1.5	7.1	112.5	0.0
9708	7.3	5.6	107.0	-15.5	12.1	5.7	46.9	8833.3	0.0
9709	9.3	7.0	100.0	-12.8	12.9	4.6	28.8	3220.9	0.0
9710	7.3	6.2	43.1	-2.7	7.8	2.0	8.2	184.1	0.0
9711	5.4	4.8	41.8	-17.4	7.3	2.2	11.8	419.7	0.0
9712	4.4	4.4	17.4	-1.8	3.5	0.8	3.9	14.2	0.0

Source: SIS, Authors' calculations

Note: 1.)Since the statistics are based on unweighted measures, mean is not equal to published monthly inflation figures.

2.) **Skewness** is a measure of asymetry of the distribution of the series around its mean. The skewness of a symetric distribution such as the normal distribution is zero. Positive skewness means that the distribution has a long tail. And negative skewness means that the distribution has a long left tail *(Eviews 4.0 User's Guide).*

3.) **Kurtosis** measures the peakedness or flatness of the distribution of the series. Kurtosis of the normal distribution is 3. If the kurtosis exceeds 3 the distribution is peaked (leptokurtic) relative to the Normal. If the kurtosis is less than 3, the distribution is flat (platykurtic) relative to the normal *(Eviews 4.0 User's Guide).*

(*)Obs.	Mean[1]	Median	Maximum	Minimum	Std. Dev.	Skewness[2]	Kurtosis[3]	Jarque-Berra	P-Value
9801	7.3	5.6	48.5	-2.0	8.5	2.4	9.9	306.6	0.0
9802	4.9	4.1	49.6	-4.8	6.6	3.5	22.2	1785.7	0.0
9803	5.3	4.2	33.1	-0.5	6.1	2.6	11.2	406.4	0.0
9804	4.7	3.8	24.1	-0.7	4.7	1.5	5.8	72.9	0.0
9805	3.7	3.2	24.6	-19.2	5.2	0.3	10.9	269.3	0.0
9806	3.9	3.4	46.7	-41.6	7.5	0.0	25.3	2137.1	0.0
9807	4.2	3.4	34.8	-11.6	6.4	2.1	10.5	316.2	0.0
9808	5.3	3.0	106.7	-21.2	15.1	5.2	32.9	4314.3	0.0
9809	7.1	4.1	103.0	-2.9	12.0	5.9	43.9	7757.4	0.0
9810	4.5	3.3	35.4	-6.6	5.7	2.5	12.0	452.5	0.0
9811	3.8	3.1	41.1	-3.6	5.1	4.1	29.3	3265.9	0.0
9812	2.3	2.0	11.1	-8.8	2.6	0.2	6.2	43.8	0.0
9901	5.2	3.7	33.7	-6.0	6.5	2.0	7.8	168.2	0.0
9902	3.6	2.8	27.0	-4.8	5.0	2.3	9.9	295.5	0.0
9903	4.5	3.0	80.7	-2.5	8.8	6.7	57.3	13411.8	0.0
9904	3.6	2.8	36.9	-3.1	5.1	3.9	23.7	2111.8	0.0
9905	3.2	3.4	13.0	-26.0	4.0	-3.4	28.4	2962.3	0.0
9906	3.4	3.0	31.9	-27.7	5.9	-0.5	14.9	609.1	0.0
9907	5.1	3.1	77.0	-17.8	9.4	4.6	35.7	4949.2	0.0
9908	4.2	2.7	78.5	-6.4	10.7	5.9	39.6	6333.8	0.0
9909	7.5	4.0	91.5	-0.6	12.3	4.4	26.2	2627.9	0.0
9910	4.8	3.7	26.8	-1.1	5.2	1.9	7.3	140.0	0.0
9911	3.0	2.7	17.5	-2.4	3.0	1.6	8.0	153.4	0.0
9912	7.5	4.3	100.0	-5.3	14.8	4.6	25.4	2518.7	0.0
0001	6.1	4.4	79.5	-4.9	9.1	5.4	43.2	7424.8	0.0
0002	3.2	2.9	29.1	-5.5	4.2	2.6	16.4	880.4	0.0
0003	2.7	2.1	22.3	-2.7	3.7	3.0	14.0	674.0	0.0
0004	2.3	2.1	15.5	-16.5	4.2	-0.9	10.6	260.3	0.0
0005	2.4	2.1	20.2	-14.3	4.1	1.1	11.6	336.1	0.0
0006	1.2	1.2	19.6	-41.5	5.0	-5.6	54.4	11897.8	0.0
0007	2.5	1.4	21.2	-6.6	4.0	2.2	9.5	263.4	0.0
0008	2.6	1.5	40.1	-12.3	6.0	4.0	23.7	2118.1	0.0
0009	3.0	2.2	24.6	-8.5	4.0	2.5	13.3	563.0	0.0
0010	2.7	1.9	18.2	-2.7	3.6	2.0	8.0	177.0	0.0
0011	3.2	2.2	20.9	-3.8	3.9	2.1	8.6	206.9	0.0
0012	1.7	1.3	7.0	-0.7	1.8	1.2	3.8	26.1	0.0
0101	3.0	1.8	51.1	-6.6	6.0	5.2	41.7	6906.0	0.0
0102	2.1	1.5	25.0	-5.1	3.9	2.9	16.9	975.1	0.0
0103	6.6	5.2	31.3	-0.7	6.4	1.6	5.5	67.7	0.0
0104	10.9	11.0	44.3	-2.9	8.2	0.9	5.0	32.3	0.0
0105	6.0	5.1	50.0	-8.1	6.7	3.0	20.1	1405.8	0.0
0106	3.5	2.3	21.4	-8.9	4.9	1.5	6.7	96.5	0.0
0107	2.5	2.3	15.6	-13.2	3.8	0.3	6.6	57.7	0.0
0108	4.3	2.9	59.5	-25.5	8.4	3.4	25.0	2274.8	0.0
0109	6.2	4.4	56.3	-1.7	7.9	3.4	18.7	1252.1	0.0
0110	5.6	4.6	34.8	-14.7	6.1	1.3	8.5	157.0	0.0
0111	4.1	3.6	31.5	-9.5	5.3	1.4	9.2	199.1	0.0
0112	2.7	1.5	52.8	-4.0	6.0	6.3	50.1	10203.9	0.0
0201	5.1	2.5	65.4	-17.2	9.9	3.3	18.2	1184.5	0.0
0202	2.1	1.3	28.6	-5.9	4.9	3.2	16.9	1008.3	0.0
0203	1.5	1.1	18.4	-16.7	3.9	0.6	13.5	477.3	0.0
0204	2.1	1.0	26.3	-12.2	4.8	2.1	11.9	417.4	0.0
0205	1.5	0.8	20.4	-37.6	5.0	-3.9	39.9	6120.9	0.0
0206	1.1	1.1	11.8	-34.9	6.2	-3.7	21.6	1714.5	0.0
0207	1.7	1.5	17.0	-16.4	4.3	-0.4	8.4	128.5	0.0
0208	2.9	1.3	60.3	-18.8	8.3	5.1	34.6	4725.7	0.0
0209	3.8	2.2	45.6	0.0	6.5	4.3	24.3	2272.6	0.0
0210	2.7	1.3	31.9	-5.8	4.8	3.1	16.7	980.1	0.0
0211	2.4	1.3	29.2	-4.8	4.0	3.6	21.8	1732.8	0.0
0212	1.4	0.9	16.7	-6.0	2.6	2.4	13.9	608.3	0.0

