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Disinflation in Transition Economies: The Role of Relative Price Adjustment

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Abstract

In light of the persistence of moderate inflation in many transition economies, this paper analyzes whether inflation resulted from insufficiently tight financial policies and wage pressures or from the protracted adjustment of relative prices. Using a new database for 21 countries, the effect of relative price variability on inflation is estimated within a framework controlling for nominal and real shocks. Money and wage growth were the most important determinants of inflation; relative price variability had a sizable effect at high inflation during initial liberalization and a small effect at moderate inflation. Cost recovery may contribute to variability, particularly in the advanced stages of the transition.

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Summary

In light of concerns over the persistence of moderate inflation, this paper analyzes the empirical evidence on the determinants of inflation in 21 transition economies. Beyond the classic sources of inflation, in particular insufficiently tight financial policies and wage pressures, it focuses on the possible role of protracted relative price changes—a feature of transition economies that may make rapid disinflation more costly than in market economies.

Using a new database, the statistical distributions of relative price changes were analyzed for each country to obtain measures of relative price variability. An equation for inflation—derived from a simple analytical model—was estimated for the pool of 21 countries and the robustness of these estimates was assessed. Based on evidence of parameter instability, separate specifications were obtained for Eastern Europe, the Baltics, and the other states of the former Soviet Union. The experiences of five countries—the Czech Republic, Poland, Estonia, Moldova, and Russia—were examined to gain further insights on factors underlying relative price variability, money growth, and real appreciation.

The evidence suggests that significant relative price adjustments occur throughout the transition even well beyond comprehensive initial liberalization. Money growth plays a dominant role in explaining inflation in all three regions, and nominal wage growth has a substantial impact in Eastern Europe and the countries of the former Soviet Union. Relative price variability effects vary by region and over the sample period, being sizable at high inflation during initial liberalization and small at moderate inflation. Downward price rigidity and inertia tend to be significant at moderate inflation. The estimates do not show a significant impact of real appreciation and are inconclusive regarding an independent effect of explicit exchange rate anchors. The evidence suggests that cost recovery may be a factor underlying relative price variability, inflation, and real appreciation, particularly in the later stages of transition.

DISINFLATION IN TRANSITION ECONOMIES: THE ROLE OF RELATIVE PRICE ADJUSTMENT

I. INTRODUCTION

Although most formerly centrally planned economies experienced very high rates of inflation at the beginning of their transition, many have succeeded in lowering inflation to moderate levels of about 20-40 percent a year. However, there has been limited success in reducing inflation to relatively low levels of the order of about 10 percent a year. In some cases, inflation has declined to low monthly rates, but these reductions have, so far, rarely been sustained.

A key question for Fund-supported programs in these economies is whether the persistence of moderate inflation results from the traditional factors of insufficiently tight financial policies and wage pressures, or from factors peculiar to transition economies—specifically the sizeable adjustment of relative prices that is necessary for the transformation to a market economy. This paper attempts to shed light on this issue by analyzing the empirical evidence relating to the determinants of inflation in a group of 21 transition economies. It considers whether relative price adjustments take place over a prolonged period—even following rapid liberalization—and contribute to a period of moderate inflation, perhaps initially through an increase in velocity and, depending on exchange rate policy, over time through an increase in the money supply via the balance of payments. Some factors that could underlie the marked real appreciation experienced by many transition economies are also examined. The paper does not provide specific levels of feasible or appropriate inflation targets for Fund-supported programs. This would require an analysis of the output and other costs of disinflation as well as consideration of the relative priorities placed on disinflation versus other program objectives: subjects which are beyond the scope of this paper.

A review of inflation performance in transition economies under Fund-supported programs indicates that the overshooting of inflation targets has frequently been associated with money growth in excess of program projections (Table 1). However, targets have been overshot even when money growth projections were met (and vice versa), suggesting that the link between money growth and inflation may shift in ways that are difficult to anticipate and that money growth alone does not provide a complete explanation of inflation, particularly in the short run. These features point to a need to understand better some of the factors that could contribute to money growth and to unstable velocity in these countries, such as relative price adjustment.

The paper is organized as follows. Section II briefly reviews the literature on the determinants of inflation, particularly that relating relative price variability to overall inflation, and provides a broad analytical framework for the subsequent empirical work. Section III analyzes the characteristics of the distribution of price changes in 21 transition economies

Table 1: Summary of Performance under Recent Fund-Supported Programs in Transition Economies 1/

(By number of program periods) 2/

		Exceeded Inflation Target		Met Inflation Target	
By region					
Total	51	39		12	
Eastern Europe	12	6		6	
Baltics	15	14 3/		1	
FSU	24	19 4/		5 4/	
By type of arrangement					
Total	51	39		12	
SBA	32	26 5/		6	
First Credit Tranche	1	1		0	
STF	12	10		2 4/	
EFF	2	2		0	
ESAF	4	0		4	
		of which:		of which:	
		Exceeded Broad Money Projection	Met Broad Money Projection	Exceeded Broad Money Target	Met Broad Money Target
By region					
Total	51	25	14	10	2
Eastern Europe	12	3	3	6	0
Baltics	15	7 3/	7	0	1
FSU	24	15 4/	4	4 4/	1
By type of arrangement					
Total	51	25	14	10	2
SBA	32	17 5/	9	5	1
First Credit Tranche	1	1	0	0	0
STF	12	7	3	1 4/	1
EFF	2	0	2	0	0
ESAF	4	0	0	4	0

Source: Annex I.

1/ For programs approved from June 1992 to June 1995 in the sample of 21 countries included in this study. Levels of targeted and actual inflation and broad money growth during each program period (defined as periods of at least half a calendar year, unless otherwise noted) are given in Annex I.

2/ Inflation and money growth generally measured at end-of-period growth rates.

3/ Includes two program periods of one calendar quarter.

4/ Includes one program period of one calendar quarter.

5/ Includes three program periods of one calendar quarter.

using disaggregated CPI data.[1] The results of econometric estimates of a semi-reduced form inflation model using panel data for the 21 countries are examined in Section IV. These results are complemented by Section V which takes a closer look at some issues related to relative price adjustment in five countries—Czech Republic, Poland, Estonia, Moldova, and Russia—selected to cover a range of progress with regard to stabilization and structural reform as well as different policy regimes. The concluding section summarizes the main findings of the paper.

II. REVIEW OF THE LITERATURE AND ANALYTICAL FRAMEWORK

The literature suggests four broad groups of factors that could explain the stickiness of inflation in transition economies after the initial monetary overhang has been dissipated: monetary growth fueled by fiscal obligations, often reflecting delayed structural reforms; wage increases out of line with productivity gains; underlying pressures for an appreciation of the real exchange rate coupled with a policy of stabilizing the nominal exchange rate; and relative price adjustment combined with downward price rigidities, or more generally, asymmetric price responses. The last three factors may be associated with unanticipated capital inflows and endogenous money growth through the balance of payments.

A. Fiscal Obligations and Money Growth

At the beginning of the transition, most centrally planned economies faced both a stock and flow macroeconomic disequilibrium. The former took the form of a monetary overhang which dissipated relatively quickly following an initial burst of inflation when prices were liberalized. The flow disequilibrium—mainly due to the monetization of explicit and implicit fiscal obligations—however, has been a driving force behind the persistence of inflation in many countries (Bruno (1993), Fischer, Sahay, and Vegh (1995), Scacciavillani (1994)). The weakening of the ability to expropriate enterprise surpluses and the collapse in output often contributed to a sharp decline in government revenue while subsidies and transfer payments increased. In many cases, fiscal deficits were financed by bank borrowing; however, even when these deficits were relatively small, banking system credit to public enterprises often increased sharply and fuelled rapid money growth. Indeed, in transition economies, the measured fiscal deficit vastly understates the true extent of fiscal obligations which mainly arise from unreformed institutional relationships, particularly with regard to public enterprises and the banking system (Dornbusch (1992), McKinnon (1992)).

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[1]The structure of the sample is shown in Appendix I, Table 13 and Appendix III, Table 19. Transition economies in Asia and the republics of the former Yugoslavia (except Slovenia) are not included in the analysis. Tajikistan and Turkmenistan are also excluded because of data problems.

An additional factor influencing the persistence of inflation even when some degree of monetary control has been established is the credibility of the fiscal adjustment which could contribute to shifts in velocity. Public perceptions of the sustainability of a fiscal and credit tightening are influenced by such factors as progress with regard to fiscal reform—particularly social safety net and pension reform and the adoption of an inflation-resilient tax system—public enterprise restructuring and privatization, and the health of the banking system (Bruno (1993)).

B. Wage Pressures

Wage policies can contribute to the stickiness of inflation in several ways. First, wage increases in excess of productivity gains can directly place upward pressure on prices. Second, higher wage bills are often responsible for the expansion of credit, and hence money, to state enterprises and to the government (Sahay and Vegh (1995a)). Third, explicit or implicit wage indexation can contribute to significant inflation inertia. Fourth, the lack of relative wage flexibility both at the sectoral and enterprise level can raise the output cost of reducing inflation and weaken the eventual economic recovery, thus making continued inflation a more politically acceptable alternative (Edwards (1992), SM/95/316). Although the empirical evidence is mixed on whether exogenous wage increases have driven inflation in transition economies, there are indications that large wage increases in reaction to an initial inflation shock have sustained and fueled inflationary pressure in a number of countries (Citrin and Lahiri (1995), Commander (1992), Dayal-Gulati (1996), SM/95/316).[2]

C. Real Exchange Rate Appreciation and Capital Inflows

Many transition economies have experienced strong upward pressure on their real exchange rates.[3] In those countries that maintain a relatively stable nominal exchange rate, this real appreciation would be accompanied by capital inflows and monetary expansion and would be associated with a rate of inflation above that of trading partners. On the other hand, in countries with flexible exchange rates, real appreciation would be associated with nominal appreciation and downward pressure on the overall rate of inflation. The literature identifies at least three factors that could lead to real appreciation during transition.

- Initial undervaluation of the real exchange rate relative to its equilibrium level. In transition economies, undervaluation usually arises when the nominal exchange rate of new

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[2]In a number of Fund-supported programs in the FSU, nominal wage growth substantially exceeded program expectations and turned out significantly higher than the corresponding inflation targets (Citrin and Lahiri (1995)).

[3]Measured either in terms of the relative price of traded and nontraded goods (the definition used in most of the analytical literature) or in terms of relative CPIs (the definition commonly used in empirical work).

currencies is initially set at excessively low levels (often to minimize risks to competitiveness or international reserves) or when the nominal exchange rate is influenced by temporary distortions in asset markets.[4] Undervaluation may be manifested in different ways: first, the domestic prices of tradable goods may be lower than comparable goods in world markets because the arbitrage of traded goods prices takes place only gradually.[5] Second, even after traded goods prices have equalized, real product wages may be lower than indicated by labor productivity in traded goods; these low wages would also be reflected in prices of services that are lower than in countries with comparable levels of per capita PPP-adjusted GDP.[6] Evidence of very low prices of services have been found for Russia (De Masi and Koen (1995)) and the Baltics (Richards and Tersman (1995)). Although undervaluation is likely to have been significant in the early years of the transition (Saavalainen (1995)), there is little clear-cut evidence that it persists several years after liberalization, particularly when international differences in productivity in traded goods are taken into account.

• Differential productivity growth between the tradable and nontradable sectors (Balassa (1964), Samuelson (1964)): higher productivity growth in tradables relative to nontradables may raise real wages and lead to an increase in the prices of nontradables relative to tradables, and hence, to a real appreciation. Although such productivity growth differentials have been observed in market economies,[7] and suggested for the Baltics (Richards and Tersman (1995)), hard empirical evidence for transition economies is scant. Moreover, it is unclear whether productivity growth differentials in favor of tradables should be expected in transition economies since productivity gains in the relatively underdeveloped

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[4]For instance, with negative real interest rates on bank deposits and no other liquid inflation hedges, foreign exchange can become the most important form of liquid wealth holding and can drive the exchange rate far from its purchasing power parity level (Bruno (1993)).

[5]While price differentials in tradables could arise from trade barriers, quality differentials, and the embodiment of a non-tradable component in the form of distribution costs, some have argued that these factors alone may not explain the large deviations from international prices of traded goods found, for instance, in Russia (De Masi and Koen (1995)) and Latvia (Richards and Tersman (1995)).

[6]An important implication of the Balassa-Samuelson model is that cross-country differences in nontradable prices (i.e., wages and service prices) are explained by differences in productivity in traded goods. Thus, in principle, price levels would be comparable only among countries that have similar PPP-adjusted levels of per capita GDP.

[7]For instance, higher productivity growth in tradables in Japan and Western Europe has been found to explain a significant part of the downward secular trend in the post-war U.S. dollar real exchange rate (Faruqee (1995), Rogoff (1996)). The evidence, however, is mixed for comparisons across EMS and OECD countries (De Gregorio et al. (1993), Froot and Rogoff (1991), Micossi and Milesi-Ferretti (1994)).

service sector (e.g., financial services, communications, retailing and wholesaling) could be substantial during transition (Halpern and Wyplosz (1996)).

• Demand pressures associated with a perceived shift to a higher level of permanent income: the move to market-determined prices may increase permanent income in transition economies; while potential output takes time to expand, private consumption may adjust more rapidly through external borrowing. Similarly, an increase in investment financed by foreign savings may temporarily raise the demand for domestic resources.[8] These increases in domestic absorption could give rise to a temporary appreciation of the equilibrium real exchange rate during transition. However, increases in private consumption or the fiscal deficit in excess of levels that would be supported by a higher permanent income could give rise to excessive real appreciation and capital inflows that would eventually be reversed.

D. Relative Price Adjustment

Evidence for transition economies

While in the long run inflation is determined by money supply growth, the adjustment of relative prices from a highly distorted to a market-determined structure could, under certain conditions, contribute to upward pressure on inflation in transition economies.[9] Evidence for Russia and Kazakhstan indicates that price liberalization entails a measured increase in the variability of relative prices (De Broeck et al. (1995) and De Masi and Koen (1995)). Notably, in the case of Russia, although price variability subsided following a relatively rapid and comprehensive initial liberalization, it persisted at high levels in comparison with market economies. In addition, in both countries, variability is positively associated with inflation

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[8]A related factor is the change in the relative size of the public sector which would affect the real exchange rate because of the tendency for public expenditure to fall mainly on nontradables in comparison with private expenditure (Froot and Rogoff (1991), De Gregorio et al. (1993)). However, because of the drastic changes in the composition of public revenues and expenditures that typically occur during transition, the direction of this effect is difficult to gauge.

[9]Fund staff have argued that "administered price increases" have been a major factor behind inflation performance in the FSU (e.g., Citrin and Lahiri (1995)). However, while such price increases may contribute to inflation volatility, they cannot be considered a fundamental determinant of inflation over a sustained period if these prices are periodically restored to the same relative value; in such a case, administered prices would contribute to lower inflation during periods when they are not being raised (Phillips (1994)). Hence, administered price increases may be considered a determinant of inflation only if they are part of a process of relative price adjustment and other prices are sticky downwards. In a statistical sense, the upward adjustment of a particular administered price during a period in which other nominal prices are not adjusted does contribute to inflation in the short run.

(and changes in inflation), although this finding is based on a simple correlation which does not control for common shocks to both variables.

The persistence of relative price variability in transition economies following even comprehensive initial price liberalization could be explained in terms of the unavoidably limited speed of structural reforms and the changing structure of output and demand associated with the gradual move to a market economy. Another explanation, which also has implications for the appreciation of the real exchange rate, is the cost-recovery hypothesis which argues that the adjustment of certain capital-intensive service prices (housing, utilities, transportation) must take place more gradually than the adjustment of other prices, particularly tradables which are subject to international competition (Zavoico (1995), Saavalainen (1995)). These services are distinguished by a capital stock that not only was inherited, with no associated debt, from the pre-transition era, but also is large relative to the PPP-adjusted per capita income of these countries. Initially, when consumer wage levels are low, such service prices would be set to cover only current costs, even in a fully liberalized environment, because there are no associated debt service costs. Maintenance costs may not be covered because it is optimal initially to consume the excessively large capital stock. As real incomes rise and the capital stock that can be supported by these incomes also rises,[10] the prices of these services would be raised, at first to cover maintenance costs and then to cover (future) capital costs, until they reach a level at which new investment can take place.

The gradual nature of the capital stock adjustment and cost recovery process suggests that some service prices will continue to adjust over several years following even comprehensive price liberalization.[11] It also implies that price levels in such economies would be lower than indicated by international comparisons of PPP-adjusted GDP, not due to undervaluation, but because of the pricing of capital.[12] Thus the real exchange rate may also

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[10]Real incomes could rise because of general productivity growth, whatever its source. Unlike the Balassa-Samuelson effect, this does not require differential productivity growth between traded and nontraded goods.

[11]In practice, many prices for which cost-recovery is a consideration are government controlled in most transition economies and may involve a subsidy element as well. Nevertheless, the point of the cost-recovery hypothesis is that even if these administered prices are set according to market principles (i.e., involve no net subsidy), they would initially be substantially lower than in market economies—where such capital-intensive service prices largely reflect the cost of capital—and would rise sharply as real income grows and creates a demand for new investment. This phenomenon has been observed, for instance, in Estonia, where there is little or no budgetary subsidy on public services, and some items such as housing have been privatized (Zavoico (1995)).

[12]The undervaluation argument outlined above involves an element of disequilibrium whereas the gradual adjustment of service prices described here is an equilibrium phenomenon, which

(continued...)

be expected to appreciate more steeply as real incomes rise (and the prices of these services are increased to permit new investment) than may normally be expected for market economies.[13] Any attempt to bring about a more immediate adjustment in the relative prices of cost-recovery items—if successful—is likely to entail a substantial contraction in demand or—if unsuccessful—higher inflation.

Analytical approaches

What implications does the extensive theoretical literature have for an empirical investigation of the relationship between inflation and relative price variability? Classical theory suggests that relative price adjustment reflects real factors and would not affect the increase in overall prices, which depends on money growth. However, the empirical association in market economies between inflation and relative price variability—which can be measured in different ways (Box 1)—has long been noted (since the 1920s). The theoretical basis for this association is quite varied, particularly with regard to the implied direction of causality between inflation and variability—an important consideration for empirical work.

Since price liberalization and structural reform in transition economies continue to cause the realignment of relative prices, under what conditions could this realignment, as reflected by relative price variability, contribute systematically to inflation? According to one view (see Box 1), real sectoral shocks increase the dispersion of both desired and actual relative price changes and lead to an increase in inflation because firms (not affected by the shock) resist a decline in their own prices and, in general, respond asymmetrically to disturbances which induce a rise in desired prices than to those which induce a fall in such prices.[14] This downward price inflexibility, or more generally asymmetric price response, implies that an increase in inflation would be associated not only with higher variance, but also

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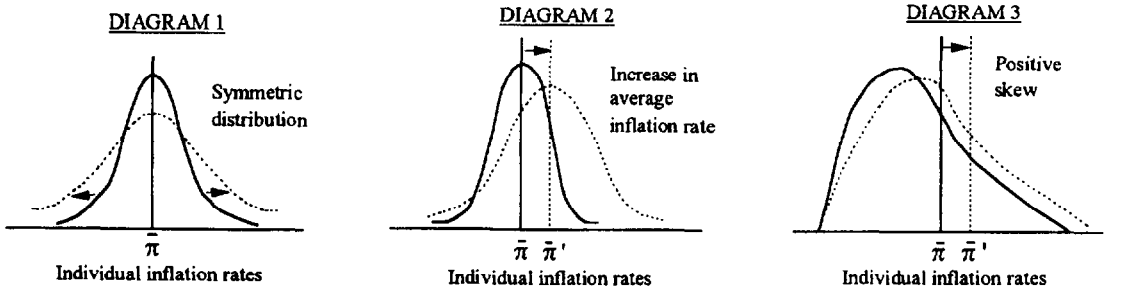
[12](...continued)
does not necessarily involve market distortion, inefficiency, or excess profits.

[13]The Balassa-Samuelson model implies that the ratio of nontraded to traded goods prices is positively related to per capita real GDP. This proposition has been empirically supported across a broad group of high income and low income countries based on the United Nations International Comparison Program (ICP) data. However, the robustness of this result among industrial countries as a group and developing countries as a group is less clear (Heston et al. (1994), Rogoff (1996)).

[14]See Ball and Mankiw (1994, 1995), Fischer (1981, 1982), and Frenkel (1982). The asymmetry of the price response is frequently simply assumed and justified informally in terms of the storability of different goods or as the result of expectations about the government's policy response, particularly the likelihood of monetary accommodation. However, asymmetry may also be derived rigorously as an endogenous response in a menu-cost model with positive trend inflation (Ball and Mankiw (1994)).

Box 1. Relative Price Variability and Inflation

Changes in relative prices or relative price variability can be measured in terms of the characteristics—or shape—of the distribution of individual inflation rates of goods and services comprising a price index (such as the CPI), at a given point in time. The shape of such a distribution is commonly described by the measures of variance and skewness. An increase in relative price variability, for instance, would result in a greater dispersion of individual inflation rates and a broadening of the distribution—or an increase in variance (Diagram 1). The question whether relative price adjustment is associated with inflation can thus be seen in terms of whether changes in the shape of the distribution are systematically related to shifts in the mean of distribution—which correspond to changes in the average inflation rate (Diagram 2). Clearly, an increase in variance need not necessarily lead to an increase in inflation if price increases of some goods are matched by commensurate declines in others—as in a symmetric distribution. When a price distribution is positively skewed, however, large increases in the prices of a few goods are accompanied by small price increases (or even price declines) in other goods (Diagram 3). Since the latter are not commensurate with the large price increases, suggesting downward price inflexibility, an increase in positive skewness may be associated with an increase in average inflation.



An important consideration, which has implications for empirical work, is whether the direction of causality runs from variability to inflation or vice versa. Theoretical models in this area can be classified into three broad approaches according to the implied differences in these causal relations:

- In the first approach, the dispersion of relative price changes and the unanticipated change in inflation (as well as the time variance of inflation) are determined simultaneously, and depend on the variance of unanticipated aggregate and relative demand shocks.[1] Normality in the distribution of prices is important to the derivation of the results from these

[1]This group includes stochastic rational expectations models with imperfect information where agents cannot distinguish between general and relative price changes (Lucas (1973), Barro (1976) Hercowitz (1981)) and models with differential adjustment in individual markets due to staggered contracts (Blanchard (1983), Taylor (1981)). In a two-sector (controlled versus free goods) version of an imperfect information model, Leiderman (1987) shows that in addition to unanticipated aggregate and relative demand shocks, relative price variability within the free goods sector increases to the extent that price increases of controlled goods are not synchronized with (anticipated) nominal money supply growth.

type of models. Since common exogenous shocks simultaneously increase relative price variance and inflation, which are both endogenous, the direction of causality is ambiguous (Cukierman (1979)). Increased relative price variability is associated symmetrically with unanticipated inflation or deflation.

• In the second approach, the rate of inflation is treated as exogenous and causality runs from inflation or unexpected inflation to relative price variability.[1] Because of differential costs of adjusting prices ("menu costs"), not all firms increase prices simultaneously when inflation (anticipated or not) rises, which leads to a greater dispersion of relative price changes. Since menu costs are symmetric, relative price variance rises with both increases or decreases in inflation. In transition economies, the administrative costs of adjusting prices of public services (rents, utilities, transport etc.,) have a similar effect, in terms of making prices sticky, as menu costs; thus when inflation rises, relative price variance could increase because administered prices are not adjusted in line with market conditions.

• Under the third approach, real sectoral shocks increase the dispersion of prices and raise inflation because firms not affected by the shock resist a decline in their own prices. Causality thus runs from relative price variability to inflation; a positive relationship between the skewness of the distribution of price changes and the rate of inflation is also suggested. As indicated above (see Diagram 3), if individual prices are downwardly rigid, increases in a few prices in response to a real sectoral shock both increase the degree of skewness and shift the mean of the distribution to the right (and hence raise the inflation rate). In a more rigorous analysis, Ball and Mankiw (1995) also derive a positive relationship between skewness and inflation by introducing menu costs.

These analytical approaches to the relationship between inflation and relative price variability have two implications for empirical work: first, although much of the existing empirical evidence is based on simple bivariate correlations between inflation and relative price variability, the association between the two variables needs to be considered in a multivariate setting that controls for common shocks. Second, since causality can, in principle, run in either direction, it is important to examine the factors underlying increases in relative price variability.[2]

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[1]This group comprises models with inter-firm differences in costs of adjusting prices ("menu costs") (Sheshinski and Weiss (1977)) and deterministic models of imperfect information (Parks (1978)). The latter differs from stochastic models (included in the first group) in that they do not explicitly model expectations formation, but rather take the expected overall inflation rate as a given.

[2]This is done, as an illustrative example, for five countries in Section V. Causality tests are not feasible in the current sample because of the short observation period for each country. In any case, such tests can capture only temporal precedence rather than logical causality. For market economies, causality tests find no clear patterns of leads and lags between inflation and relative price variability (see Appendix I).

a positively skewed distribution of individual price changes. In transition economies, the adjustment of relative prices to a new market-determined structure—including the adjustment of capital-intensive service prices according to the cost-recovery hypothesis—can be interpreted as a series of real sectoral shocks which, when combined with downward price rigidity and, over time, an accommodative monetary policy stance, can lead to higher inflation.

III. EMPIRICAL EVIDENCE ON RELATIVE PRICE BEHAVIOR

The preceding discussion suggests that the shape of the distribution of individual inflation rates of goods and services comprising a price index can provide important insights into factors underlying the relationship between inflation and relative price adjustment. This section, therefore, briefly reviews the main results of a detailed analysis of the characteristics of the inflation distributions (based on the CPIs) of the 21 transition economies included in the study.[15] The sample of quarterly CPI data covers the period from 1991-92 to the third quarter of 1995 for most countries and typically has a level of disaggregation varying from 10-70 categories of goods and services (Appendix I, Table 13).

The analysis was based on four indicators characterizing the sample distributions of individual price changes, weighted by their contribution to the CPI or unweighted, for each time period and country. The results are broadly in line with findings for market economies (see Appendix I) and indicate that:

- the sample distributions tend to shift substantially over time within countries indicating the presence of substantial relative price changes throughout the transition period—even well beyond comprehensive initial liberalization. This finding was confirmed by the lack of significant time persistence, in all but a few cases, in the different relative price variability measures.[16] The evidence also suggests variations in the degree and nature of relative price adjustment across countries.[17]

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[15]The sample characteristics and results of the analysis are presented in greater detail in Appendix I which also summarizes the main messages from existing empirical work on market economies (as a basis for comparing these results) and reviews definitions of the different measures of relative price variability.

[16]A distinction is made in this paper between relative price variability which refers to the volatility of relative prices and may be measured by variance or skewness and relative price variance which refers to measures reflecting the width of the distribution (or dispersion) of individual inflation rates comprising the CPI (see Box 1).

[17]Comparisons of the characteristics of price distributions across countries should be interpreted with caution since such differences can also reflect differing weights and levels of

(continued...)

• The distributions also show frequent and significant departures from both normality and symmetry, consistent with the presence of downward inflexibility in individual prices (Appendix I, Table 14; see Box 1 for the implications of non-normality and asymmetry). The rate of rejection of normality and symmetry increases noticeably for weighted price changes, indicating that the weighting system exerts a significant influence on asymmetry.

• When asymmetry prevails, the direction of skewness is frequently positive, suggesting that a small number of large relative price increases led the inflationary process and coexisted with a large number of small relative price reductions (Table 2).

• A decomposition of variance indicates that most (some 65-75 percent on average) of the total variation in relative prices stems from within tradables, and to a lesser extent (about 15-25 percent), from within nontradables; the contribution from variance between tradable prices and nontradable prices is relatively minor.[18]

In addition, in keeping with the literature, the relationship between the average inflation rate and various indicators of relative price variability, were examined on a country by country basis (Appendix I, Tables 15-18).[19] The main result is that the empirical relationship between inflation and relative price adjustment could be sensitive to the choice of variability indicator, particularly between variance and skewness, suggesting that both measures of relative price variability should be included in the panel regressions. While variance appears to be somewhat positively correlated with inflation, skewness in the distribution of price changes appears to be only weakly associated with the level of inflation, although when significant, it too tends to be positively correlated.[20]

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[17](...continued)
disaggregation in the CPI data.

[18]The decomposition was based on a measure of relative price variance, commonly used in the literature, referred to in this paper as the "Theil variance" (from Theil (1967); see Appendix I). These average proportions are similar to those reported for Mexico (Blejer and Leiderman (1982)), although the period-to-period fluctuations are much greater for transition economies. These patterns may, however, reflect the dominance of tradable goods, both in terms of weights and the number of commodities, in the CPI baskets. (Detailed results available upon request).

[19] These results are only tentative since diagnostic tests reveal the likelihood of misspecification (and hence, the need for multivariate estimation) and since the sample size for each country is small.

[20]As the panel regressions reported in the next sections show, skewness becomes more significant in a multivariate estimation.

Table 2. Share of Total Sample of Quarterly Observations with Positive Skewness

(In percentages)

Region	Country	Unweighted Commodity Price Changes		Weighted Commodity Price Changes	
		Share of Total Sample Skewed	Of Which Positively Skewed	Share of Total Sample Skewed	Of Which Positively Skewed
East and Central Europe	Albania	73.3	81.8	93.3	78.6
	Bulgaria	38.1	62.5	90.5	100.0
	Czech Rep.	68.4	84.6	78.9	93.3
	Hungary	31.6	66.7	68.4	92.3
	Poland	90.9	90.0	86.4	94.7
	Romania	100.0	93.3	100.0	93.3
	Slovenia	81.3	53.8	62.5	70.0
	Slovak Rep.	86.7	46.2	80.0	83.3
Baltics	Estonia	76.9	70.0	92.3	100.0
	Latvia	92.3	75.0	92.3	75.0
	Lithuania	92.3	100.0	100.0	92.3
FSU	Armenia	36.4	100.0	100.0	90.9
	Azerbaijan	100.0	100.0	100.0	100.0
	Belarus	86.7	100.0	100.0	100.0
	Georgia	42.9	100.0	85.7	66.7
	Kazakstan	73.7	85.7	100.0	89.5
	Kyrgyz Rep.	100.0	100.0	100.0	100.0
	Moldova	80.0	91.7	93.3	85.7
	Russia	100.0	93.3	100.0	100.0
	Ukraine	76.4	92.3	88.2	100.0
	Uzbekistan	83.3	100.0	83.3	100.0

IV. EMPIRICAL EVIDENCE ON THE DETERMINANTS OF INFLATION

In view of the discussion in the preceding sections, what light does an econometric analysis shed on the sources of inflationary pressure in transition economies? This section discusses the underlying methodology and results of such an analysis for a panel of 21 transition economies. These regressions are intended to capture the impact on inflation of relative price adjustment, including those giving rise to real appreciation, when nominal shocks such as money and nominal wage growth are controlled for.

A. The Basic Model for Inflation

The factors explaining inflation discussed in Section II were brought together in a simple static two-sector model of traded and nontraded goods and money market clearing to derive and interpret an estimated equation for inflation (Appendix II). Dynamics were not included because the limited time coverage of the data (on average about 12 quarters per country) permits the estimation of only short-run (mainly within-quarter) effects, with no distinction made between short- and long-run parameters. A semi-reduced form for inflation was selected for estimation rather than a reduced form version (Equations (11) or (11') in Appendix II) because of the relevance of the regressors, particularly the real exchange rate, to the policy debate. The basic equation derived from the analytical model can be expressed as:

$$\pi = \gamma_0 + \gamma_2 m + \gamma_3 w + \gamma_4(\pi_{NT} - \pi_T) + \gamma_5 V_\pi$$

$$\gamma_2 > 0;\ \gamma_3 > 0;\ \gamma_4 < 0;\ \gamma_5 > 0$$

where the $\gamma's$ are functions of the structural parameters of the analytical model as shown in Equation (8) of Appendix II.[21] Hence, the initial specification was of the form:[22]

$$\pi = \gamma_0 + \gamma_1 \pi(t-1) + \gamma_2 m + \gamma_3 w + \gamma_4(\pi_{NT} - \pi_T) + \gamma_5 TVAR + \gamma_6 TSK + \textit{seasonal dummies}$$

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[21]The variables are as follows: π = overall inflation rate; m = nominal money growth; w = nominal wage growth; $(\pi_{NT} - \pi_T)$ = rate of change of the real exchange rate (i.e., the change in the ratio of prices of nontradables to tradables); V_π = relative price variability. In the initial specification for estimation (see next equation), a lagged inflation term $(\pi(t-1))$ was added and relative price variability was measured with two variables: the Theil variance (*TVAR*) and the Theil skewness (*TSK*) (see Appendix I).

[22]Since several variables in the equation, including money growth, may be endogenous, problems of simultaneity could arise and need to be addressed in the estimation.

B. Estimation Methodology[23]

With the dependent variable defined as the quarterly end-of-period inflation rate, on the basis of the above equation, the specification initially included: 1) the lagged inflation rate, to account for inflation inertia; 2) the growth rate of broad money, both contemporaneous and up to a two-quarter lag; 3) an indicator of labor cost pressure (unit labor cost growth, when available, or nominal wage growth), both contemporaneous and with one-quarter lag;[24] 4) an indicator of real exchange rate behavior (the differential growth of nontraded and traded goods prices), both contemporaneous and with a one-quarter lag;[25] 5) and indicators of relative price adjustment (the Theil variance and skewness analyzed in Appendix I). Additive dummies were included to control seasonal effects. The differential impact of the exchange rate regime on inflation was tested through additive and multiplicative dummies (on both the inflation inertia and the real exchange rate terms) for countries and periods where the exchange rate was used as an explicit nominal anchor (see Appendix III, Table 19).[26]

The equations were estimated by ordinary least squares with corrections for the bias in standard errors (and hence t-statistics) due to heteroschedasticity, as indicated by diagnostic tests.[27] Using a "general to specific" modelling strategy, a more parsimonious final equation was derived from a larger initial set of explanatory variables following a specification search which eliminated statistically insignificant regressors in order of least significance (Appendix III, Table 20). The final specification estimates were then tested for robustness to different definitions of the most important regressors: liquidity and relative price variance.

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[23]The sample coverage and methodology are presented in greater detail in Appendix III.

[24]Nominal unit labor costs are used for Eastern Europe (except Albania) and nominal wages for the Baltics and the FSU. Hence, for Albania, the Baltics, and the FSU, no allowance is made for wage growth accounted for by productivity growth. However, to the extent that productivity growth could often be negative in these countries (due to labor hoarding, negative output shocks etc.), it is difficult to establish, a priori, whether the estimated coefficient would overstate or understate true labor cost pressures.

[25]This indicator reflects more closely the definition used in most of the analytical literature than the more commonly used (and more easily available) measure based on relative CPIs.

[26]A dummy variable was also included for an extreme outlier (in the data for Armenia) which resulted in a highly nonnormal distribution of residuals and made tests of statistical significance (F and t tests) uninterpretable.

[27]The residuals of the estimated equations were examined for, but did not reveal in most cases, evidence of autocorrelation (results available upon request).

Based on evidence of parameter instability across regions (Table 3; Appendix III, Table 22),[28] three regional specifications were estimated separately for Eastern Europe, the Baltics, and FSU, respectively.[29] The robustness of the estimated coefficients was assessed by re-estimating the regional specifications by weighted least squares (Appendix III, Tables 23-25). In addition, the sensitivity of the results to changes in the sample period was examined by re-estimating the regional specifications for Eastern Europe and the Baltics excluding the initial period of liberalization.[30] Since consumer expenditure weights can give a distorted view of the relative importance of certain sectors (public services, for instance, tend to have a very small weight in the CPI of many transition economies), the sensitivity of the results to unweighted indicators of relative price variability was also examined.[31]

To address the issue of simultaneity, a full instrumental variables procedure was attempted, but the estimates proved highly sensitive to the choice of instruments. Since the available instruments (which are limited by the availability of data) were only very poorly correlated with the two relative price variability terms, a more limited exercise was undertaken for each of the three regions: in order to account for one obvious source of simultaneity arising from the presence of price-controlled goods in the CPI,[32] the variance and skewness

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[28]The predictive performance of the pooled model in different regional subsamples suggested that it was being driven by the subsample corresponding to the FSU; the pooled model performed less well for the Eastern European and Baltic regional blocks. Formal testing of parameter instability through standard Chow/F-tests and recursive procedures was made difficult by heteroschedasticity and nonnormality of the residuals.

[29]"Eastern Europe" includes transition economies in Eastern and Central Europe and "FSU" refers to countries that were part of the Former Soviet Union, other than the three Baltic countries.

[30]A similar analysis could not be made for the FSU because the delayed and gradual nature of price liberalization in many countries limited the sample period excessively.

[31]Relative price variability can be measured in many ways (see Appendix I). A choice has to be made whether price changes should be weighted by their contribution to the CPI or be unweighted, and if the former, how the weights should enter into the definition of variability. Measured variability thus depends on the characteristics of the sample, particularly the degree of disaggregation of the price data—which influences the dispersion of the weights—and the accuracy of the weights. Hence, any observed empirical relationship between inflation and relative price variability is likely to be sensitive to the choice of indicator and the characteristics of the sample.

[32]With price controlled goods, an increase in inflation would automatically increase relative price variance if such prices are not immediately raised in line with market conditions (see Box 1).

Table 3. Sensitivity to Specification of Regional Subsamples 1/

(OLS-HCSE estimates; dependent variable: quarterly CPI inflation rate)

Variable	Pooled Sample	East and Central Europe	Baltics	FSU
Constant	13.80 (2.35)**	0.92 (0.58)	6.64 (2.07)**	43.27 (2.41)**
Money growth	0.26 (2.94)***	0.05 (0.24)	-0.02 (-0.23)	0.24 (2.12)**
Money growth, lagged 1 quarter	0.38 (4.08)***	0.52 (2.16)**	0.29 (3.53)***	0.37 (3.21)***
Money growth, lagged 2 quarters	0.09 (1.78)*	0.10 (0.77)	0.06 (0.87)	0.08 (1.45)
Variance of relative prices 2/	0.04 (6.54)***	0.03 (8.82)***	0.02 (1.86)*	0.04 (3.24)***
Outlier dummy	1517.3 (89.15)***			1495.22 (62.16)***
Seasonal dummies	Some significant	Not significant	Some significant	All significant
R-squared corrected	0.92	0.52	0.60	0.92
F-statistics (zero slopes)	380.4***	20.04***	7.93***	149.51***
Breusch-Pagan test for heteroschedasticity	101.49***	95.87***	1.88	36.23***
White test for heteroschedasticity	174.68***	101.72***	—	78.76***
Jarque-Bera test for normality of residuals	3780.98***	169.85***	7.67**	176.17***
Number of observations	260	122	33	105

1/ For the t-statistics reported in parenthesis, three asterisk indicates statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level; - indicates that the variable was not included because of lack of significance in the specification search. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ Measured by the Theil variance.

terms were recalculated only on the basket of liberalized goods.[33] These new terms were substituted for the two contemporaneous relative price variability indicators and the equations were re-estimated, instrumenting for all other contemporaneous terms—i.e., money and nominal wage growth.

C. Estimation Results

The specification search yielded equations with high explanatory power (an adjusted R-squared of over 0.9 for the pooled sample of 21 countries and the FSU and about 0.7 for the other two regions) and significant, and generally plausible, parameter estimates (Table 4).[34] Variations in inflation in the post-liberalization period in Eastern Europe and the Baltics proved more difficult to capture and the corresponding equations have somewhat lower explanatory power (an adjusted R-squared of 0.5-0.6). The estimations for all three regions were robust to the correction of standard errors for bias due to heteroschedasticity and to re-estimation using weighted least squares (Appendix III, Tables 23-25).[35] The results for Eastern Europe and the Baltics were generally robust to estimation by instrumental variables, although the statistical significance (but not the size) of the coefficient on wage growth tended to diminish. For the FSU, the coefficient on wage growth increased and that on money growth became statistically insignificant. The latter appeared to be due to the lack of a good instrument for money growth in the available data set, perhaps reflecting the fact that money growth in the FSU has resulted mainly from discretionary credit expansion, and hence, would be difficult to instrument. In addition, as indicated above and is well-known in the literature, these estimates are sensitive to the choice of instruments.

The specification search also revealed collinearity between nominal wage growth and relative price variance in the pool and the FSU block (the correlation coefficient in the two samples is almost 0.8), so that both terms could not be individually significant at the same time. Although the pooled sample results are driven mainly by the FSU, the procedure followed in the specification search resulted in the wage cost term being eliminated from the

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[33]The basket of liberalized goods was defined by eliminating all public services (rents, utilities, transport etc.,) and any commodity whose price did not change for three consecutive quarters. Although this would not necessarily yield a basket of liberalized goods for every country, it should eliminate price-controlled goods from the sample in most cases.

[34]Although the specifications for Eastern Europe and the Baltics include a lagged dependent variable, long-run elasticities should not be inferred from the estimates, because dynamic relationships are not sufficiently well-captured in these panel regressions where much of the sample variation is cross-sectional.

[35]Some caution may be called for in the interpretation of F and t statistics since diagnostic tests reveal non-normal residuals, although the large sample sizes (over 100 observations) may help in this regard.

Table 4. Final Specification: Pooled and Regional Estimates 1/

(Dependent variable: quarterly CPI inflation rate)

Variable	Pooled Sample	East and Central Europe		Baltics		FSU
	OLS-HCSE	Full sample OLS-HCSE	Post-liberalization OLS-HCSE	Full sample OLS-HCSE	Post-liberalization OLS-HCSE	OLS-HCSE
Constant	13.80 (2.35)**	0.36 (0.29)	1.18 (1.24)	1.56 (0.96)	4.18 (4.80)***	57.51 (3.61)***
Additive dummy for exchange rate anchors	-	-	-	-	-	-
Multiplicative dummy for exch. rate anchor effects on inflation inertia	-	-0.15 (-1.44)	0.03 (0.26)	-	-	-
Inflation rate, lagged	-	0.23 (3.30)***	0.41 (4.68)***	0.25 (3.27)***	0.09 (1.36)	-
Money growth	0.26 (2.94)***	-	-	-	-	0.20 (2.14)**
Money growth, lagged 1 quarter	0.38 (4.08)***	0.32 (2.29)**	0.21 (1.99)**	0.32 (3.82)***	0.23 (4.77)***	0.30 (2.94)***
Money growth, lagged 2 quarters	0.09 (1.78)*	-	-	-	-	-
Nominal wage growth	-	0.21 (3.21)***	0.13 (1.91)*	-	-	0.21 (2.34)**
Nominal wage growth, lagged 1 quarter	-	0.08 (2.72)***	-0.008 (-0.15)	-	-	-
Real exchange rate change (PNT/PT), lagged 1 quarter	-	-0.15 (2.08)**	-0.26 (-5.19)***	-	-	-
Variance of relative prices 2/	0.04 (6.54)***	0.02 (5.65)***	0.005 (0.57)	-	-	-
Skewness of relative prices 2/	-	-	-	0.90 (2.59)**	0.89 (2.93)***	
Skewness of relative prices, lagged 1 quarter 2/	-	-	-	-	-	5.40 (1.96)*
Seasonal dummies	some significant	-	-	-	-	some significant
Outlier dummy	1517.3 (89.15)***	-	-	-	-	1489.27 (82.19)***
R-squared corrected	0.92	0.66	0.58	0.73	0.53	0.94
F-statistics (zero slopes)	380.4***	34.07***	20.50***	30.05***	12.04**	187.46***
Breusch-Pagan test for heteroschedasticity	101.49***	105.59***	75.50***	5.95*	9.55***	37.18***
White test for heteroschedasticity	174.68***	80.60***	53.36**	9.50	6.25	77.11***
Jarque-Bera test for normality of residuals	3780.98***	407.26***	91.84***	0.66	8.84**	52.72***
Number of observations	260	122	100	33	31	105

1/ For the t-statistics reported in parenthesis, three asterisks indicate statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level; - indicates that the variable was not included because of lack of significance in the specification search. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.
2/ Measured by the Theil variance and skewness, respectively.

pooled sample (and the Theil variance retained) and vice versa for the FSU. Hence, alternative specifications were derived retaining the wage term in the pool but eliminating it in the FSU (Table 5).