APPENDIX 2: UNIT ROOT TESTS

In order to be able to interpret the results of the OLS regressions presented in Section IV correctly, we need to investigate the time series properties of the series used in our regressions, i.e by carrying out unit-root tests. Besides, looking for the presence of unit-root in various relative price variability measures, i.e VR103(mom), VR103(yoy), VR10(mom), VR10(yoy) would provide information about whether the effect of shocks to the variability measures would dissappear over time or approach a nonzero permanent level.

In testing for the presence of a unit-root in various relative price variability measures and variables related to inflation, we make use of the Augmented Dickey-Fuller (ADF) test. Suspecting (from the plot of the data) that the series in question may have one or more outliers, we test for the presence of additive outliers (AO) using the methodology developed by Vogelsang (1999) and carry out the ADF tests also by introducing the additive outliers in the regression equation in the manner suggested by Franses and Haldrup (1994)[32].

Table A.2.1: Results of Outlier Detection Test Results

	τ_c	Outlier
vr103(mom)	8.936**	1994:04
vr103(yoy)	4.686**	2002:01
	5.401**	2002:02
vr10(mom)	6.372**	1995:09
	5.496**	1994:04
	5.264**	1998:08
vr10(yoy)	3.307**	1999:11
	3.515**	1999:01
π (mom)	9.014**	1994:04
π (yoy)	2.624	1995.01
π^S (mom)	14.260**	1994:04
	4.869**	2001:04
	4.575**	2001:03
π^F (mom)	3.29**	2001:04

Notes: The critical values for the τ_c are taken from the Table 1 of Erlat (2002).

Asymptotic Critical Values for the τ_c Test:

Significance Level (α)	No. Of Outliers	Critical Value
0.10	1	2.81
	2	3.38
	3	3.88
0.05	1	2.99
	2	3.69
	3	4.29

*:significant at the 10% level. **: significant at the 5% level

In Table A.4.1 the results of the outlier detection procedure of Vogelsang (1999) is shown[33]. For all of the series measured on a month over month basis (except for π^F which starts from January 1995), April 1994 shows itself as a highly significant outlier. The monthly

[32] This methodology was applied by Erlat (2002) for the Turkish inflation series between January 1987-January 2000.