What light do the results shed on the sources of inflationary pressure in transition economies, particularly the role of relative price adjustments? Do the estimates suggest significant regional differences in these sources and whether their relative influence may shift over time? The main messages that emerge from the empirical analysis can be summarized as follows:

- Inflation is strongly and positively correlated with broad money growth and displays a relatively rapid response to a monetary shock. Contemporaneous and lagged money growth has an elasticity of about 0.5-0.7 in the pooled sample and the FSU and about 0.3 in the other two regions (Table 4).[36] Evaluated at the sample mean, it contributes on average about one half of inflation in the pool and over one third in each of the regions (Table 6). In Eastern Europe and the FSU, the relative contribution of money growth to inflation is higher in 1995 (the final year of the estimation) than in the sample mean. The money variable may reflect accommodation—either exogenously through credit creation or endogenously through capital inflows and reserve accumulation—of wage and relative price shocks, including real appreciation. This suggests that better monetary control, including by allowing nominal appreciation, could help bring about greater disinflation.

- Nominal wage pressures appear to have a significant impact on inflation, with an elasticity of about 0.2-0.3, accounting on average for about a fifth to a fourth of quarterly inflation in Eastern Europe and the FSU; wage pressures do not appear to be a significant factor in the Baltics (Tables 4 and 6). However, since these labor cost indicators capture only pressures arising from monetary remuneration, the estimated coefficients may understate pressures arising from non-wage benefits (most likely monetized, and hence, reflected in the money growth variable) which were considerable, especially in the FSU. In Eastern Europe, the relative contribution of wage growth to inflation is higher in 1995 than in the sample mean.

- The empirical significance of the impact of relative price adjustment is sensitive to the indicator used to measure variability—particularly between variance and skewness—and to the sample period. Except in the case of the FSU, the results are generally robust to the

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[36]Estimations over the pooled sample suggest this result is robust to a change in the definition of the regressor from broad money to domestic credit (of the banking system) due to the high correlation between these two variables, which reflects the limited capacity of commercial banks in most transition economies to lend or borrow abroad. However, inflation appears more responsive to a broad concept of money which includes foreign currency deposits than to a narrow concept which excludes them (the estimated elasticity is nearly halved in the latter case), consistent with evidence for market economies (Appendix III, Table 21).

Table 5. Relative Price Indicators: Alternative Specifications in Pooled Sample and FSU 1/

(Dependent variable: quarterly CPI inflation rate)

Variable	Pooled Sample		FSU	
	Final specification	Alternative specification: including nominal wage growth 2/	Final specification	Alternative specification: excluding nominal wage growth 3/
Constant	13.80 (2.35)**	17.47 (2.79)***	57.51 (3.61)***	59.80 (3.24)***
Additive dummy for exchange rate anchors	-	-5.64 (-2.19)**	-	-
Money growth	0.26 (2.94)***	0.24 (3.05)***	0.20 (2.14)**	0.23 (2.03)**
Money growth, lagged 1 quarter	0.38 (4.08)***	0.32 (4.10)***	0.30 (2.94)***	0.40 (3.08)***
Money growth, lagged 2 quarters	0.09 (1.78)*	0.09 (1.68)*	-	0.12 (2.20)**
Nominal wage growth	-	0.16 (2.90)***	0.21 (2.34)**	-
Variance of relative prices 4/	0.04 (6.54)***	0.02 (1.68)*	-	0.04 (4.37)***
Variance of relative prices, lagged 1 quarter 4/	-	-	-	-0.02 (-2.66)***
Skewness of relative prices, lagged 1 quarter 4/	-	-	5.40 (1.96)*	7.57 (2.39)**
Seasonal dummies	some significant	some significant	some significant	all significant
Outlier dummy	1517.3 (89.15)***	1512.05 (96.41)***	1489.27 (82.19)***	1465.4 (60.42)***
R-squared corrected	0.92	0.93	0.94	0.93
F-statistics (zero slopes)	380.4***	358.88***	187.46***	139.77***
Breusch-Pagan test for heteroschedasticity	101.49***	114.04***	37.18***	43.57***
White test for heteroschedasticity	174.68***	206.18***	77.11***	83.62***
Jarque-Bera test for normality of residuals	3780.98***	2364.69***	52.72***	152.58***
Number of observations	260	260	105	105

1/ For the t-statistics reported in parenthesis, three asterisks indicate statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level; - indicates that the variable was not included because of lack of significance in the specification search. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ If nominal wage growth term is retained at an earlier stage of the specification search (despite being statistically insignificant, as indicated by the t statistic.)

3/ If nominal wage growth term is eliminated (despite being statistically significant) and relative price variance is retained at an earlier stage of the specification search.

4/ Measured by the Theil variance and skewness, respectively.

Table 6. Inflation Decomposition at Sample Mean and Final Year (1995) 1/

(In percentage points of inflation) 2/

I. Sample mean

Variable	Pooled Sample		East and Central Europe	Baltics	FSU	
	Final Specification	Alternative Specification	Final Specification	Final Specification	Final Specification	Alternative Specification
Actual Inflation	41.97	41.97	9.39	9.58	90.01	90.01
Constant and dummies variables 3/	5.57	9.81	-0.19	1.56	35.70	24.39
Lagged inflation rate	-	-	2.55	3.58	-	-
Money growth 4/	24.22	21.19	3.51	4.18	32.10	48.67
Nominal wage growth 4/	-	6.15	2.50	-	17.76	-
Real exchange rate change (PNT/PT) 4/	-	-	-0.44	-	-	-
Variance of relative prices	12.18	4.82	1..46	-	-	10.70
Skewness of relative prices 4/	-	-	-	0.27	4.45	6.24

II: 1995

Variable	Pooled Sample		East and Central Europe	Baltics	FSU	
	Final Specification	Alternative Specification	Final Specification	Final Specification	Final Specification	Alternative Specification
Actual Inflation	11.69	11.69	3.89	6.33	20.12	20.12
Constant and dummies variables 3/	-5.37	-3.03	-2.18	2.97	-2.67	-8.60
Lagged inflation rate	-	-	1.18	1.86	-	-
Money growth 4/	12.18	10.67	2.81	2.10	12.80	21.13
Nominal wage growth 4/	-	2.11	1.37	-	5.30	-
Real exchange rate change (PNT/PT) 4/	-	-	-0.09	-	-	-
Variance of relative prices	4.88	1.93	0.80	-	-	1.01
Skewness of relative prices 4/	-		-	-0.60	4.69	6.58

1/ Final specification from Table 4, full sample period; alternative specification from Table 5.
2/ "-" indicates that the variable was not included because of lack of significance in the specification search.
3/ Includes regression residuals in 1995; residuals are zero at the sample mean.
4/ Combined effect of contemporaneous and lagged variables (see Tables 4 and 5).

substitution of unweighted variance and skewness for the corresponding Theil measures (Tables 4 and 7). In particular, although both the Theil and unweighted variance are significant in the full sample estimation for Eastern Europe, they become statistically insignificant in the post-liberalization period; the unweighted skewness, on the other hand, captures some effect of relative price variability on inflation during this period.

- Overall, the results suggest that relative price adjustment has a significant impact on inflation, although the size of this effect and the indicator capturing it varies by region and over the sample period. Since the estimations reflect only the partial, impact effects on inflation during a quarter (holding other factors constant), the size of the estimated effect may be understated to the extent that pressures on inflation stemming from relative price adjustments are accommodated by money growth—and thus captured by the money variable in the equation.

- In the pooled sample and the FSU, variability is associated with nominal wage shocks. In the pool, relative price variance is estimated to contribute slightly less than a third of inflation (Tables 4 and 6). Due to collinearity in the data, the estimated contribution declines when nominal wage growth is included in the specification (Tables 5 and 6). Similarly, in the FSU, when wage growth is included, the estimated contribution from variability appears small, on average, although it picks up quite substantially in 1995; when the wage term is excluded, the estimated contribution—from both variance and skewness—rises to about a fifth of inflation.[37]

- In Eastern Europe variance contributes, on average, about a sixth of inflation (Table 6). As indicated above, the impact of variance becomes insignificant in the post-liberalization period although the unweighted skewness suggests a small, but significant, relative price effect (Tables 4 and 7). Similarly, in the Baltics, variability is estimated to make only a small contribution to inflation. The significance of skewness rather than variance in the post-liberalization periods in Eastern Europe and the Baltics (which may be considered more advanced reformers with lower inflation rates), and the marked increase in the contribution of skewness when inflation declined sharply in the FSU in 1995, suggests that downward price rigidity may be a factor at moderate levels of inflation.[38]

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[37]The negative sign on the coefficient of the lagged variance is consistent with the partial reversal of the initial (within-quarter) positive impact of relative price shocks on inflation.

[38]Prices may be downwardly rigid in an absolute, but not a relative, sense. At sufficiently high rates of overall inflation, a slower-than-average rate of inflation for a good could deliver a substantial fall in its relative price whereas at low overall rates of inflation, a similar decline in a relative price may imply absolute price reductions, which may be resisted by economic agents.

Table 7. Sensitivity to Relative Price Indicators: Unweighted Indicators 1/

(Dependent variable: quarterly CPI inflation rate)

Variable	Pool	East and Central Europe		Baltics		FSU
	Full sample OLS-HCSE	Full sample OLS-HCSE	Post-liberalization OLS-HCSE	Full sample OLS-HCSE	Post-liberalization OLS-HCSE	Full sample OLS-HCSE
Constant	12.11 (2.05)**	0.76 (0.84)	0.98 (1.06)	1.50 (0.87)	4.38 (5.00)***	58.09 (3.92)***
Multiplicative dummy for exch. rate anchor effects on inflation inertia	-	-0.13 (-1.38)	0.02 (0.28)	-	-	-
Inflation rate, lagged	-	0.21 (3.16)***	0.44 (5.45)***	0.25 (2.97)***	0.07 (1.06)	-
Money growth	0.22 (2.72)***	-	-	-	-	0.20 (2.72)***
Money growth, lagged 1 quarter	0.35 (3.99)***	0.26 (2.55)**	0.19 (2.08)**	0.32 (3.44)***	0.21 (4.27)***	0.29 (3.91)***
Money growth, lagged 2 quarters	0.10 (1.81)*	-	--	--		0.21 (8.03)***
Nominal wage growth	-	0.17 (2.88)***	0.14 (2.03)**	-	-	-
Nominal wage growth, lagged 1 quarter	-	0.07 (2.18)**	0.004 (0.08)	-	-	-
Real exchange rate change (PNT/PT), lagged 1 quarter	-	-0.16 (2.57)**	-0.24 (-5.20)***	-	-	-
Variance of relative prices 2/	0.03 (5.14)***	0.02 (3.88)***	-	-	-	-
Skewness of relative prices 2/	-	-	0.41 (2.23)**	0.71 (2.02)*	0.86 (3.09)***	-
Skewness of relative prices, lagged 1 quarter 2/	-	-	-		-	1.87 (0.43)
Seasonal dummies	all significant	-	-	-	-	all significant
Outlier dummy	1490.33 (92.77)***	-	-	-	-	495.4 (87.01)***
R-squared corrected	0.92	0.73	0.60	0.71	0.52	0.930.93
F-statistics (zero slopes)	379.86***	47.04***	21.30***	27.41***	11.62***	182.96***
Breusch-Pagan test for heteroschedasticity	109.03***	57.68***	75.02***	6.03**	9.37***	40.23***
White test for heteroschedasticity	166.46***	95.68***	39.53***	11.95	9.10	71.63***
Jarque-Bera test for normality of residuals	3031.40***	44.03***	85.61***	0.49	9.16**	46.59***
Number of observations	260	122	100	33	31	105

1/ For the t-statistics reported in parenthesis, three asterisks indicate statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level; - indicates that the variable was not included because of lack of significance in the specification search. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ Unweighted variance and skewness, respectively.

- The results do not show a significant impact of real appreciation on inflation, except in Eastern Europe where it has a negative elasticity of about 0.2 and, evaluated at the sample mean, shows a small dampening effect on inflation for a given money growth (Tables 4 and 6). The negative impact is consistent with nominal appreciation (see the analytical model derived in Appendix II), although the small estimated effect may reflect the tendency for countries in the sample to resist nominal appreciation through intervention and endogenous increases in money via the balance of payments. Hence, as in the case of relative price variability, some of the impact of real appreciation may be captured by the money growth term. Since strong real appreciation is a feature of many transition economies, a few related issues are examined in Section V.

- Inflation inertia—reflecting backward-indexation or backward- looking expectations in wage and price formation—may become more important as moderate levels of inflation persist, suggesting that the output costs of reducing inflation tend to increase at these levels. Inertia (as measured by lagged inflation) appears to have contributed about one quarter to one third of the inflation in Eastern Europe and the Baltics, but is not significant in FSU countries where the level of inflation is on average much higher (Tables 4 and 6). In the post-liberalization period, however, the experiences of Eastern Europe and the Baltics diverge, with inertia effects becoming stronger in Eastern Europe, but insignificant in the Baltics.

- Explicit exchange rate anchors appear to have only a marginal—and statistically weak—dampening effect on inflation. This does not, however, necessarily imply that exchange rate anchors are ineffective since they can contribute to lower money growth and nominal wage pressure by disciplining financial policies and dampening inflation expectations. While in the alternative specification for the pool, an exchange anchor enters as an additive dummy, in Eastern Europe it is manifested as a multiplicative dummy on the lagged inflation term, suggesting a reduction in inertia through a beneficial effect on expectations formation.[39] An exchange regime effect could not be observed in the Baltics, most likely reflecting the somewhat similar experiences and policy actions of Estonia, which maintained a formal peg, and Latvia, which did not.[40]

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[39]The dummy reflects only formal anchors—rather than a policy of resistance to nominal appreciation—for given nominal money and wage growth. Although the t-statistic indicates a lower than standard level of significance, the elimination of this dummy is rejected by F and chi-squared tests and worsens the performance of the estimated equation, suggesting some overall significance. The insignificance of the dummy in the post-liberalization period in Eastern Europe is consistent with a diminishing signalling effect for long-standing anchors. A multiplicative exchange regime dummy was introduced on the real exchange rate term, but turned out to be insignificant in the pool and in each of the regions.

[40]An exchange regime dummy could not be introduced in the FSU block since no country

(continued...)

V. RELATIVE PRICE ADJUSTMENT IN FIVE TRANSITION ECONOMIES

In light of the fact that the econometric results can provide only a broad indication of the influence of relative price adjustment on inflation, as an illustrative exercise, this section examines the evidence from five selected countries—the Czech Republic, Poland, Estonia, Moldova, and Russia—to obtain more insights into the role of relative price adjustment. The analysis is framed in terms of a few specific issues which are relevant to the policy debate:

- What factors underlie variability in relative prices as measured by the variance and skewness of the price distributions?

- Do the sources of money growth give some indication of how relative price and other shocks are accommodated under different policy regimes?

- Does the analysis of relative price adjustment shed some light on the factors that could explain the marked real appreciation in transition economies?

The five selected countries have all achieved an initial macroeconomic stabilization and implemented some amount of liberalization and adjustment of relative prices. Nevertheless, they represent a range of progress in these areas, particularly with regard to inflation reduction, and also reflect some diversity in macroeconomic and structural policies (Table 8). The timing of their initial liberalization varies and they also adopted somewhat different strategies: the Czech Republic, Poland, and Estonia followed a "big-bang" approach, undertook extensive liberalization early, and used an explicit exchange rate anchor, while Moldova and Russia adopted a gradual approach to both stabilization and structural reform and relied on a more flexible exchange rate policy (see Annex II).

A. Factors Underlying Relative Price Variability

A common feature of the present sample is the periodic sharp peaks in the measured variance of relative prices, concurrent with peaks in inflation, particularly in the early stages of transition (Chart 1). For the five countries, these peaks largely coincide with episodes of trade and price liberalization, wage and administered prices increases, tax reform, and terms of trade shocks, in some instances accompanied by monetary accommodation (particularly in Russia), and suggest that spikes in variance largely reflect exogenous relative price shocks stemming from structural change, at times accommodated by money growth. In terms of the models

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(...continued)
maintained a formal peg during the sample period (except Russia in the third quarter of 1995).

Table 8. Country Performance in Key Areas

Annual Inflation Rates
(December on December)

	1990	1991	1992	1993	1994	1995
Czech Republic	19.7	52.0	12.6	18.8	9.7	8.1
Poland	249.3	60.3	44.4	37.7	29.4	22.6
Estonia	...	...	946.7	35.7	41.6	28.8
Moldova		136.3	2198.4	835.8	116.0	23.8
Russia			561.9	841.6	202.7	131.4

Fiscal Balance
(in percent of GDP)

	1990	1991	1992	1993	1994	1995
Czech Republic 1/	...	...	0.4	0.6	-1.3	-2.4
Poland 2/	3.4	-6.7	-6.6	-2.9	-2.0	-2.7
Estonia	...	5.2	-0.3	-0.7	1.3	-0.8
Moldova	...	...	-23.4	-8.9	-8.1	-4.6
Russia	...	...	-18.9	-7.6	-10.1	-4.9

Current Account Balance
(in percent of GDP)

	1990	1991	1992	1993	1994	1995
Czech Republic	...	4.7	0.2	2.2	0.0	-4.2
Poland		2.2	3.2	0.9	2.9	2.7
Estonia	...	...	3.4	1.4	-7.5	-5.3
Moldova	...	...	-4.5	-13.4	-6.9	-5.9
Russia	...	...	-4.8	0.2	1.2	1.3

Average Monthly Wage in U.S. Dollars

	1990	1991	1992	1993	1994	1995
Czech Republic				204.7	240.7	288.6
Poland		172.5	218.2	225.9	248.9	297.2
Estonia			28.7 3/	82.5	131.5	205.7
Moldova			14.8	17.1	26.1	28.8
Russia			27.1	63.5	98.9	106.5

Liberalization Index 4/
(values ranging from 0 to 1)

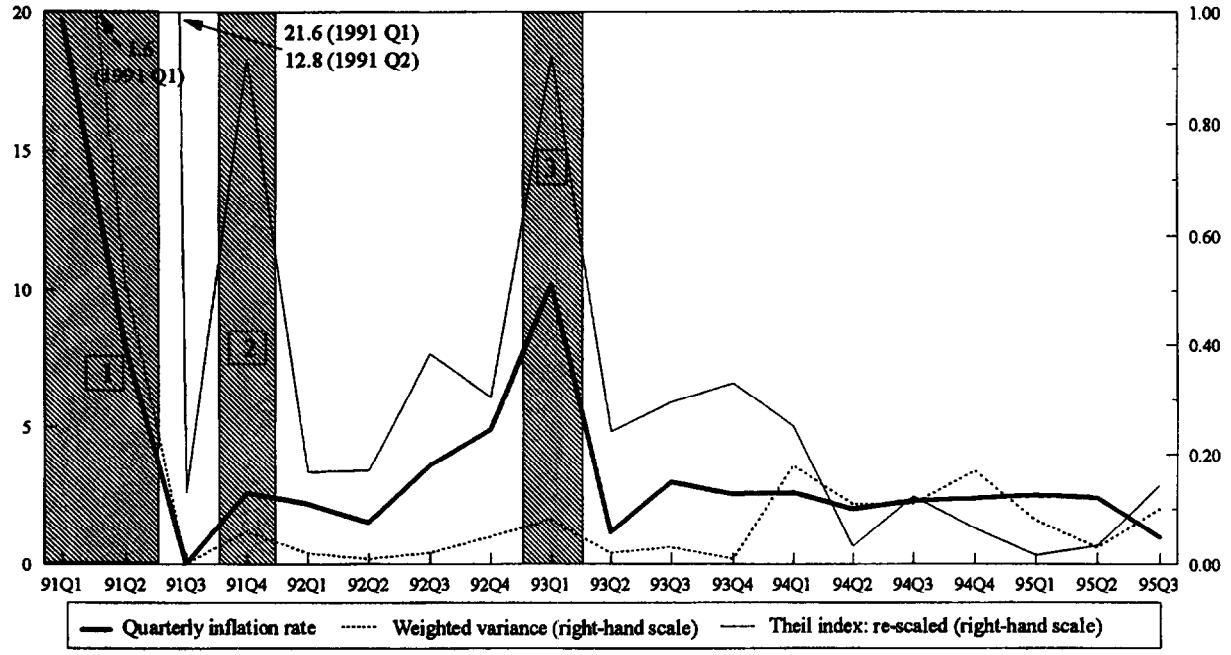
	Reform Grouping	Annual					Cumulative Index (1989-94)
		1990	1991	1992	1993	1994	
Czech Republic	Advanced	0.16	0.79	0.86	0.90	0.90	3.61
Poland	Advanced	0.68	0.72	0.82	0.82	0.86	4.14
Estonia	High intermediate	0.20	0.32	0.64	0.81	0.89	2.93
Moldova	Low intermediate	0.04	0.10	0.38	0.51	0.55	1.62
Russia	Low intermediate	0.04	0.10	0.49	0.59	0.66	1.92

1/ Excludes proceeds from privatization as fiscal revenues.
2/ Includes proceeds from privatization as fiscal revenues.
3/ June-December 1992.
4/ Liberalization index and reform grouping from De Melo, Denizer, and Gelb (1995) based on rankings in three areas: internal markets, external markets, and private sector entry; reflects the judgment of the authors, World Bank staff, and work by the EBRD.

CHART 2

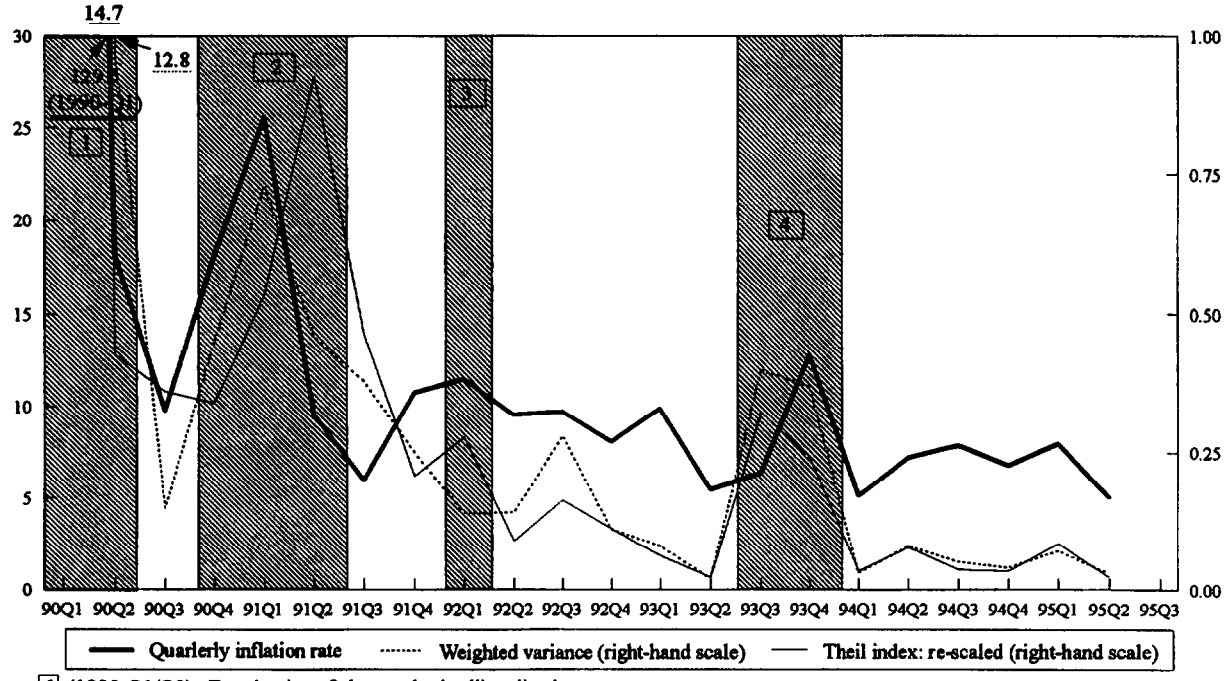
Inflation and Relative Price Variance

CZECH REPUBLIC



1 (1991-Q1/Q2): Price liberalization, collapse of CMEA, and pass-through to administered prices of devaluations in 1990.
2 (1991-Q4): Administered price adjustments and further price liberalization.
3 (1993-Q1): Mainly introduction of VAT, but also adjustments of administered prices and uncertainty related to break up of federation.

POLAND

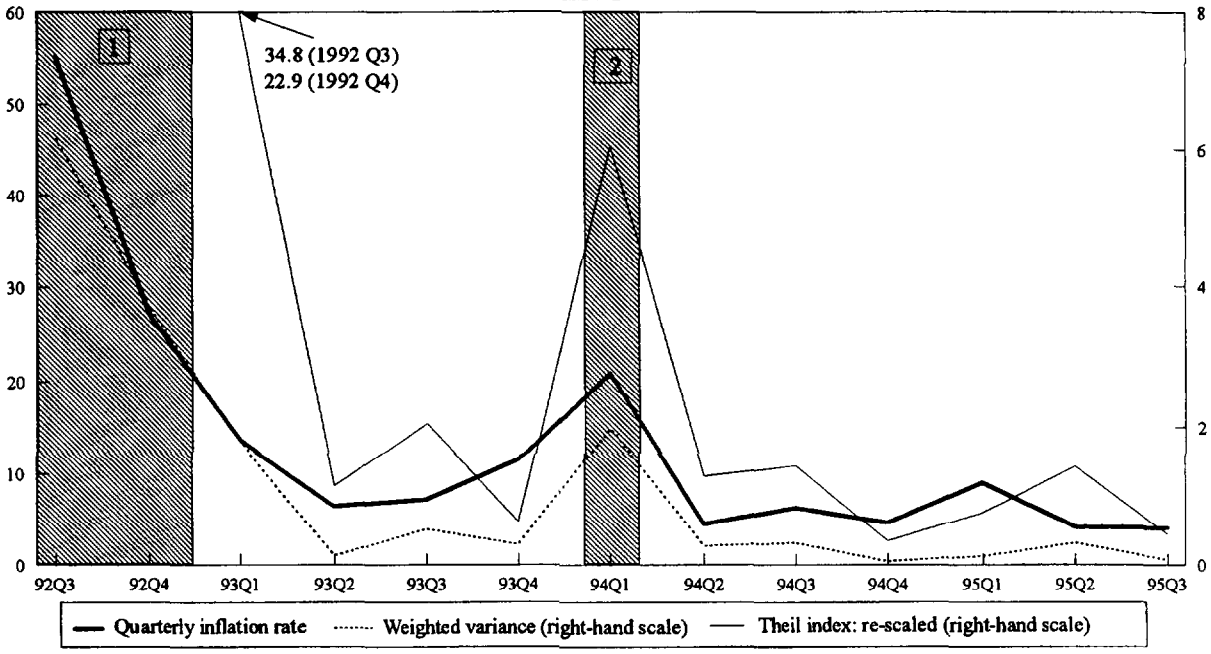


1 (1990-Q1/Q2): Devaluation of zloty and price liberalization.
2 (1990/Q4-1991/Q2): Relaxation of monetary policy, wage increases, and increase in domestic cost of imported oil, breakup of CMEA.
3 (1992-Q1): Increases in certain excises, import duties, and administered prices (energy, heating and hot water).
4 (1993-Q3/Q4): Devaluation in end-August, surge in wages at year-end (in part a result of change in government).

CHART 2 (continued)

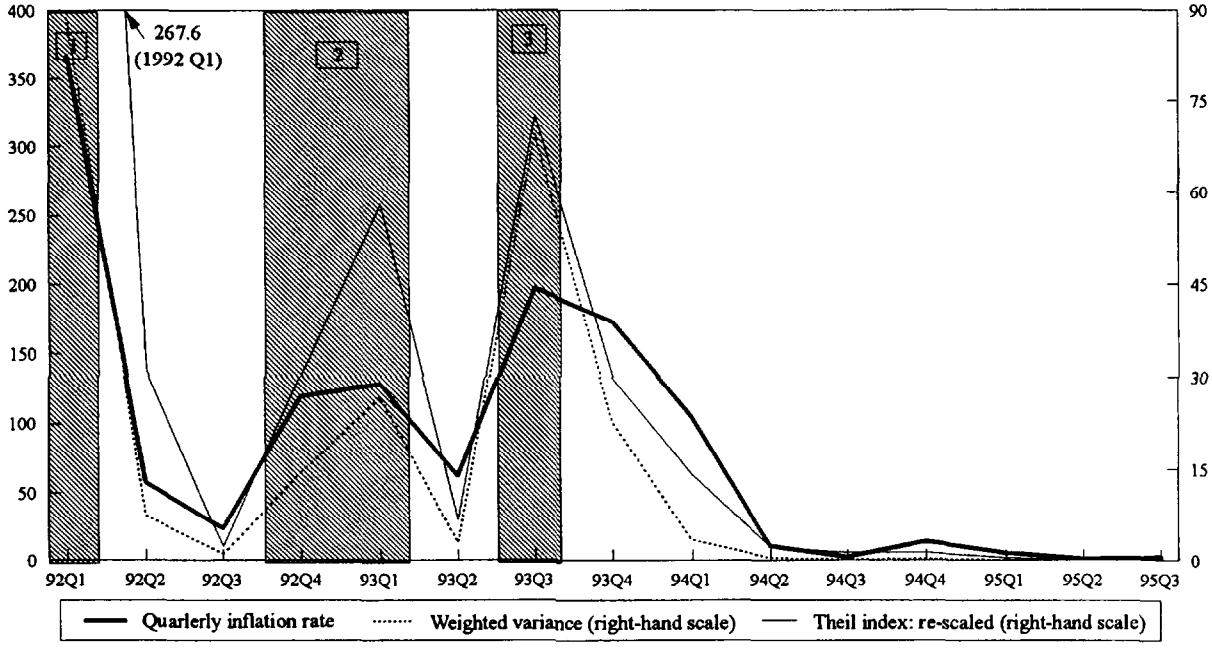
Inflation and Relative Price Variance

ESTONIA



1 (1992-Q3/Q4): Price and trade liberalization; changes in VAT; introduction of currency board.
2 (1994-Q1): Real appreciation of Russian ruble vis-a-vis kroon in 1993 Q3 which amounted to a terms of trade shock (EBS/94/61).

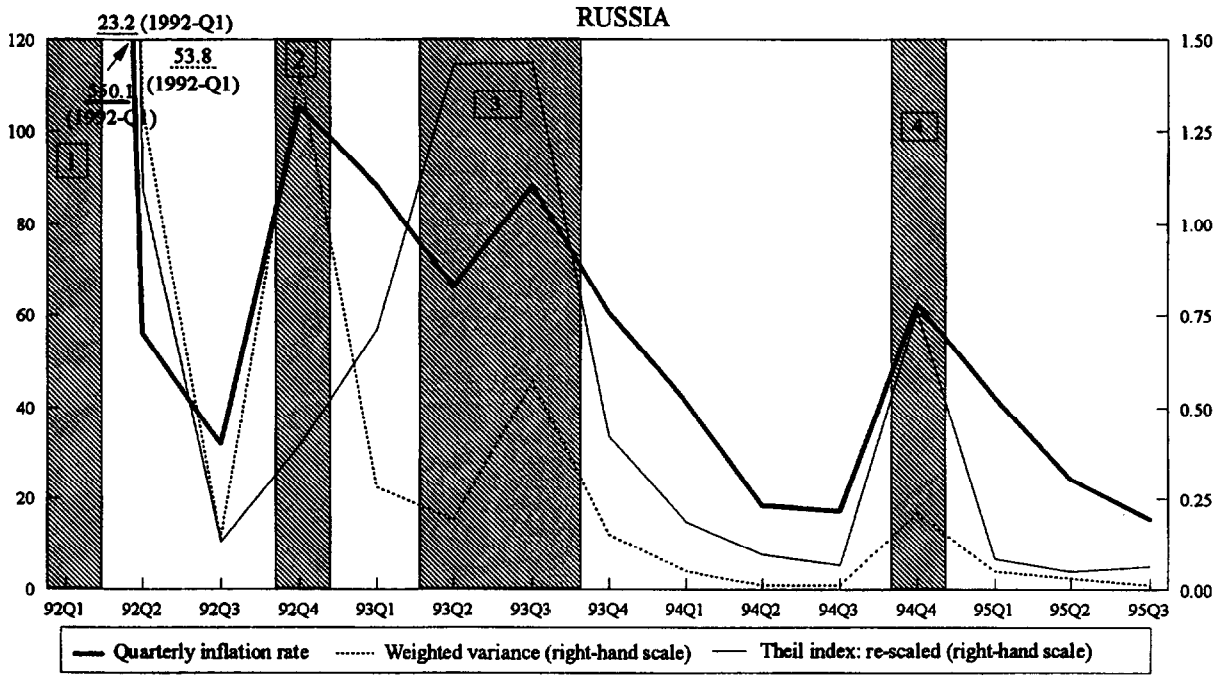
MOLDOVA



1 (1992-Q1): Price liberalization and introduction of VAT and excises.
2 (1992-Q4/1993-Q2): Spill-over from lax financial policies in Russia, increased energy prices, and changes in VAT and excises.
3 (1993-Q3): Second round of price liberalization, large administered price increases, and sharp depreciation of (temporary) Moldovan ruble in anticipation of introduction of national currency.

CHART 2 (concluded)

Inflation and Relative Price Variance



1 (1992-Q1): Price liberalization.
2 (1992-Q4): Carry-over of energy price increase in September and some effect of relaxation of financial policies in Q3 (domestic credit), in particular initiation of netting and clearing of enterprise arrears.
3 (1993-Q2/Q3): Relaxation of financial policies, further price liberalization, and adjustments in administered prices.
4 (1994-Q4): Substantial relaxation of financial policies (SM/95/105, SM/95/121, EBS/95/149).

discussed in Section II (Box 1), this would suggest either a simultaneous effect or a direction of causality running from relative price variability to inflation.[41]

Although variance declines sharply following the initial bouts of price liberalization in all five countries, it appears to remain high relative to market economies. Comparisons of variance across countries need to be interpreted with caution because the measures also reflect the weights and level of disaggregation of the CPI data. Nevertheless, as a rough indication, a comparison of the Theil variance and unweighted variance for 1995 with corresponding indices for Argentina, Greece, Italy, and the United States suggests that relative price variance in these transition economies—with the exception of the Czech Republic—is substantially higher than in the market economies (Table 9). In addition, the contribution from variance within tradables tends to be somewhat greater in the transition economies, although this may reflect the relatively low weight given to nontradables in the CPI (particularly for Moldova and Russia).

Given previous indications that downward price rigidity may be an important factor in translating relative price shocks to an increase in overall inflation, can an analysis of skewness reveal any insights about factors—such as the cost-recovery hypothesis—which could explain a prolonged period of relative price adjustment? A comparison of inflation rates of cost-recovery items with overall inflation indicates that prices of these items tend to be adjusted discontinuously rather than smoothly (Chart 2). This may reflect the administrative and political costs of changing such prices which induce the authorities to recover the deterioration of these relative prices (during periods when prices are not changed) by periodically raising them well in excess of average inflation.[42] Given this pattern of periodic price adjustments, goods for which cost-recovery is a consideration may be expected to dominate as outliers in periods when the distribution of prices is positively skewed. Moreover, if these prices increase in relative terms on a sustained basis as argued by the cost-recovery hypothesis, rather than simply being adjusted periodically to keep up with

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[41]If causality tends to run from inflation to variability, spikes in the two variables should coincide with aggregate shocks (e.g., relaxation of financial policies) and not just with relative price shocks (e.g., episodes of intensive liberalization, wage shocks); an exception in this regard is the fourth quarter of 1994 in Russia which seems to be mainly related to a relaxation of financial policies (see Chart 1).

[42]Services for which cost-recovery is a consideration (rents, utilities, transport, communication) tend to be publicly owned in most of these countries. This type of step-adjustment would be consistent with a "menu cost" model used by Ball and Mankiw (1994) to derive an asymmetric price response endogenously (see Box 1).

Table 9. Relative Price Variance in Some Transition and Market Economies

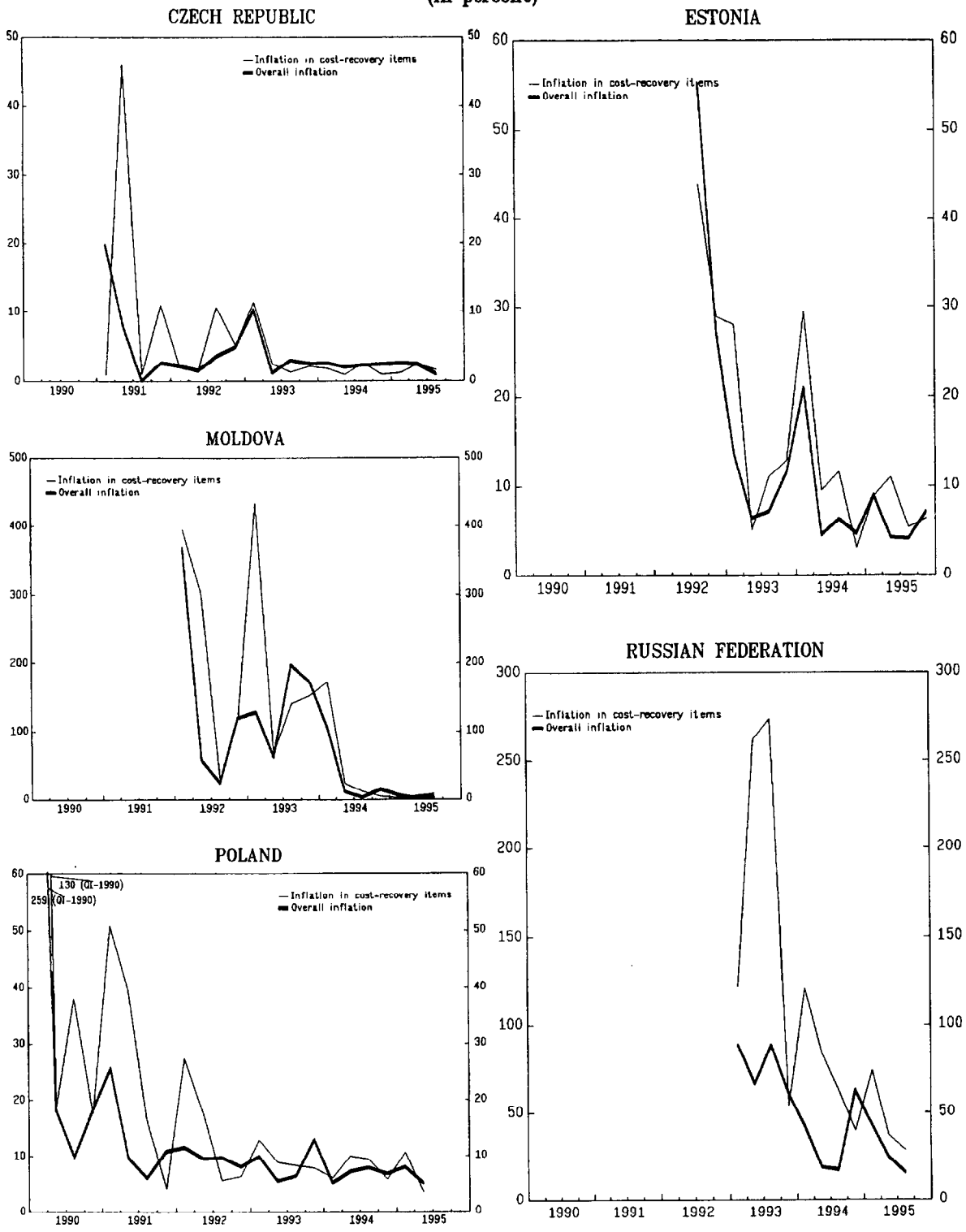
	Average Contribution to Variance From: (1995 Average in Percent)				Variance 1/ (1995 Average)	
	Tradables	Non-tradables	Between tradables and nontradables	Weight of non-tradables in CPI	Theil	Unweighted
Eastern Europe	64.7	24.1	11.2	--	42.7	41.1
Czech Republic	45.5	33.0	23.5	36.1	2.5	2.6
Poland	67.2	27.6	5.2	26.6	21.5	16.7
Baltics	76.5	15.6	7.9	--	81.6	92.2
Estonia	68.3	19.9	11.8	50.0	47.7	59.2
FSU	68.1	22.8	9.1	--	661.5	400.1
Moldova	86.0	3.1	2.0	12.3	172.0	97.7
Russia	78.0	16.4	5.6	9.5	182.8	155.7
Argentina	91.2	8.1	0.7	29.1	7.0	5.4
Greece	14.9	37.4	47.7	44.8	4.7	4.3
Italy	23.3	73.9	2.8	38.4	0.5	0.6
United States	61.3	37.2	1.4	46.9	3.3	4.0

1/ All figures multiplied by 10,000.

CHART 2

Consumer Price Inflation

(In percent)



average inflation, they would also tend to dominate the distribution of prices when inflation rates are calculated on a cumulative basis.[43]

An analysis of the distribution of individual inflation rates calculated on a cumulative and quarterly basis suggests that in three countries—the Czech Republic, Poland, and Estonia—cost-recovery items indeed dominate the distributions of cumulative inflation rates; in addition, on average they frequently rank among the ten most extreme outliers in periods when the distributions of quarterly inflation rates are positively skewed (Chart 3): a pattern which is evident in both the early and later years of the transition.[44] In Russia, cost-recovery items are less dominant, although this relates to the much higher degree of disaggregation of the CPI data in which items with strong price seasonality (e.g., fruits and vegetables) appear individually.[45] In Moldova, cost-recovery items dominate the distribution of cumulative inflation rates in the early years, but are strikingly absent from the later years—suggesting that these prices, which are largely administratively set, have not been adjusted during 1994-95 when overall inflation declined markedly.

B. Sources of Broad Money Growth

The impact of relative price adjustments, including those that contribute to real appreciation, on inflation clearly depends on the extent to which these adjustments are accommodated by money growth. A decomposition of broad money growth reveals some marked differences in the sources and extent of money growth (Table 10). In the Czech Republic and Estonia, base money growth almost entirely reflects increases in NIR under a fixed exchange rate regime, notwithstanding some sterilization in the former case. In Poland, both NIR and NDA play a role, consistent with a crawling peg accompanied by periodic devaluations. By contrast, in Moldova and Russia, not only does the expansion in NDA almost entirely dominate the growth in base money, but the growth in both variables is much larger than in the other cases. These patterns are suggestive of two aspects of the role of policies in transmitting relative price shocks to inflation. On the one hand, a fixed or crawling peg exchange regime can result in quite rapid and significant endogenous money

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[43]Outliers in the quarterly distribution of individual inflation rates may reflect seasonal and other factors which are not necessarily related to a sustained change in relative prices. However, if inflation rates are calculated over a given period on a cumulative basis, outliers would indicate goods which experienced a sustained change in their relative price.

[44]Unweighted CPI data were used for this analysis because the very small weight typically given to cost-recovery items in consumer expenditures biases these price changes downwards. Since these items are also intermediate inputs and affect the final prices of other goods, the use of CPI weights would distort the significance of these relative price changes.

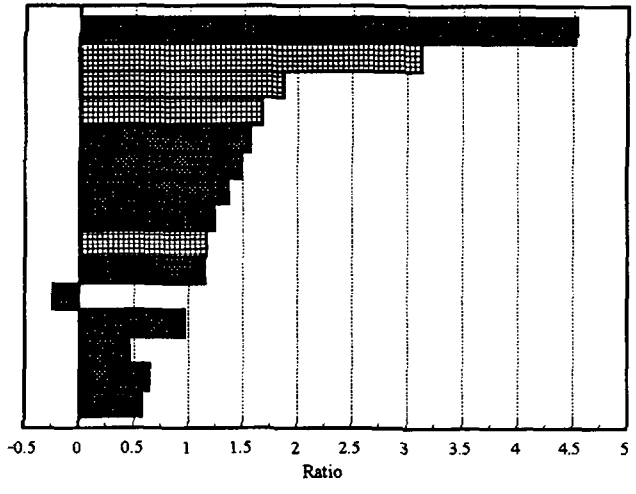
[45]A cumulative inflation distribution cannot be constructed for Russia because the commodity classifications change annually.