[33] For the details of the outlier detection procedure see Vogelsang (1999) and Erlat (2002). The computer program used in outlier detection is the one written by Haluk Erlat in Shazam.

relative price variability measure based on a 10 commodity breakdown, which is in fact less volatile than the measure based on 103 degree of aggregation, has two more outliers, September 1999 and August 1998. As expected, the graphs shown in Section III also support the presence of the outliers found significant by the additive outlier detection procedure for the monthly and annual meausures of VR103. No significant outlier was found for the yearly rate of change in CPI.

Having detected the significant outliers in the series of interest, we go on with ADF tests (Table A.4.2). We include the additive outliers to the test equation in such a way that the distribution of the asymptotic null distribution of the t-statistics are not changed (Erlat,2002). For this end, each outlier is included in the regression with the appropriate lag length, i.e supposing that the ADF test equation involves 3 lags of the dependent variable, each outlier appears with three lags in the regression. Thus, if there are 2 outliers, there would be 6 dummy variables. As stated in Erlat (2002), the inclusion of the additive outliers in the above-mentioned manner may be problematic especially if the outliers are close to the beginning of the sample or if there are adjacent outliers. In such cases, the equation cannot be estimated because of perfect multicollinearity.

Table A.2.2: ADF Test Results With and Without Impulse Dummies

	T	P	ADF	LB(24)	Dummies
Without Dummies					
vr103(mom)	105	0	**-9.243****	8.189 (0.999)	
vr103(yoy)	94	1	**-3.607****	11.178 (0.988)	
vr10(mom)	105	0	**-10.478****	26.852 (0.311)	
vr10(yoy)	94	1	**-3.147****	15.668 (0.900)	
π (mom)	105	0	**-6.449****	26.923 (0.308)	
π (yoy)	94	1	**-2.030**	16.117 (0.884)	
π^S (mom)	105	0	**-7.121****	4.732 (1.000)	
π^F (mom)	89	6	**-4.821****	22.25 (0.564)	
With Dummies					
vr103(mom)	105	0	**-12.172****	34.409 (0.078)	d9404
vr103(yoy)	94	1	**-5.252****	27.702 (0.273)	d0201
vr10(mom)	105	0	**-14.845****	27.753 (0.271)	d9509, d9404, d9808
vr10(yoy)	94	1	**-2.824**	16.659 (0.863)	d9911, d9901
π (mom)	105	0	**-9.643****	55.232 (0)	d9404
π (yoy)	94	1	**n.a**	n.a	None
π^S (mom)	105	1	**-6.241**	18.913 (0.757)	d9404,d0104
π^F (mom)	89	6	**-3.672**	22.24 (0.565)	d0104

Notes: LB stands for the Ljung-Box statistic which has an asymptotic chi-square distribution with k-p degrees of freedom under the null hypothesis, with k number of autocorrelations. In this case, k=24

Due to Franses and Haldrup (1994**) the MacKinnon critical values** (with constant) are used.

T	p	T-p-1	0.01	0.05	0.10
105	0	104	-3.494	-2.889	-2.581
94	1	92	-3.502	-2.893	-2.583

Following Erlat (2002) the lag length is chosen in the following manner: First of all, the choice of lag length is made without accounting for the existence of the outliers. In choosing the lag length, essentially three kinds of information are used: Akakie Information Criterion (AIC), the Schwartz Information Criterion (SIC) and the sequential testing of the coefficient of the last lag. If two of these comply with each other, the corresponding lag length is chosen, if there is no compliance among them, the choice is made according to the one that gives the highest lag length. The most important criteria in the lag choice is the lack of autocorrelation in the residuals. Thus if there is autocorrelation in the residuals despite agreement among all the other criteria, we increase the lag length until we get rid of autocorrelation[34].

The results of the ADF tests with and without impulse dummies are shown in Table 2. The ADF tests *without* dummies imply that only annual CPI inflation has a unit root. The null hypothesis of a unit root is strongly rejected especially for the month over month relative price variability measures. When we include impulse dummies to account for the presence of additive outliers, the rejection is even more stronger for VR103(mom), VR103(yoy) and VR10(mom). On the other hand, the unit root hypothesis cannot be rejected for VR10(yoy) when the impulse dummies are added to test equation. The rejection of a unit root for the monthly inflation rate seems to be stronger when the April 1994 dummy is added to the test equation, but this ADF statistic cannot be interpreted because there is autocorrelation in the residuals. In this particular case, when the lag length is increased to get rid of autocorrelation say to 2, the test equation cannot be estimated because the second lag of D9404 is a zero vector. Thus, we have to rely on the implication of the standard ADF statistic for this variable, which suggests that there is no unit root in the monthly inflation rate. This is also valid for the case of annual inflation rate, since no significant outliers were found using the outlier detection methodology described above.

[34] In the lag length procedure, first a maximal lag length is chosen (13 in our case). Then, AIC and SIC are calculated dropping one lag at a time but keeping the sample size constant for the information criteria to be comparable. Testing for autocorrelation is done by using Ljung-Box statistic. The computer program which is originally written by Prof. Dr. Haluk Erlat in Shazam, is modified for this specific case.