CHART 3

CZECH REPUBLIC

Relative Price Changes in Cost-Recovery Items

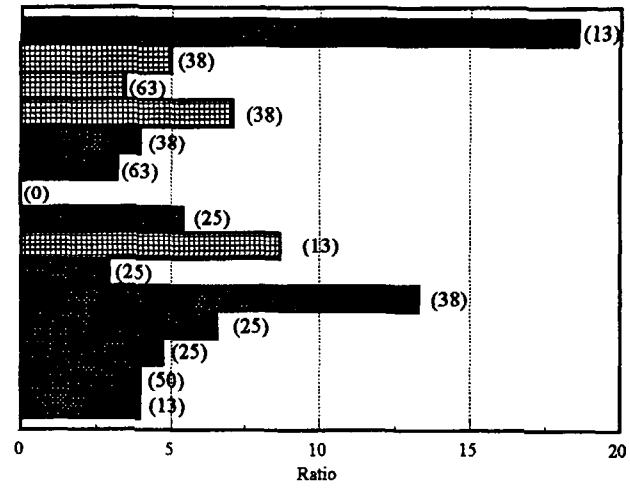
Cumulative Inflation Rates 1/



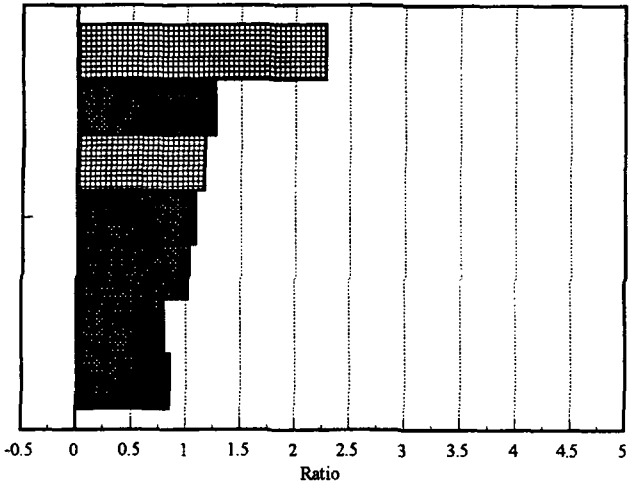
1991 - 1993

Fuel
Rent/municipal services 3/
Transport/communications 3/
Education, culture, sport 3/
Personal services
Footwear/leather goods
Various local services
Milk products
Health care/social services 3/
Culture
Potatoes
Hygiene, drugs
Building/construction needs
Egg products
Travel/sporting goods

Quarterly Inflation Rates 2/



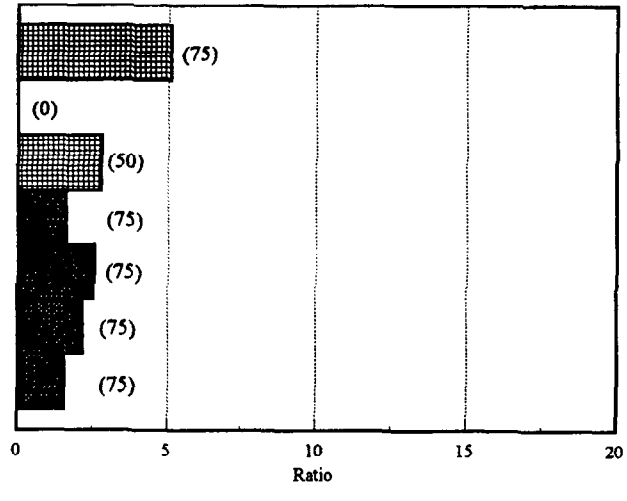
Cumulative Inflation Rates 1/



1994 - 1995

Education 3/
Catering
Housing 3/
Clothing
Food
Other
Leisure

Quarterly Inflation Rates 2/

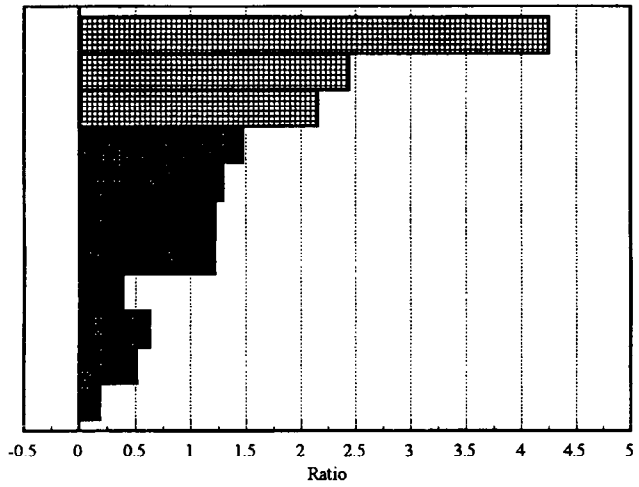


1/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, both calculated on a cumulative basis.
2/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, averaged over the quarters in which the distribution (of individual inflation rates) was positively skewed. Numbers in parentheses indicate percentage of quarters when individual inflation rates were at least 1.5 times the mean.
3/ In the "cost-recovery" category.

ESTONIA

Relative Price Changes in Cost-Recovery Items

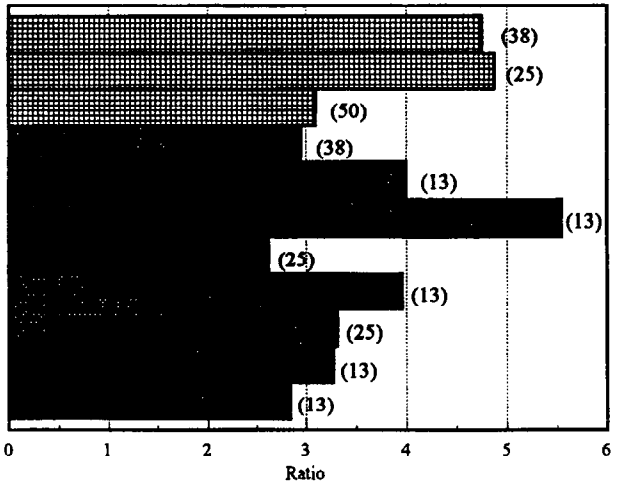
Cumulative Inflation Rates 1/



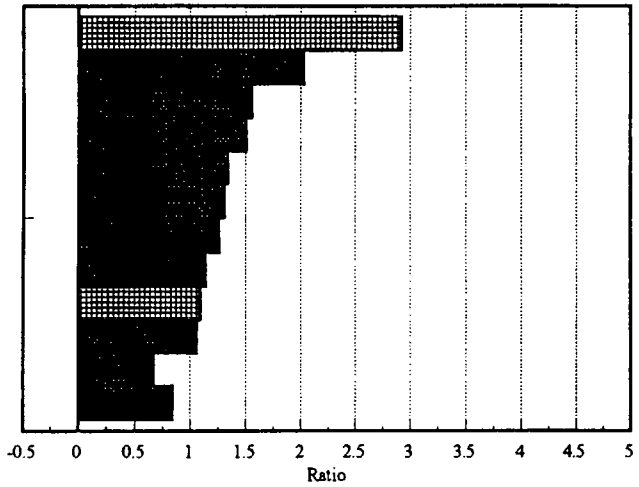
1992 - 1995

Rent, water, sewerage3/
Communication 3/
Medical care 3/
Books, newspapers, supplies
Bread/cereals
Personal care
Personal services, other
Tobacco
Recreation/culture
Non-alcoholic beverages
Oils/fats

Quarterly Inflation Rates 2/



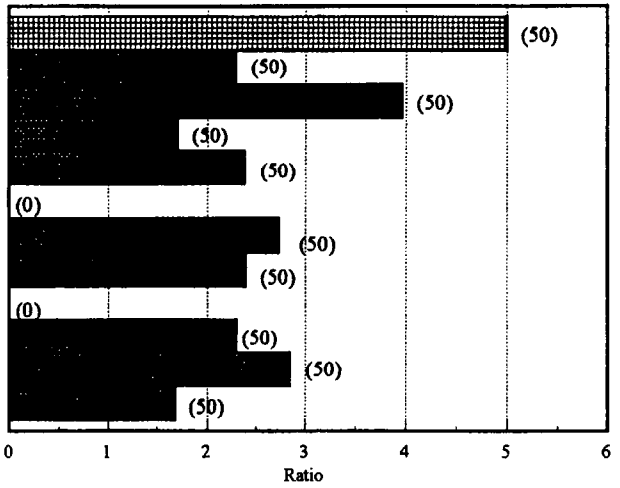
Cumulative Inflation Rates 1/



1994 - 1995

Rent, water, sewerage 3/
Books, newspapers, supplies
Tobacco
Housing maintenance/repair
Personal services, other
Personal care
Recreation/culture
Eating out
Medical care 3/
Fuel/power
Oils/fats
Clothing

Quarterly Inflation Rates 2/

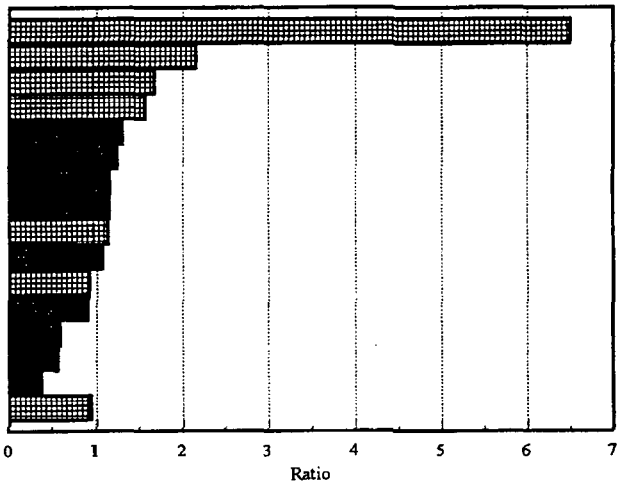


1/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, both calculated on a cumulative basis.
2/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, averaged over the quarters in which the distribution (of individual inflation rates) was positively skewed. Numbers in parentheses indicate percentage of quarters when individual inflation rates were at least 1.5 times the mean.
3/ In the "cost-recovery" category.

POLAND

Relative Price Changes in Cost-Recovery Items

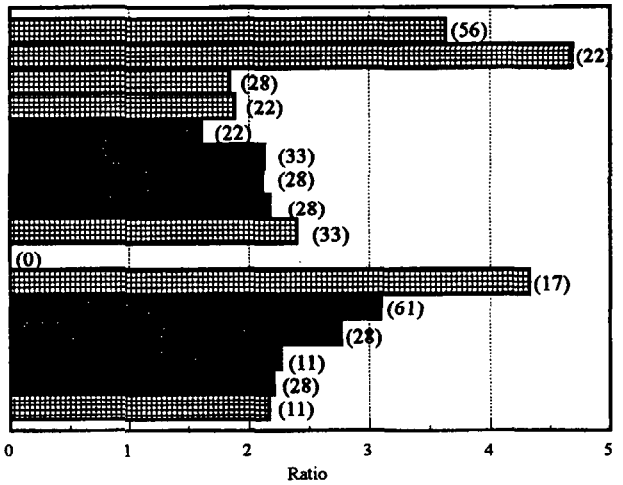
Cumulative Inflation Rates 1/



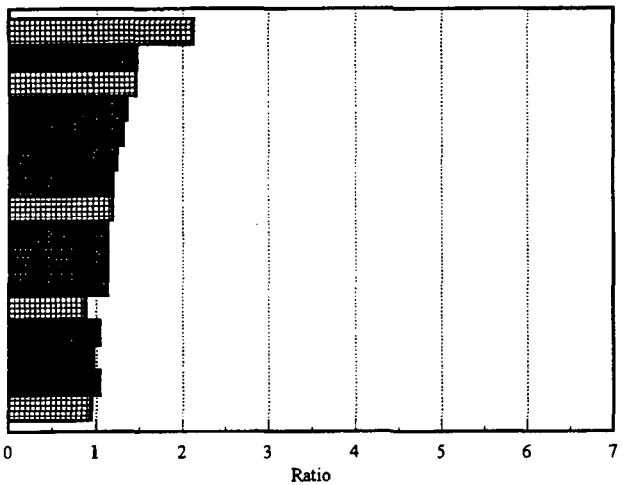
1990 - 1995

Hot water 3/
Electricity 3/
Health 3/
Transport 3/
Personal care
Fuel
Recreation
Milk/eggs
Rents 3/
Catering
Telecommunications 3/
Fruits
Edible fats
Condiments
Drugs
Education 3/

Quarterly Inflation Rates 2/



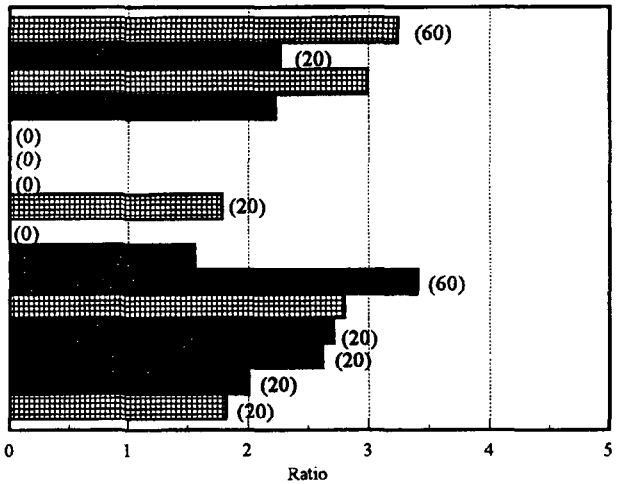
Cumulative Inflation Rates 1/



1992 - 1995

Hot water 3/
Condiments
Rents 3/
Drugs
Publications
Catering
Cosmetics
Transport 3/
Sport equipment
Cereals
Fruits
Electricity 3/
Edible fats
Fuel
Sugar/honey
Health 3/

Quarterly Inflation Rates 2/



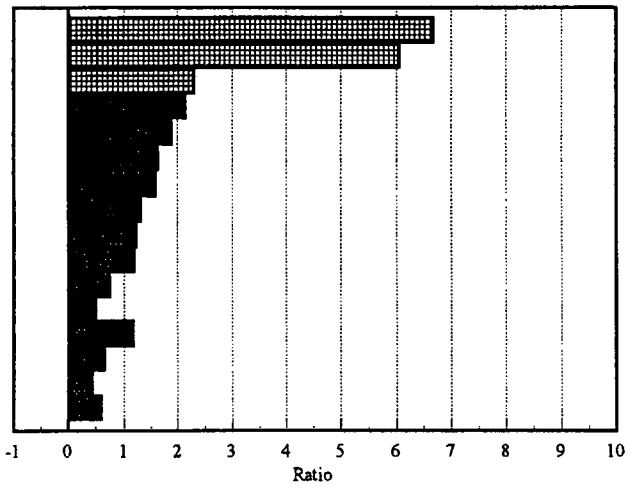
1/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, both calculated on a cumulative basis.
2/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, averaged over the quarters in which the distribution (of individual inflation rates) was positively skewed. Numbers in parentheses indicate percentage of quarters when individual inflation rates were at least 1.5 times the mean.
3/ In the "cost-recovery" category.

CHART 3 (continued)

MOLDOVA

Relative Price Changes in Cost-Recovery Items

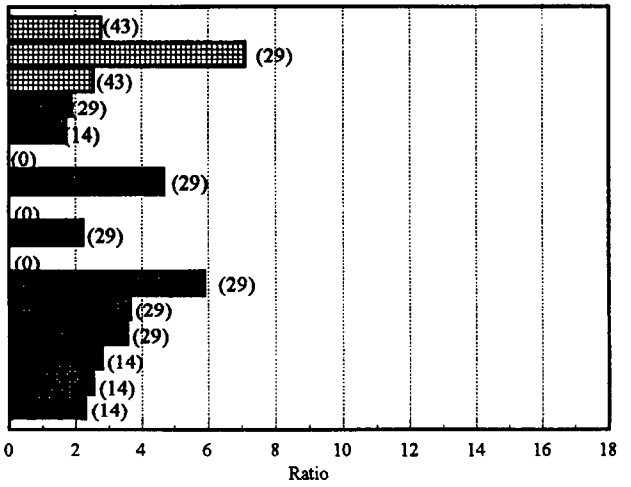
Cumulative Inflation Rates 1/



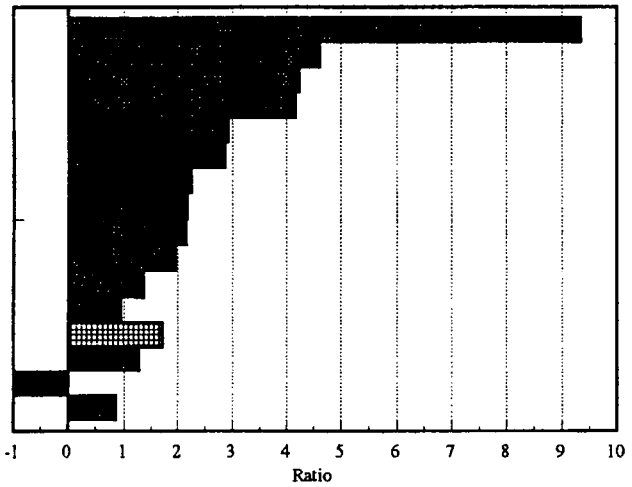
1992 - 1993

Public transportation 3/
Communal services 3/
Telecommunications 3/
Clothing accessories (fur articles)
Repairs of refrigerators
Furniture making/repairing
Eggs
Clothing/bedding
Radios
Clothes for children
Electrical appliances
Drugs/chemicals
Bread/cereal products
Laundry
Sport goods
Clothing accessories (caps/hats)

Quarterly Inflation Rates 2/



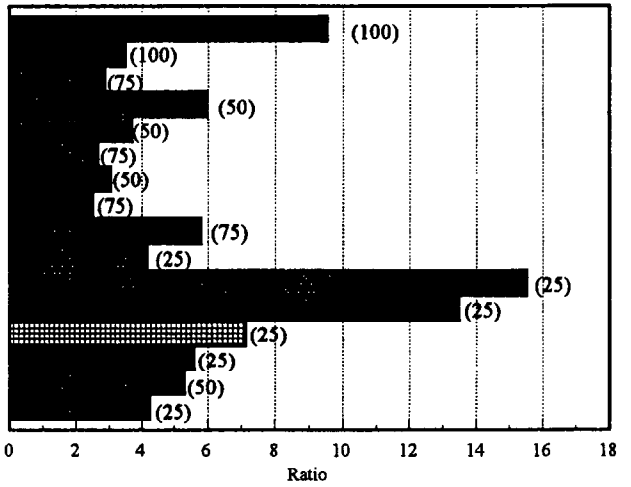
Cumulative Inflation Rates 1/



1994 - 1995

Cosmetics
Milk
Sugar
Radios
Current repairs
Hygiene/cosmetic services
Laundry/dry-cleaning
Funerals
Sport goods
Bread
Citrus fruit
Potatoes
Education 3/
Culture
Fresh fruit
Fuel

Quarterly Inflation Rates 2/

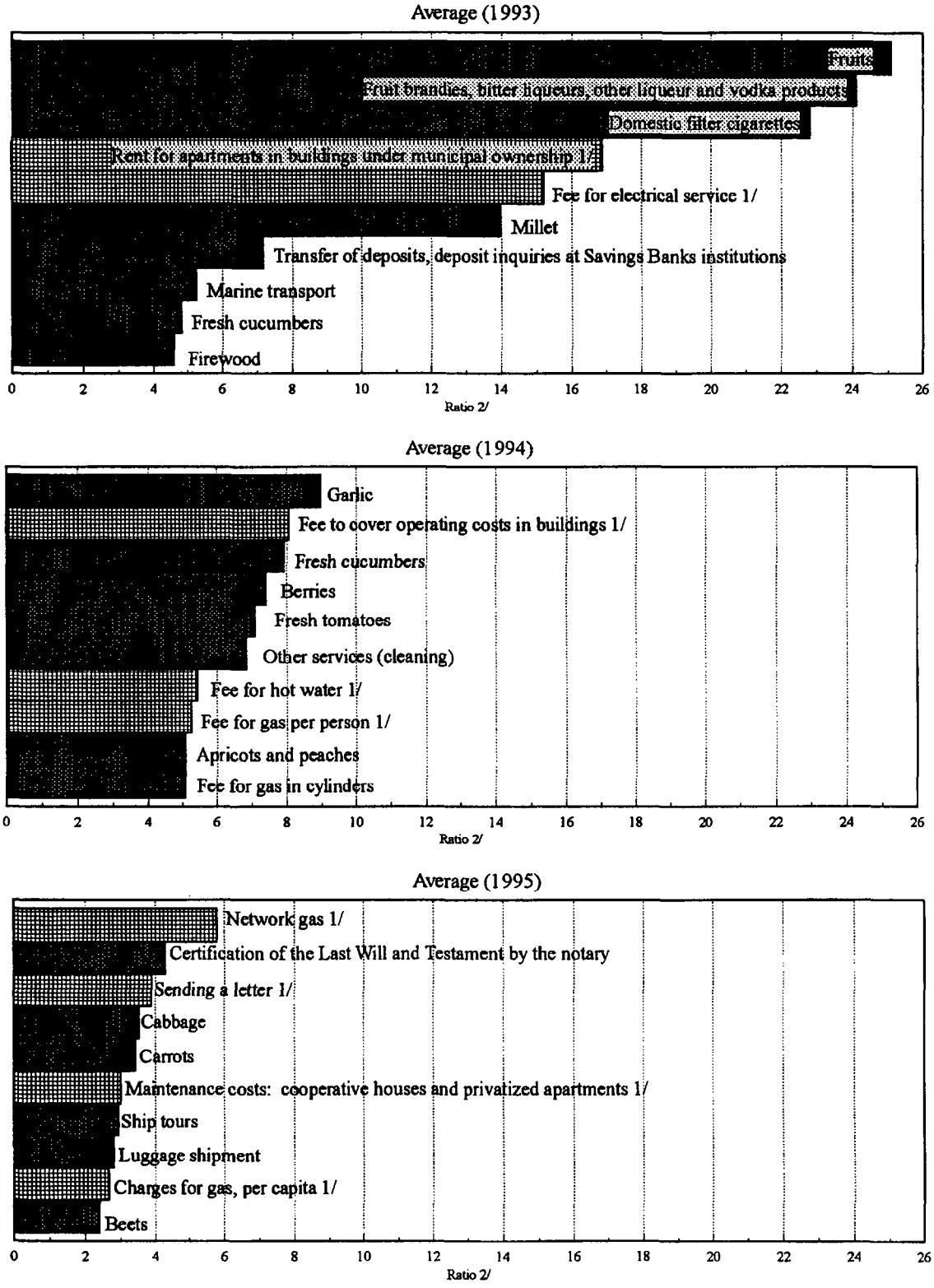


1/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, both calculated on a cumulative basis.
2/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, averaged over the quarters in which the distribution (of individual inflation rates) was positively skewed. Numbers in parentheses indicate percentage of quarters when individual inflation rates were at least 1.5 times the mean.
3/ In the "cost-recovery" category.

CHART 3 (concluded)

RUSSIA

Relative Price Changes in Cost-Recovery Items



1/ In the "cost-recovery " category.
2/ Bars indicate the ratio of individual inflation rates to the mean unweighted inflation rate, averaged over the quarters in which the distribution (of individual inflation rates) was positively skewed.

Table 10: Decomposition of Changes in Broad Money (1993–95)
(End-of-period rates of change, unless otherwise noted)

	1993				1994				1995		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Czech Republic											
Broad Money 1/	−3	6	6	10	2	6	3	10	−1	3	9
Money Multiplier	35	−20	16	−4	−1	−6	−7	7	−3	−3	−3
Base Money	−28	33	−9	15	3	13	11	2	2	7	12
NDA 2/	−21	−0	−28	−9	−21	−14	−4	−16	−35	−9	−35
NIR 3/	−7	33	19	24	24	27	16	18	37	16	47
Money multiplier (in levels)	7	6	7	6	6	6	6	6	6	6	5
Estonia											
Broad Money 1/	−12	22	19	23	3	4	7	12	3	10	7
Money Multiplier	−34	−3	1	5	5	3	4	3	6	−2	0
Base Money	34	26	18	17	−1	1	3	9	−3	12	6
NDA 2/	9	0	−6	12	−7	−3	1	−1	−13	−3	−1
NIR 3/	25	25	24	6	5	4	1	10	10	15	7
Money multiplier (in levels)	2	1	2	2	2	2	2	2	2	2	2
Moldova											
Broad Money 1/	17	60	74	29	−7	114	−7	16	1	13	23
Money Multiplier	10	−15	−38	48	−16	66	−28	−6	10	4	−3
Base Money	7	88	183	−13	10	29	29	24	−8	9	26
NDA 2/	5	98	182	−12	12	28	29	21	−6	10	26
NIR 3/	1	−10	0	−0	−2	2	0	2	−2	−1	1
Money multiplier (in levels)	2	2	1	1	1	2	1	1	2	2	2
Poland											
Broad Money 1/	7	6	9	11	6	7	9	12	5	7	...
Money Multiplier	9	−1	5	2	−2	−2	7	9	−4	−4	...
Base Money	−2	7	3	9	8	8	2	3	10	12	...
NDA 2/	4	10	−1	3	5	7	−6	5	−5	−11	...
NIR 3/	−6	−3	4	6	4	1	8	−3	15	23	...
Money multiplier (in levels)	3	3	3	4	3	3	4	4	4	4	...
Russia											
Broad Money 1/	49	76	38	48	21	51	30	25	11	46	14
Money Multiplier	−6	−7	−14	−5	0	1	−1	3	7	−1	−6
Base Money	59	88	61	55	21	49	32	20	4	47	22
NDA 2/	54	74	46	55	23	46	35	20	4	42	21
NIR 3/	5	14	15	0	−3	3	−3	1	0	5	1
Money multiplier (in levels)	5	4	3	3	3	3	3	3	3	3	3

1/ Broad money growth equals ((1+percentage change in money multiplier)*(1+percentage growth in base money))−1. For small changes, this is approximately equal to the sum of the rates of change in the money multiplier and base money.

2/ Calculated residually as the difference between base money and NIR.

3/ Includes only assets and liabilities in convertible currencies. Evaluated at exchange rates of end−December 1992.

growth—frequently at annual rates in excess of 20 percent in one quarter—which could accommodate inflationary pressures from relative price adjustments.[46] Hence, other things equal, when relative price adjustments are significant, a money anchor could result in lower inflation because of stronger monetary control, including through nominal appreciation. On the other hand, in the absence of an exchange rate anchor, the accommodation of relative price shocks through discretionary credit creation can result in even greater money expansion because of the absence of a deterrence effect on lax financial policies and because of the difficulties of targeting money when money demand is unstable. Hence, countries with exchange rate pegs may end up with lower levels of inflation because monetary accommodation is more limited.[47]

C. Some Factors Underlying Real Appreciation

All five countries have experienced considerable real appreciation since the beginning of the transition, although the measured degree of appreciation is sensitive to the choice of index (Chart 4).[48] Undervaluation is frequently cited as an explanation for this appreciation, even in the later stages of transition. Although international price comparisons are often used as evidence, direct comparisons can be misleading if differences in PPP-adjusted GDP are not taken into account (see Section II). A price comparison for 1993 suggests that price levels in all five countries, except Poland, were significantly lower, relative to a comparator Western European country (Austria) than would be indicated by differences in PPP-adjusted GDP (Table 11). The discrepancy is especially marked for Moldova and seems surprisingly large for the Czech Republic.

Undervaluation can be reflected in international price differences in tradables, if there is only gradual arbitrage in traded goods prices (see Section II). Evidence from price comparisons suggesting that traded goods prices are often much lower relative to those in industrialized countries than can be accounted for by transportation costs has sometimes been used as evidence of undervaluation (for instance, in Table 11, traded goods prices in 1993 in

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[46]In Poland, lagged inflation is statistically significant in explaining future broad money growth, suggesting monetary accommodation of inflation shocks (SM/95/316).

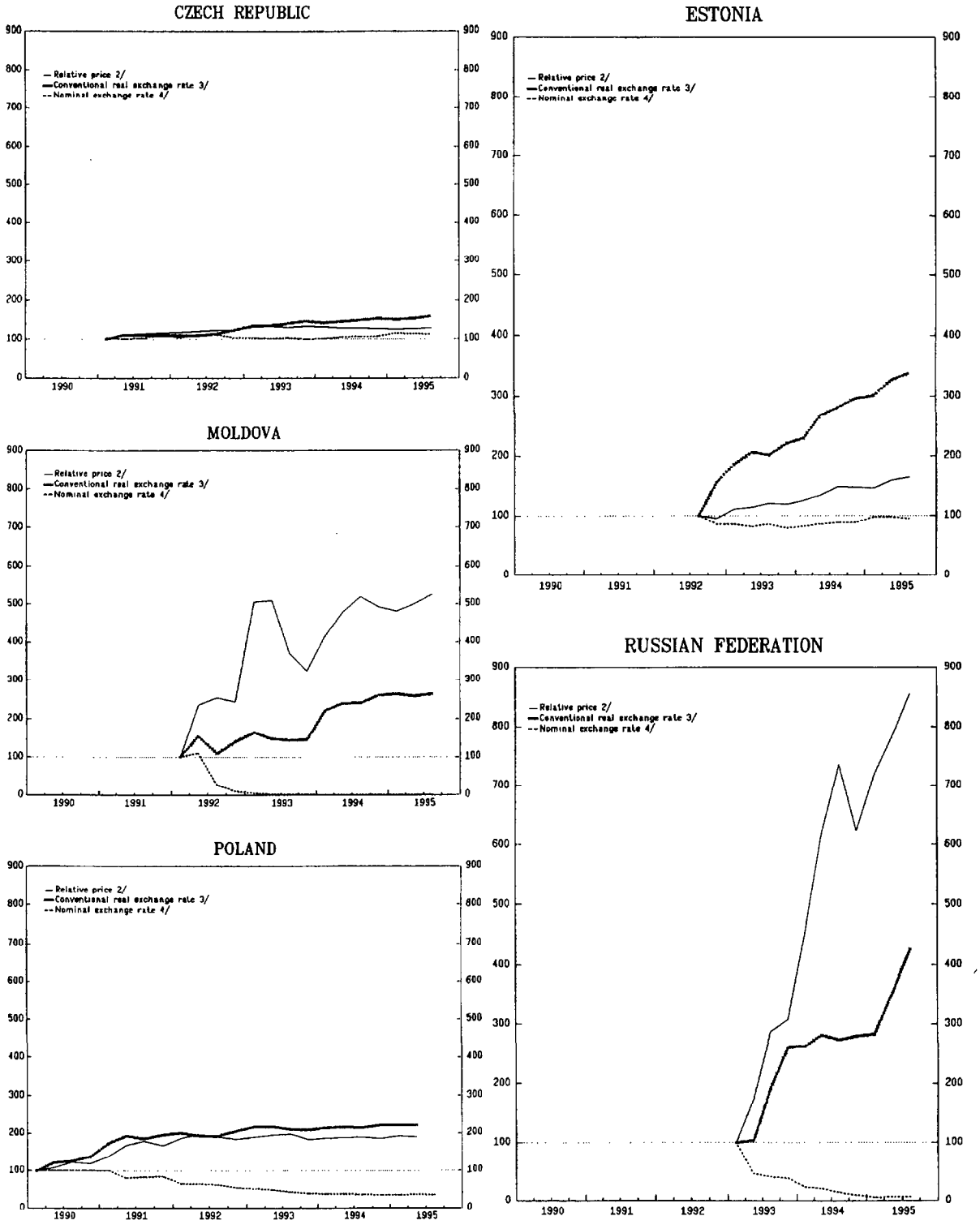
[47]This does not imply that a formal exchange rate anchor will, by itself, discipline credit policy. Clearly causality can work in the other direction: countries that are unable or unwilling to follow disciplined financial policies would avoid adopting a formal exchange rate anchor.

[48]The weighting in the CPI plays an important role in the divergence in the two measures. In Moldova and Russia, nontradables received a very small weight in the overall CPI; hence, for a given real appreciation (defined as an increase in the prices of nontradables relative to tradables), the relative CPI-based measure would be lower than the ratio of nontradable to tradable prices.

CHART 4

Indicators of Real Exchange Appreciation 1/

(Index: 1st observation= 100)



1/ Starting period coincides approximately with the period of initial price liberalization, except for Russia where data are not available for 1992.
2/ Relative price of nontradables to tradables.
3/ Real exchange rate based on CPI relative to trading partner CPIs.
4/ U.S. dollars per unit of local currency.

Table 11: Comparison of Price Levels in Each Country to that of Austria

	1993				
	Czech Republic	Poland	Estonia	Moldova	Russia
Commodity Price Level in Percent of Corresponding Austrian Price Level:					
Food, Beverages, and Tobacco	36	47	28	14	26
Clothing and Footwear	36	49	23	10	28
Household Equipment and Operation	39	60	31	14	25
Gross Rents, Fuel and Power	15	22	13	4	8
Medical Care	19	22	7	7	6
Transport and Communication	43	56	18	14	17
of which:					
Purchased transport services	33	46	8	8	11
Communication	32	36	8	4	10
Recreation and Education	20	28	19	7	11
Misc. Goods and Services	29	51	25	9	29
Overall Price Level in Percent of Overall Austrian Price Level	26	35	19	9	16
Predicted Price Level in percent of Austrian Price Level 1/	45	38	42	29	36
Memorandum Items:					
PPP-adjusted GDP in Percent of Austrian GDP (EPCP)	45	20	11	24	27
PPP-adjusted GDP in Percent of Austrian GDP (WEO)	38	28	33	16	26

Source: European Price Comparison Program.

	1994 2/				
	Czech Republic	Poland	Estonia	Moldova	Russia
Commodity Price Level in Percent of Corresponding Austrian Price Level:					
Food, Beverages and Tobacco	53	56	...	...	60
Clothing and Footwear	42	67	...	...	21
Household Equipment and Operation	48	46	...	...	17
Gross Rents, Fuel and Power	16	38	...	...	36
Transport and Communication	30	19	...	...	25
Recreation and Education	35	39	...	...	26
Misc. Goods and Services	29	103	...	...	39
Overall Price Level in Percent of Overall Austrian Price Level 3/	42	51	...	...	42
Predicted Price Level in percent of Austrian Price Level 1/	38	29	...	...	22
Memorandum Item:					
PPP-adjusted GDP in Percent of Austrian GDP (WEO)	29	22	...	...	17

Source: Business Eastern Europe.

1/ Calculated by dividing the predicted price level relative to the US level (for each country) by the predicted price level of Austria relative to the US, using an equation estimated on 1990 ICP data by Richards and Tersman (1995): Predicted price level relative to the US=21.7+1.2*PPP-adjusted GDP in percent of US GDP+12.1*dummy for Europe-43.0*dummy for US. PPP-adjusted GDP obtained from WEO database.

2/ Price data collected only in country capitals; the results from the two studies are therefore not directly comparable.

3/ Unweighted mean of all 60 commodity price ratios covered by the subgroups above.

all five countries are typically less than half the levels in Austria).[49] Moreover, the tendency for the real exchange rate measured on the basis of relative CPIs to appreciate more than the ratio of nontraded to traded goods in the Czech Republic, Poland, and Estonia is consistent with the gradual convergence of domestic traded prices to those of trading partners (Chart 4).[50] Nevertheless, while undervaluation may explain the sharp real appreciation at the initial stages of transition, gradual arbitrage in traded goods prices is not very plausible in small, open economies like the Czech Republic, Poland, and Estonia. However, to the extent that tradable goods prices incorporate a substantial nontradable element, and the pricing of capital pushes nontradable prices (which are dominated by capital-intensive services) below levels predicted for market economies, a more plausible explanation may be offered by the cost-recovery hypothesis. Since cost-recovery appears to be a factor at least in the Czech Republic, Poland, and Estonia (Chart 3), part of the real appreciation and gradual convergence of tradable and nontradable prices to market economy levels may be driven by cost-recovery considerations rather than by undervaluation per se.

An alternative explanation of real appreciation in the later stages of transition, particularly in the Baltics, is the Balassa-Samuelson effect based on faster productivity growth in tradables than nontradables. However, numerical examples based on the observed real appreciation (as measured by the change in prices of nontradables relative to tradables in the CPI) and some plausible assumption on total factor productivity growth (TFP) in tradables in the five countries imply highly implausible rates of TFP growth in nontradables, particularly when real appreciation is large as in Estonia, Moldova, and Russia (Table 12). For the entire sample period, the observed real appreciation is sufficiently large to imply sizeable negative TFP growth in nontradables in almost all cases.[51] For the last year of the sample, plausible rates of productivity growth in nontradables obtain only in the Czech Republic and Poland where real appreciation is much more moderate.

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[49]Using differences in traded goods prices as evidence of undervaluation, however, is of questionable validity since a sizeable body of empirical evidence demonstrates that international differences in price levels of similar traded goods are large and persistent even across industrial countries (Rogoff (1996)). Kravis and Lipsey (1982) argue that international price differences for tradables are large enough to suggest a substantial nontradable element.

[50]The two measures yield similar results if the ratio of nontradable to tradable prices in trading partners is relatively stable and there is close price arbitrage in traded goods, i.e., tradable prices increase at similar rates domestically and abroad (De Gregorio et al. (1993); Lipschitz and McDonald (1991)). If domestic tradable prices rise faster, consistent with gradual price arbitrage, the relative prices of nontraded to traded goods need not change, but the CPI-based measure would show a real appreciation.

[51]A generous assumption of an annual TFP growth in tradables of 5 percent was made to bias the implied productivity growth in nontradables upward. If productivity growth in tradables is lower, the implied productivity growth in nontradables would be lower as well.

Table 12. Real Exchange Rate Appreciation and Implied Productivity Growth Consistent with the Balassa—Samuelson Model 1/

(In percent)

	Czech Republic	Poland	Estonia	Moldova	Russia
Whole period 2/					
Total real appreciation:					
Relative consumer price index	56.8	121.1	173.0	164.3	326.9
Price of non-tradables relative to price of tradables	27.5	89.0	88.2	424.5	754.0
Implied annual productivity growth, non-traded sector; Case I 3/	-0.5	-7.0	-15.0	-34.6	-55.5
Implied annual productivity growth, non-traded sector, Case II 4/	0.4	-6.1	-14.1	-34.0	-55.0
Later period 5/					
Total real appreciation:					
Relative consumer price index	9.4	2.7	19.2	10.3	52.1
Price of non-tradables relative to price of tradables	-0.4	0.1	18.0	9.5	38.1
Implied annual productivity growth, non-traded sector; Case I 3/	5.3	4.9	-8.0	-2.4	-18.9
Implied annual productivity growth, non-traded sector; Case II 4/	6.3	5.9	-7.1	-1.4	-18.1

1/ The implied productivity growth is calculated as: $(\hat{P_N/P_T}) = (\alpha_N/\alpha_T)\,\hat{\Theta}_T - \hat{\Theta}_N$, where a "^" denote rate of change; derived by assuming linear homogenous production functions in the traded (T) and non-traded sectors (N): $Y_i = \Theta_i K_i^{(1-\alpha_i)} L_i^{\alpha_i}$; i = T, N (Asea and Corden, 1994). Assuming $\alpha_N/\alpha_T = k$ (a constant), the formulation for discrete changes is $(\hat{P_N/P_T}) = [(1+k\hat{\Theta}_T)/(1+\hat{\Theta}_N)-1]$. The implied productivity growth in non-tradables would be higher than that in tradables if there is a real depreciation or k is sufficiently larger than unity.

2/ Czech Republic: 1991:Q1-1995:Q3; Poland: 1990:Q1-1995:Q2; Estonia: 1992:Q3-1995:Q2; Moldova: 1992:Q1-1995:Q3; Russia: 1993:Q1-1995:Q3.

3/ Case I: Assumes $\alpha_N = \alpha_T$ (k = 1) and $\hat{\Theta}_T$ (annual productivity growth in tradables) of 5 percent.

4/ Case II: Assumes $\alpha_N/\alpha_T = k = 1.2$ and $\hat{\Theta}_T$ of 5 percent.

5/ All Countries: 1994:Q3-1995:Q3.

VI. CONCLUSIONS

In the context of the concerns over the persistence of moderate inflation, the paper has analyzed the empirical evidence regarding the sources of inflation in transition economies, in particular the role of relative price adjustment. The analysis, based on a sample of 21 transition economies in Eastern and Central Europe, the Baltics, and the Former Soviet Union, suggests the following main messages:

- Inflation distributions (of the components of the CPI) in transition economies display a high degree of variance, indicating that significant relative price adjustments take place throughout the transition period even well beyond comprehensive initial liberalization. Following an initial sharp burst at the beginning of the transition, variance typically declines, but remains high relative to market economies. There is also widespread evidence that these distributions are positively skewed, consistent with downward price inflexibility and suggesting that a small number of large price increases have led the inflationary process.

- In general, money growth plays a dominant role in explaining inflation in the 21 countries. Inflation is more responsive to broad money including foreign currency deposits and domestic credit of the banking system than to broad money excluding foreign currency deposits. The significance of money growth—whether generated through credit expansion or endogenously through the balance of payments—suggests, other things equal, that tighter monetary control, including through nominal appreciation, could help lower inflation in the presence of relative price adjustments.

- Nominal wage growth is also estimated to have a substantial impact on inflation in Eastern Europe and the FSU. By contrast, wage pressures do not appear to be an important factor in the Baltics.

- Overall, relative price variability has a significant impact on inflation, although—more than in the case of the other explanatory variables—the size of the effect varies by region and over the sample period. Variability is associated with nominal wage shocks in the pooled sample (which is dominated by the FSU) and the FSU. In these cases, relative price variability is estimated to make a small contribution to inflation when nominal wage growth is included in the equation and a substantial contribution when it is excluded. The estimated impact is generally small in Eastern Europe and the Baltics, although variance has a sizeable effect on inflation during the initial liberalization period in Eastern Europe.

- The indicator that captures the effect of relative price variability on inflation also varies by region and over the sample period. In broad terms, variance appears to be significant during the initial phase of liberalization—for instance, in Eastern Europe and the FSU. However, skewness rather than variance is significant in the post-liberalization periods in Eastern Europe and the Baltics, suggesting the presence of downward price rigidity at moderate levels of inflation.

- Relative price variability arises from different sources. Sharp increases in relative price variance (which are frequently concurrent with spikes in inflation) early in the transition tend to coincide with periods of intensive trade and price liberalization, wage and administered price increases, tax reform, and terms of trade shocks, at times accompanied by monetary accommodation. The results also offer support for the cost-recovery hypothesis—particularly in countries more advanced in the transition: increases in prices of capital-intensive services (housing, utilities, transportation) relative to other prices are evident in these cases and, when combined with downward price inflexibility, suggest that cost-recovery may be an important factor influencing relative price adjustment and inflation in the later stages of transition.

- The estimations do not show a significant impact of real appreciation on inflation, except for a small dampening effect (for a given money growth) observed for Eastern Europe. This may reflect the tendency for countries to resist nominal appreciation and to accommodate pressure for real appreciation through endogenous money growth via the balance of payments.

- Strong real appreciation is, nevertheless, an important factor in many transition economies. While undervaluation and Balassa-Samuelson effects are unlikely to account for sustained large real appreciation, the cost recovery hypothesis may offer an alternative explanation of some of the underlying pressures for real appreciation.

- The estimated equations capture only the partial, impact effects of wage and relative price shocks, including real exchange rate movements, on inflation during a quarter. The total effect of these shocks is difficult to isolate because monetary accommodation can take place contemporaneously or in subsequent quarters and would tend to be captured by the money variable in the estimated equation. Indeed, the case studies suggest that monetary expansion through foreign exchange inflows can be quite substantial and can accommodate shocks to inflation over the longer-term. Thus, although substantial relative price variability and real appreciation are features of transition economies, a limited estimated impact of these variables on inflation may reflect rapid monetary accommodation through foreign exchange inflows in these small, open economies (particularly in the case of the Baltics).

- In principle, as indicated by the analytical model underlying the estimated equation, an impact effect of relative price variability on inflation suggests that shifts in velocity—or unstable money demand—may accompany relative price adjustment in the short-run (when nominal money growth is controlled for and output growth can be assumed to be fixed during the quarter).[52] Evidence in favor of a significant relative price effect in the FSU (related to nominal wage shocks) and during the initial liberalization period in Eastern Europe suggests that unstable money demand may characterize periods of intensive relative price volatility.

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[52]This can be inferred from the money market identity: money growth + change in velocity = inflation + output growth (see Appendix II). Citrin and Lahiri (1995) provide evidence for the FSU that divergences in inflation and money growth have almost always been associated with corresponding movements in velocity rather than large swings in output.

Conversely, relative price effects do not appear to account for much of the short-run shifts in velocity in the post-liberalization period in Eastern Europe and the Baltics.

- Inertia becomes a more significant influence at lower levels of inflation and in the later stages of transition in Eastern Europe suggesting that the output costs of reducing inflation tend to increase at these levels.

- The announcement effect of an explicit exchange rate anchor has only a marginal effect—which is statistically weak and becomes insignificant over time—in dampening inflation. This does not, however, imply that exchange rate anchors are ineffective in lowering inflation since two of the main channels through which such anchors would work are by disciplining financial policies, hence leading to lower money growth, and by lowering inflation expectations, hence dampening wage pressures.[53]

[53]The estimated equations capture only the effect on inflation of explicit exchange rate anchors for given nominal money and wage growth.

ANNEX I

Inflation and Money Growth Under Recent Fund-Supported Programs

(End of period growth rates, unless otherwise noted)

Region	Country	Program	Program Period 1/	Inflation		Broad Money Growth	
				Target	Actual	Projected	Actual
East and Central Europe	Albania	ESAF 7/93	1993:H2 1994	21 21	17 16	21 21	28 39
	Bulgaria	SBA 4/94	1994	30	122	22	79
	Czech Republic	SBA 3/93	1993 1994	14 9	19 10	18 13	20 22
	Hungary	SBA 9/93	1993 1994	19 17	21 21	20 18	17 13
	Poland	SBA 3/93	1993	32	38	37	36
		SBA 8/94	1994 1995	24 16	29 22	29 22	38 35
	Romania	SBA 5/94	1994 1995	77 27	62 28	108 57	138 66
	Slovak Republic	SBA 7/94	1994 1995	12 8	12 7	11 10	19 21
Baltics	Estonia	SBA 9/92	1992 1993	975 2/ 54 2/	1069 2/ 89 2/	... ...	68 58
		SBA 10/93	1993:H2 1994	8 3/ 10 3/	15 3/ 45 3/	12 18	47 30
	Latvia	SBA 9/92	1992:H2 1993:H1	60 11	124 12	61 ...	81 34
		SBA 12/93	1993:Q4 1994	6 6	19 26	10 27	15 48
		SBA 4/95	1995	15	23	25	-24
	Lithuania	SBA 9/92	1992:H2 1993:Q1	187 8	268 46	106 4/ 10 4/	120 4/ 14 4/
		SBA 10/93	1993 1994	148 13	189 45	160 ...	105 63
		EFF 10/94	1994:H2 1995	52 2/ 20 2/	54 2/ 39 2/	35 29	30 30
FSU	Armenia	STF 12/94 SBA 6/95	1995 1995:H2	4 7	32 7	54 3	72 22
	Belarus	STF 7/93	1993:H2 1994	83 24	532 1959	157 ...	177 1959
	Georgia	STF 12/94 SBA 6/95	1994:Q4 1995 1995:H2	13 29 9	-15 62 39	-6 48 22	29 144 221
	Kazakhstan	STF 7/93	1993 1994	625 30	2169 1160	380 4/ ...	1176 4/ 544
		SBA 1/94	1994	109	1160	102	544
	Krygyz Republic	SBA 5/93 ESAF 7/94	1993 1994:H2 1995:H1	360 28 19	1366 18 20	192 20 18	180 42 30
	Moldova	STF 9/93	1993:H2 1994:H1	83 18	229 86	128 -10	125 98
		SBA 12/93	1993:Q4 1994	40 37	82 116	20 40	29 116
		SBA 3/95	1995	9	24	11	65
	Russia	FCTA 7/92	1992:H2	150	180	170 4/	251 4/
		STF1 6/93	1993:Q2-Q4	172	400	138 4/	259 4/
		STF2 4/94	1994	268	203	254 4/	196 4/
	Ukraine	STF 10/94	1994:H2 1995:Q1	129 42	205 59	141 17	194 24
		SBA 4/95	1995	138	181	84	117

Source: MONA database; Board documents.

1/ H1 and H2 refer to inflation and money growth during the first and second half of the corresponding calendar year; Q1, Q2 and Q4 refer to inflation and money growth during each respective quarter.
2/ Average inflation over the same period the previous year.
3/ 1993:H2: average in inflation in the fourth quarter over average inflation in the second quarter; 1994: average inflation, fourth quarter over fourth quarter.
4/ Excluding foreign currency deposits.

Czech Republic: Structural Reforms 1/

	First Year of Transition (1991)	Subsequent years of Transition (1992–1995)
Price Liberalization		
No. of items liberalized	After some initial reforms in 1990, extensive price liberalization -- both at the producer and retail level -- was introduced on January 1, 1991. Share of regulated prices was reduced from 85 percent to 15 percent of turnover, with a further reduction to 6 percent later in 1991	
Supporting action	Subsidies almost completey eliminated jointly with price liberalization.	
Prices remaining under control	Public utilities, rents, transport, and a few intermediate inputs	
Adjustments of controlled prices		Periodic adjustments to account for higher energy costs etc.
Trade Liberalization		
Quantitative Restrictions/ Licencing of Exports	Largely eliminated, only for a few strategic commodities kept under restriction	
Export Tariffs	Entirely eliminated	
Quantitative Restrictions/ Licencing of Imports	Largely eliminated; retrictions maintained only on some agricultural products	
Import Tariffs	Ad valorem tariffs with low rates and relatively small dispersion introduced. Temporary import surcharge in place during part of 1991.	Small modifications to tariff system introduced in 1992.
Accession to GATT/WTO		Concluded several trade agreements with EC, EFTA, and bilaterally in 1992.
Tax Reform		
Turnover Tax/VAT	Strong simplification of turnover tax in 1991; number of rates and their level sharply reduced.	
Structure of Turnover Tax/ VAT		VAT introduced on January 1, 1993; standard rate of 23 percent and reduced rate of 5 percent for basic commodities. Comprehensive coverage with few exemptions.
Excises		New system of excises introduced jointly with VAT.
Exchange Regime		
Type of Regime	Fixed peg to a basket of five currencies (US$, deutche mark, Austrian schilling, Swiss franc, and British pound).	Basket reduced to only US$ and deutche mark in mid-1993.
Rate Adjustments	No.	
Current Account Convertibility	Almost full convertibility introduced in 1991.	

1/ Covers Czechoslovakia before the breakup of the federation in 1993.

Estonia: Structural Reforms

	First Year of Transition (June 1992–May 1993)	Subsequent years of Transition (June 1993–September 1995)
Price Liberalization		
No. of items liberalized	Liberalization mainly completed in 1991/early 1992	
Supporting action	Consumer subsidies largely eliminated	
Prices remaining under control	About 10 percent of price in consumer basket (electricity, fuels, rents, etc.); mainly for anti–monopoly reasons	
Adjustments of controlled prices		Significant increase in March 1993
Trade Liberalization		
Quantitative Restrictions/ Licencing of Exports	Licencing requirements sharply reduced in early 1992; by June, 1992 licences required for 38 products (food items, forest products, mineral products, and cement). Most of these eliminated during 2nd half of 1992	By Jan. 1, 1993, licences required only for shale oil, clay, and quartz. These licences were abolished during 1994.
Export Tariffs	Tariff on metal products introduced in June, 1992; also tariffs on rapeseed oil and art works.	Tariff on metal products partly repealed in early 1993; tariff on rapeseed oil and artworks repealed in December, 1993.
Quantitative Restrictions/ Licencing of Imports	All non–tariff barriers on imports eliminated by February, 1992.	
Import Tariffs	From 1992, only an administration fee of 0.5 percent plus excises on imported alcoholic beverages, furs, tobacco, gasoline, and vehicles.	
Accession to GATT/WTO		Membership application filed in 1994.
Tax Reform		
Turnover Tax/VAT	VAT introduced in 1991 at 10 percent rate; the rate was increased to 18 percent in mid–1992	
Structure of Turnover Tax/ VAT	VAT initially not destination–based; exports zero–rated to convertible currency–are only; imports generally not subject to tax. A number of basic services exempt. VAT on imports introduced in Nov., 1992.	Many VAT exemptions eliminated in 1994.
Excises	Imposed on alcoholic beverages, tobacco, furs, and gasoline.	
Exchange Regime		
Type of Regime	Currency Board from June 20, 1992; EEK1=DM1. 100 percent surrender on export earnings.	
Rate Adjustments	None	
Current Account Convertibility	Full convertibility. De facto, also considerable capital account convertibility.	

Moldova: Structural Reforms

	First Year of Transition (1992)	Subsequent years of Transition (1993–95)
Price Liberalization		
No. of items liberalized	Most industrialized and some consumer goods liberalized in Jan. 1992. Some further liberalization in Nov. 1992.	Bread prices liberalized in Q3 – 1993.
Supporting action		Subsidies on food eliminated in first half of 1994
Prices remaining under control	Considerable price control retained (especially on key food staples, rent, public transportation, and utilities) through regulations on profit margins and mark–up rates.	Regulations on profit margins and mark–up rates, with some adjustments in Q3 – 1993. Regulations eliminated in early 1995.
Adjustments of controlled prices	Large adjustments in Nov. 1992.	Large adjustments in Q3 – 1993, Jan. 1994, and June 1994.
Trade Liberalization		
Quantitative Restrictions/ Licencing of Exports	In early 1992 trade was mainly on a barter basis, and the old Soviet system of trade regulations were in effect. From mid–year an extensive system of export quotas and licencing introduced. Initially this applied to both FSU and non–FSU trade; restrictions on FSU trade were largely lifted by end–year.	General licencing requirement abolished in April, 1993; licence retained only for goods related to national security, medicine, and culture. Gradual removal of QRs, by March 1994 only a few left, and by 1995 virtually eliminated.
Export Tariffs	Old Soviet system on non–FSU exports; rates on 15, 20, and 30 percent applied to FSU exports.	Export tariffs abolished during 1993.
Quantitative Restrictions/ Licencing of Imports	Largely eliminated, licence required for a few goods from mid–1992.	
Import Tariffs	Old Soviet system, tariff levied on fixed and strongly appreciated exchange rate.	New tariff schedule introduced in Nov. 1993; rates of 5–100 percent, average rate at 30 percent. Further revisions tariff schedule in Q1, 1995; average rate 15 percent, maximum rate 30 percent. Extensive ememptions.
Accession to GATT/WTO		Discussions of accession to GATT started in 1994.
Tax Reform		
Turnover Tax/VAT	VAT introduced in Jan. 1992; standard rate 28 percent, reduced rate for a few commodities.	Basic rate reduced to 20 percent in early 1993; reduced rate for selected commodities retained. Lower rate of 16.67 percent for wholesale and manufacturing introduced in 1995.
Structure of Turnover Tax/ VAT	Not on destination basis, similar to other FSU countries. Exemptions for passenger transportation, rent, transactions related to SOEs, insurance, and culture.	From Nov. 1993, coverage extended to non–CIS imports, some new exemptions added – – mainly related to agriculture. In 1995, Zero–rating for non–CIS exports introduced, and further exemptions added.
Excises	Introduced in Jan. 1992 on alcoholic beverages, tobacco, and a few luxury items; rates of 25 – 50 percent.	1993–94: Rate structure revised to range from 10 to 80 percent. In 1995: No. of items subject to excises reduced.
Exchange Regime		
Type of Regime	Legal tender in Moldova was the Russian ruble. Jan.–Sept. 1992: 3 rates in use; a commercial and an investment rate– –both fixed, and a floating market rate based on local auctions. From Sept., only 2 rates: the MIFCE, which replaced the commercial and investment rates, and the local rate. Large spread between these rates. Until Sept., surrender requirement on net export earnings of 50–60 percent at sharply appreciated rate. After Sept., surrender requirement lowered to 35 percent, and MIFCE rate used.	Jan.–July, 1993: Russian ruble was legal tender, but cupons increasing in importance. July–Nov. 1993: transition period with Russian ruble withdrawn, and cupons/"Moldovan ruble" in circulation. Nov. 1993: Moldovan leu introduced; floating rate, determined by fixing sessions at CIFCE twice or three times a week. Surrender requirement retained at 35 percent, but basis changed to local auction rate. Surrender requirement abolished in Nov. 1994. Fixing sessions on a daily basis from Feb. 1995.
Rate Adjustments	Does not apply	Does not apply
Current Account Convertibility		Covertibility introduced in June 1995.

ANNEX II

Poland: Structural Reforms

	First Year of Transition (1990)	Subsequent years of Transition (1991-95)
Price Liberalization		
No. of items liberalized	Considerable liberalization prior to 1990; about 89 percent of prices allowed to fluctuate freely.	Revision of price system in 1992; about the same share of prices remain market-determined. Partial retail price freeze in July-Sept. 1993; also tightening of monopoly control and price notification.
Supporting action	Sharp reduction in subsidies	
Prices remaining under control	About 11 percent	About 12 percent (utilities, rents, television fees, and certain alcoholic beverages).
Adjustments of controlled prices		Sharp increases in 1992 and 1993
Trade Liberalization		
Quantitative Restrictions/ Licencing of Exports	Export licencing on 20 goods from Jan. 1, 1990	
Export Tariffs		
Quantitative Restrictions/ Licencing of Imports	All non-tariff barriers to imports eliminated by Jan. 1, 1990	Licencing requirements reintroduced on a few goods in 1991.
Import Tariffs	Regular import tariffs suspended on 4,500 goods June 1, 1990; average import tariff after suspension: 5.5 percent.	Tariff suspension lifted in Aug. 1991; average tariff rate increased to 18.4 percent. In Dec. 1991, additional surcharge of 6 percent across-the-board.
Accession to GATT/WTO	Practically all trade contracts changed to convertible currency basis during 1990.	Several agreements on improved market access to EC/EU, and EFTA. Start of negotiations on access to GATT.
Tax Reform		
Turnover Tax/VAT		Turnover tax expended in several steps: including imports (Jan. 1991); new goods added to tax net (May, 1992); higher rates on domestic goods (Dec. 1992). VAT introduced in July, 1993; standard rate 22 percent, 7 percent for selected goods.
Structure of Turnover Tax/ VAT		Zero-rating of agricultural inputs, medicines, books, and newspapers. Exemptions for 5 product groups.
Excises		Revised with the introduction of VAT; imposed on alcoholic beverages, fules, tobacco, yachts, and cars.
Exchange Regime		
Type of Regime	Fixed peg from Jan. 1990, at rate of Zl 9,500 = US$1.	May, 1991, changed to a fixed peg to a basket (US$, DM, FRF, SWF, and Pound Sterling). Oct. 1991, a crawling peg with a preannounced rate of crawl against this basket (nominal depreciation of 1.8 percent per month). May, 1995, a band of +/- 7 percent around central rate, which continued to crawl against basket.
Rate Adjustments		Step devaluations in May, 1991 (14.4 percent), March 1992 (10.7 percent), and Sept. 1993 (8 percent). Reductions in rate of crawl in ? (to 1.6 percent/month), Sept. 1994 (to 1.5 percent/month), and Nov. 1994 (to 1.4 percent/month). Feb., 1995, reduction in rate of crawl to 1.2 percent/month.
Current Account Convertibility	Full convertibility introduced from Jan. 1990.	

Russian Federation: Structural Reforms

	First Year of Transition (1992)	Subsequent years of Transition (1993-95)
Price Liberalization		
No. of items liberalized	Extensive decontrol of prices in Jan. 1992.	
Supporting action	Few	
Prices remaining under control	At federal level, prices of gas, electricity, coal, and telecommunications remained under control. In addition, extensive control of certain food staples and public transportation at local level. Controls of profit-margins of monopolies	
Adjustments of controlled prices	Energy prices increased in May and Sept., 1992.	
Trade Liberalization		
Quantitative Restrictions/ Licencing of Exports	Extensive use of quantitative restrictions and licencing.	17 broad groups of goods subject to quantitative restrictions, and 70 percent of imports subject to licencing, in part through centralized export arrangements. This system was largely in place through mid-1994, when it was scaled back. Some QRs remained in place through the rest of 1994. QRs generally abolished from Jan. 1995; centralized exports apply only to arms and defense-related goods.
Export Tariffs	About 70 percent of total exports subject to tariffs; 20 percent rate for most goods, 30 percent for barter trade.	Surcharge on barter eliminated, and rate reduced for many goods by Nov. 1993. No. of goods subject to export tariffs reduced in Sept. 1994.
Quantitative Restrictions/ Licencing of Imports	QRs and licencing requirements largely abolished by early 1992.	
Import Tariffs	Standard tariff of 5 percent applicable to most goods introduced in July, 1992. New schedule, with higher average rate aand more dispersion, introduced in Sept., 1992. Centralized imports, covering close to 50 percent of non-FSU imports, were subsidized at average rate of 95 percent; through exchange rate system until Sept. 1992, afterwards through budget.	New tariff introduced in April, 1993; rates of 5-15 percent, average rate 8 percent. Some exemptions introduced. Further revisions in July, 1994; 17 rate bands, average rate 12 percent; increase in exemptions. Import subsidies retained until mid-1993. New import tariff from Jan. 1995; rates of 5-30 percent; reductions in exemptions.
Accession to GATT/WTO		
Tax Reform		
Turnover Tax/VAT	VAT introduced in Jan. 1992, at 28 percent standard rate	Rate changed in early 1993; 20 percent standard, 10 percent on selected goods (mainly food).
Structure of Turnover Tax/ VAT	Levied on cash basis; zero-rate of non-CIS exports and passenger transportation. Exemptions only on minor items. CIS exports taxable with credit mechanism for tax paid in recipient country.	Move to accrual basis in late 1995
Excises	Introduced in Jan. 1992 on alcoholic beverages, tobacco, cars, and certain luxury items; rates 10-90 percent.	
Exchange Regime		
Type of Regime	Floating; determined in interbank trading and interventions limited to smooth out short-term fluctuations.	Exchange rate band (Rub 4,300-4,900 per US$) introduced in July 1995.
Rate Adjustments	Does not apply	Does not apply
Current Account Convertibility	Unified exchange-rate regime introduced in July, 1992; full convertibility in place by Nov. 1992.	

THE DISTRIBUTION OF RELATIVE PRICES IN INDIVIDUAL COUNTRIES

This appendix summarizes the main aspects of empirical work on relative price variability and inflation in market economies, describes the major sample characteristics of the disaggregated CPI data from which the measures of variability used in this paper were calculated, reviews the definitions and characteristics of these measures, and reports in greater detail the results of the analysis of relative prices summarized in Section III.

I. Empirical Evidence from Market Economies

The empirical work on market economies forms a useful comparison with the results reported below. Some common patterns emerge:[1]

- Relative price variability (most often the dependent variable) is strongly and positively associated with inflation and changes in inflation. However, the relationship is not always stable for long periods and the estimations suggest other variables need to be included; unanticipated inflation appears more significant than anticipated inflation.

- Causality tests find no clear pattern of leads and lags between variability and inflation (or unanticipated inflation or inflation variance), although there is strong evidence of contemporaneous correlation.

- Variability appears to be associated asymmetrically with changes in inflation and unanticipated inflation (rising more when these variables are positive than negative). In high inflation contexts, variability also appears to respond asymmetrically to monetary surprises.

- There is strong and widespread evidence of nonnormality in the distribution of relative prices. Price distributions frequently have a positive skew which changes substantially over time and which tends to be positively related to the level and acceleration of inflation, consistent with asymmetric price responses.[2]

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[1]The results summarized below are based on the analysis of price data for the United States (Ball and Mankiw (1994, 1995), Fischer (1981, 1982), Hercowitz (1982), Marquez and Vining (1984), Parks (1978), Vining and Elwertowski (1976)); Germany (Fischer (1982), Gerhaeusser (1988), Hercowitz (1981)); Japan (Fischer (1981)); United Kingdom (Mizon, Safford, and Thomas (1990)); Argentina (Blejer (1983)); Israel (Leiderman (1987)); Mexico (Blejer and Leiderman (1982)); and Poland (SM/95/316).

[2]For the United States, falling inflation is associated with a negative skew and stable inflation with a more symmetrical, albeit not normal, distribution of relative price changes (Vining and Elwertowski (1976)).

• Normality is rejected less frequently and variance tends to be smaller in annual than in monthly data, suggesting a tendency towards greater symmetry over time.[3] This is consistent with different speeds of adjustment of relative prices following an initial shock (although prices may eventually settle around a different mean rate of inflation).

• Periods of pronounced asymmetry tend to coincide with real sectoral disturbances, particularly food and energy price shocks, which also dominate relative price variance and the relationship between variance and other macroeconomic variables, particularly inflation.

• When food and energy price shocks are removed, (unanticipated) monetary disturbances and interest rates are found to be associated with unanticipated inflation and increased variability, indicating that the link between the latter two variables also depends on aggregate shocks.

II. Sample Characteristics of the Disaggregated CPI Data

Disaggregated CPI data were obtained for each of 21 transition economies in Central and Eastern Europe, the Baltics, and the FSU.[4] Reflecting data availability, the sample of disaggregated CPI data is characterized by cross-country differences in the sample period, the degree of commodity disaggregation, and the weighting system (Table 13). The coverage of the CPI is complete in all cases (i.e., the weights add up to one). A disaggregation beyond three commodities was not available for Tajikistan and apparent data discrepancies emerged for Turkmenistan. These two countries, therefore, had to be dropped from the sample.

The sample period, which typically begins in 1991-92 and ends in the third quarter of 1995, ranges from 6 quarters to 22 quarters. It predates major price liberalization episodes in Eastern Europe by about four quarters and is roughly coincident with price liberalization in the Baltics. Liberalization tends to be more gradual, less complete, and to occur late in the sample for much of the FSU. Thus in most cases, the data cover the stabilization attempts following price liberalization.

For each quarter, the level of disaggregation ranges from about 10 to 70 categories, with the exception of Russia for which some 400 categories are available. In several countries (Albania, Bulgaria, Czech Republic, Kyrgyz Republic, Lithuania, Moldova, Romania, Russia, and Ukraine), the disaggregation changes over the sample period. The weighting system remains constant in some countries (sometimes because of an unchanged CPI basket), but

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[3]However, since the power of any test for nonnormality increases with the number of observations, the nonrejection of normality with annual data may only reflect the fact of fewer annual than monthly observations.

[4]These data were provided by EU1 and EU2, either through the respective country desks or through the resident representatives.

Table 13. Sample Characteristics of the CPI Data

Region	Country	Observation Period, First and Last Quarter	Breakpoints Occurs 1/	Number of Categories Before/After Breakpoints 2/	CPI Weights Available in:
East and Central Europe	Albania	Q1 92 - Q3 95	Q4 93	8/24	92
	Bulgaria	Q3 90 - Q3 95	Q4 92	11/11	90, 93
	Czech Republic	Q1 91 - Q3 95	Q4 93	30/10	91, 94
	Hungary	Q1 91 - Q3 95	Q4 92	7/7	91, 93, 94, 95
	Poland	Q1 90 - Q2 95		33	90, 91, 92, 93, 94, 95
	Romania	Q1 92 - Q3 95	Q4 93	69/161	92, 94
	Slovak Republic	Q1 92 - Q3 95		34	92
	Slovenia	Q1 92 - Q4 95		17	92, 93, 94, 95
Baltics	Estonia	Q3 92 - Q3 95		23	92
	Latvia	Q3 92 - Q3 95		51	92, 94
	Lithuania	Q3 92 - Q4 95		79	92, 94
FSU	Armenia	Q1 93 - Q3 95		9	93, 95
	Azerbaijan	Q1 91 - Q3 95		42	91, 92, 93, 95
	Belarus	Q1 92 - Q3 95		33	92
	Georgia	Q1 94 - Q3 95		16	94
	Kazakhstan	Q1 91 - Q3 95		18	91
	Kyrgyz Republic	Q1 92 - Q3 95	Q4 94	32/33	92/95
	Moldova	Q1 92 - Q3 95	Q4 93	53/72	95
	Russia	Q1 92 - Q3 95	Q4 92 Q4 93 Q4 94	153/382 382/392 392/288	92, 93, 94, 95
	Ukraine	Q1 91 - Q1 95	Q4 92 Q4 93	8/8 8/39	91, 92, 93, 94
	Uzbekistan	Q1 94 - Q2 95		15	94, 95

1/ A breakpoint refers to a change (resulting from either a change in data availability, CPI methodology, or both) in the number of goods and services included in the calculation of the various measures of relative price variability.

2/ Number of goods and services included in the calculation of the various measures of relative price variability.

changes annually in others. For many countries, precise weights were not available for every time period, but quarterly end-of-period rates of change of the average CPI calculated from the disaggregated data were compared with the corresponding CPI inflation rate from the macroeconomic data to ensure that deviations between the two generally remained small.

III. CALCULATION OF INDICES OF RELATIVE PRICE VARIABILITY

A. Weighted and Unweighted Variance and Skewness

The distribution of weighted price changes was obtained by treating as separate observations the inflation rates of individual goods and services ("commodities") of the CPI multiplied by the corresponding weights. (i.e., corresponding to a density function $f(w_i\pi_i)$ where w_i is the weight of the ith commodity and π_i is the percentage change of the price of that commodity). The distribution of unweighted price changes was obtained by treating the individual commodity inflation rates as separate observations (i.e., corresponding to a density function $f(\pi_i)$). The weighted and unweighted variances are the second moment of these two respective distributions while the weighted and unweighted skewnesses are the third moment (the respective moments were calculated in TSP). For n number of goods, the respective formulae are:

Weighted variance

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

Unweighted variance

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

Weighted skewness

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

Unweighted skewness

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

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

The mean of the distribution of weighted price changes is thus equal to the rate of inflation of the CPI, divided by the number of commodities in the CPI, while the mean of the distribution of unweighted price changes is equal to the unweighted average inflation rate. Note that the weighted variance does not, in general, assume a value of zero when all individual commodity inflation rates are equal, i.e., when there is no relative price change.

Rather, it assumes a zero value when all weighted inflation rates are equal and, hence, can be interpreted as a measure of the dispersion of the contribution of individual commodity inflation to overall inflation. The unweighted variance, on the other hand, assumes a value of zero when all individual inflation rates are equal, but treats all deviations of individual price changes from the overall inflation rate equally, regardless of their relative importance in consumption expenditures.[5] However, since CPI weights in transition economies often do not accurately reflect the relative importance of certain sectors (particularly public services) because of subsidies and other price distortions, unweighted indicators can provide a useful measure of relative price variability in an economy.

B. The Theil Index of Relative Price Variance

The Theil variance (based on Theil (1967)) is the most commonly used measure of relative price variability in the literature. It is the weighted sum of the squared deviations of individual commodity inflation from the rate of inflation of the CPI (where the latter is defined as the weighted average of the commodity inflation rates) and is given by:

$$(1)\quad TVAR = \sum_{i=1}^{n} w_i \, (\pi_i - \bar{\pi})^2 \qquad where \ \bar{\pi} = \sum_{i=1}^{n} w_i \pi_i$$

Although the Theil variance does not strictly correspond to the second moment of a weighted or unweighted price distribution, it is often preferred in empirical work because it does not suffer from some of the drawbacks of the weighted and unweighted variance, discussed above. Specifically, unlike the weighted variance, the Theil variance assumes a value of zero when all individual inflation rates are equal, i.e., when there are no relative price changes; however, unlike the unweighted variance, it uses the expenditure weights to reflect the relative importance to the consumer of various relative price changes. In the current sample, the three measures are generally highly correlated for each country, but not necessarily across countries, reflecting the sample heterogeneity of the CPI data in terms of the level of disaggregation and expenditure weights.

A useful feature of the Theil variance is its aggregation property. The resulting total variance can be decomposed fully into the variance between groups (e.g., between tradables and nontradables) and the variance within each of group (e.g., within tradables and nontradables). Thus,

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[5]Calculations were based on individual commodity inflation rates and not on relative inflation rates, where the latter are defined as the deviations of the individual commodity inflation rates (weighted or unweighted) from the corresponding mean. The moments of the distribution of individual commodity price changes and of relative price changes are identical except for the mean.

$$(2)\ TVAR = VTNT + \beta VT + (1 - \beta)VNT \quad where\ \beta = \sum_{i=1}^{g} w_i$$

where commodities i = 1...g are tradable and the rest are nontradable. Thus, ß is the weight of tradables in the CPI. The variance between the traded and nontraded groups is:

$$(3)\ VTNT = \beta(\pi_T - \bar{\pi})^2 + (1 - \beta)(\pi_{NT} - \bar{\pi})^2$$

where the inflation rate of tradables is:

$$(4)\ \pi_T = \sum_{i=1}^{g} \frac{w_i}{\beta}\pi_i$$

and the inflation rate of nontradables is:

$$(5)\ \pi_{NT} = \sum_{i=g+1}^{n} \frac{w_i}{(1-\beta)}\pi_i$$

Thus $(w_i/ß)$ and $(w_i/(1-ß))$ represent the share of commodity *i* in the tradable or nontradable baskets, respectively. The variance within tradables and nontradables, respectively, is:

$$(6)\ VT = \sum_{i=1}^{g} \frac{w_i}{\beta}(\pi_i - \pi_T)^2$$

and:

$$(7)\ VNT = \sum_{i=g+1}^{n} \frac{w_i}{(1-\beta)}(\pi_i - \pi_{NT})^2$$

Hence, the proportion of total variance accounted for by variance between tradables and nontradables is (VTNT/TVAR); by variance within tradables is (VT/TVAR); and by variance within nontradables is (VNT/TVAR). In addition, the rate of change of the real exchange rate measured by the relative price of tradables to nontradables (used in the regressions in Section IV) is defined as:

$$(8)\ [\mathbf{P_N}\ \hat{/}\ \mathbf{PT}] = [\frac{1+(\pi_{NT} / 100)}{1+(\pi_T / 100)} - 1] \times 100$$

Note that an increase in (VTNT/TVAR) does not necessarily correspond to a particular movement in the real exchange rate. As implied by (3), such an increase would be consistent with a real appreciation or depreciation or, to the extent there are offsetting movements in π_T and π_{NT}, with a constant real exchange rate.

The variance decomposition and the attribution of shares arising from the three identified sources (between and within tradables and nontradables) in the Theil index is naturally sensitive to the weighting system. In countries where nontradables have a low weight in the CPI basket (mainly reflecting the low prices of public services), the proportion of variance arising from within nontradables appears correspondingly lower, making cross-country comparisons difficult. For instance, the share of variance arising from within nontradables appears greater in industrialized countries than in transition countries and may reflect the larger weight of nontradables in the CPI in the former (Table 9 in Section V). In addition, if (1 - ß) is small, a persistent real appreciation represented by a rising (PNT/PT) would not necessarily be reflected in a marked increase in (VTNT/TVAR); rather if ß is large, movements in (VT/TVAR) may dominate total variance.

C. Theil Skewness

The weighted skewness and unweighted skewness measures also suffer from the same drawbacks as the two corresponding measures of variance, discussed above. Specifically, the weighted skewness generally assumes a non-zero value when all individual commodity inflation rates are equal while the unweighted skewness treats all relative price changes equally. Hence, a measure of skewness which corresponds to the Theil variance was defined as follows:

$$TSK = \frac{\sum_{i=1}^{n} w_i (\pi_i - \bar{\pi})^3}{[\sum_{i=1}^{n} w_i (\pi_i - \bar{\pi})^2]^{3/2}} \quad \text{where} \quad \bar{\pi} = \sum_{i=1}^{n} w_i \pi_i$$

Note that the denominator (which is the third power of the standard deviation) is based on the Theil variance. Moreover, like the Theil variance, this measure assumes a zero value when all commodity inflation rates are equal and uses the expenditure weights to reflect the relative importance of various goods and services to the consumer.

IV. ANALYSIS OF THE SAMPLE PRICE CHANGE DISTRIBUTIONS FOR EACH COUNTRY

The second and third moments of the weighted and unweighted price change distributions, (i.e., the weighted and unweighted variance and skewness) were used to infer the shape of the price change distributions across countries and time periods, particularly, normality and symmetry, which emerge as important properties suggestive of the factors

underlying relative price adjustment.[6] The normality of each cross-section of disaggregated CPI observations (i.e., the distribution of individual commodity inflation rates per country, per quarter) was assessed statistically on the basis of Jarque-Bera tests, which use jointly the information provided by skewness and kurtosis measures and which are known to outperform other types of tests in small samples (Jarque and Bera (1987), White and MacDonald (1980)).[7] The analysis of skewness and kurtosis relied on standard measures based on the third and fourth sample moments (Theil (1971), Greene (1993)), which are computed in TSP with a correction for finite sample size. The results indicate that both weighted and unweighted price change distributions are frequently non-normal and positively skewed (Table 14 in this appendix and Table 2 in Section III).

Since in much of the literature, measures of price variability are regressed on inflation and functions of inflation, four measures of variability—unweighted variance and skewness and the Theil variance and skewness—were regressed on the inflation rate and the change in inflation, the latter term being intended to capture possible nonlinearities in the relationship between the moments (Tables 15-18). Overall, the unweighted variance and the Theil variance appear somewhat positively correlated with inflation and negatively correlated with the change in inflation; the two measures of skewness, however, appear only weakly associated with inflation.

In about half the countries in the sample, the regressions for variance display fairly high explanatory power and pass joint significance tests, although individual parameters for the change in inflation term are often insignificant, possibly as a result of multicollinearity. However, the frequent presence of serial correlation, heteroschedasticity and/or parameter instability point to the likelihood of a misspecified relationship, most likely because of a need to consider a multivariate setting; deviations from normality of the residuals also make statistical inferences derived in these small samples questionable. In addition a significant proportion of the results seem dominated by influential outliers, as witnessed by relatively high measures of adjusted R-squared driven by the contemporaneous burst of inflation and relative price changes at the start of price reforms, despite abnormally large residuals for other parts of the sample.

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[6]For the purpose of analyzing the normality and symmetry of the price change distributions, the weighted and unweighted sample moments were calculated with quarterly end-of-period commodity inflation rates defined in percentage terms. This was preferable to a definition in log difference terms because the latter tends to understate large price changes. However, for the regressions on inflation (Tables 15-18) as well as the econometric analysis (Section IV and Appendix III), the various measures of relative price variability were defined in log difference terms because a definition based on percentage changes would give rise to a spurious positive relationship with inflation since the respective price variability formulae (see above) are based on the arithmetic difference of each commodity inflation rate from the overall inflation rate.

[7]Kurtosis is the fourth moment of a distribution and reflects its "peakedness."

Table 14. Share of Quarterly Observations Violating Normality/Symmetry Assumptions

(In percent of total sample size) 1/

Region	Country	Sample/No. of Commodities	Unweighted Commodity Price Changes			Weighted Commodity Price Changes		
			Jarque-Bera Normality Test	Skewness Test	Kurtosis Test	Jarque-Bera Normality Test	Skewness Test	Kurtosis Test
East and Central Europe	Albania	Q1 92 - Q3 95	73.3	73.3	73.3	93.3	93.3	93.3
	Bulgaria	Q3 90 - Q3 95	33.3	38.1	47.6	85.7	90.5	90.5
	Czech Republic	Q1 91 - Q3 95	73.7	68.4	68.4	89.5	78.9	89.5
	Hungary	Q1 91 - Q3 95	21.1	31.6	31.6	52.6	68.4	52.6
	Poland	Q1 90 - Q2 95	100.0	90.9	90.9	95.5	86.4	77.3
	Romania	Q1 92 - Q3 95	100.0	100.0	100.0	100.0	100.0	100.0
	Slovenia	Q1 92 - Q3 95	75.0	81.3	81.3	62.5	62.5	56.3
	Slovak Republic	Q1 92 - Q3 95	93.3	86.7	93.3	100.0	80.0	100.0
Baltics	Estonia	Q3 92 - Q3 95	100.0	76.9	100.0	84.6	92.3	69.2
	Latvia	Q1 93 - Q3 95	100.0	92.3	92.3	100.0	92.3	100.0
	Lithuania	Q3 92 - Q3 95	100.0	92.3	100.0	100.0	100.0	100.0
FSU	Armenia	Q1 93 - Q3 95	27.3	36.4	45.5	100.0	100.0	100.0
	Azerbaijan	Q1 91 - Q3 95	100.0	100.0	94.7	100.0	100.0	100.0
	Belarus	Q1 92 - Q3 95	86.7	86.7	93.3	100.0	100.0	100.0
	Georgia	Q1 94 - Q3 95	42.9	42.9	28.6	85.7	85.7	85.7
	Kazakhstan	Q1 91 - Q3 95	73.7	73.7	68.4	94.7	100.0	84.2
	Krygyz Republic	Q1 92 - Q3 95	100.0	100.0	100.0	100.0	100.0	93.3
	Moldova	Q1 92 - Q3 95	100.0	80.0	100.0	100.0	93.3	100.0
	Russia	Q1 92 - Q3 95	100.0	100.0	100.0	100.0	100.0	100.0
	Ukraine	Q1 91 - Q1 95	52.9	76.4	58.8	76.5	88.2	70.6
	Uzbekistan	Q1 94 - Q2 95	83.3	83.3	50.0	83.3	83.3	50.0

1/ The significance level for all tests was 5 percent.

Table 15. Regression Estimates of the Effects of Inflation and Inflation Changes on Unweighted Variance

(OLS-HCSE correction) 1/

Region	Country	Sample	Constant (t-stat)	Inflation rate (t-stat)	Change in inflation rate (t-stat)	$\overline{R}^2$	F-test (zero slopes)	D.W.	Result of Cusum test for parameter stability	Result of Cusum of squares test for parameter stability
East and Central Europe	Albania	Q1 92 - Q3 95	0.01 (1.93)*	0.13 (5.76)***	0.04 (.65)	0.62	11.75***	2.03	stable	unstable
	Bulgaria	Q3 90 - Q3 95	-0.01 (-2.13)**	0.11 (7.52)***	-0.01 (-2.86)**	0.83	48.61***	0.88	unstable	unstable
	Czech Republic	Q1 91 - Q3 95	-0.01 (-1.25)	0.30 (1.56)	-0.20 (-1.62)	0.64	16.06***	1.62	unstable	unstable
	Hungary	Q1 91 - Q3 95	-0.01 (-1.86)*	0.16 (2.23)**	-0.05 (-1.00)	0.59	13.39***	1.87	stable	unstable
	Poland	Q1 90 - Q2 95	0.00 (0.54)	0.06 (1.07)	-0.02 (-0.55)	0.06	1.67	1.20	unstable	unstable
	Romania	Q1 92 - Q3 95	0.01 (-0.77)	0.25 (3.65)***	0.00 (0.03)	0.37	4.75**	1.11	unstable	unstable
	Slovenia	Q1 92 - Q6 95	0.01 (3.77)***	0.02 (1.06)	-0.04 (-4.69)***	0.46	7.07***	3.23	stable	unstable
	Slovak Republic	Q1 92 - Q3 95	0.01 (3.40)***	-0.04 (-0.56)	0.08 (1.28)	0.06	1.38	2.36	stable	unstable
Baltics	Estonia	Q3 92 - Q3 95	-0.01 (-1.60)	0.25 (3.26)***	-0.14 (-2.49)**	0.83	28.69***	2.16	stable	unstable
	Latvia	Q1 93 - Q3 95	0.02 (1.44)	0.08 (0.82)	-0.03 (-0.88)	-0.04	0.78	1.83	unstable	unstable
	Lithuania	Q3 92 - Q3 95	-0.00 (-0.29)	0.27 (2.74)**	0.02 (0.16)	0.73	15.71***	2.30	stable	unstable
FSU	Armenia	Q1 93 - Q3 95	0.04 (0.66)	0.07 (1.01)	-0.00 (-0.06)	0.07	1.34	2.29	stable	unstable
	Azerbaijan	Q1 91 - Q3 95	0.02 (0.50)	0.26 (3.09)***	0.04 (1.45)	0.68	18.86***	2.42	stable	unstable
	Belarus	Q1 92 - Q3 95	0.08 (2.14)*	0.02 (0.45)	-0.08 (-1.31)	0.23	2.97	2.57	unstable	unstable
	Georgia	Q1 94 - Q3 95	0.05 (0.83)	0.32 (1.09)	-0.03 (-0.14)	0.12	1.33	2.06	n.a.	n.a.
	Kazakhstan	Q1 91 - Q3 95	0.01 (0.54)	0.13 (4.71)***	-0.05 (-2.08)*	0.42	7.05***	0.76	stable	unstable
	Krygyz Republic	Q1 92 - Q3 95	0.06 (1.12)	0.20 (1.64)	0.03 (0.46)	0.16	2.25	2.68	stable	stable
	Moldova	Q1 92 - Q3 95	0.02 (2.50)**	0.14 (7.12)***	-0.06 (-5.79)***	0.81	27.92***	1.11	unstable	stable
	Russia	Q1 92 - Q3 95	0.01 (0.72)	0.10 (4.97)***	-0.01 (-1.88)*	0.61	11.03***	1.34	stable	stable
	Ukraine	Q1 91 - Q1 95	0.02 (0.93)	0.09 (1.78)*	-0.03 (-0.90)	0.10	1.82	2.73	stable	unstable
	Uzbekistan	Q1 94 - Q2 95	0.01 (0.04)	0.12 (0.31)	-0.35 (-0.84)	-0.10	0.82	1.67	n.a.	n.a.

1/ Refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

Table 16. Regression Estimates of the Effects of Inflation and Inflation Changes on Unweighted Skewness

(OLS-HCSE Correction) 1/

Region	Country	Sample	Constant (t stat)	Inflation rate (t-stat.)	Change in inflation rate (t-stat.)	R^2	F-test (zero slopes)	D.W.	Result of Cusum test for parameter stability (5 percent)	Result of Cusum of square test for parameter stability (5 percent)
East and Central Europe	Albania	Q1 92 - Q3 95	1.19 (1.43)	-1.39 (-0.27)	4.14 (1.74)	-0.06	0.63	1.36	stable	unstable
	Bulgaria	Q3 90 - Q3 95	-0.00 (-0.01)	0.52 (0.45)	-0.11 (-0.14)	-0.10	0.14	2.77	stable	unstable
	Czech Republic	Q1 91 - Q3 95	0.52 (0.53)	11.81 (0.36)	-1.19 (-0.06)	-0.11	0.14	1.98	stable	unstable
	Hungary	Q1 91 - Q3 95	-0.97 (-1.99)*	25.35 (3.23)***	0.46 (0.08)	0.44	7.56***	2.03	stable	unstable
	Poland	Q1 90 - Q2 95	-0.21 (0.18)	11.76 (1.02)	1.25 (0.70)	-0.02	0.85	2.37	stable	unstable
	Romania	Q1 92 - Q3 95	1.62 (0.87)	-2.37 (-0.35)	4.97 (0.58)	-0.14	0.20	1.63	stable	unstable
	Slovenia	Q1 92 - Q6 95	-0.76 (-1.60)	24.76 (3.94)***	21.68 (5.83)***	0.39	5.43**	2.18	stable	unstable
	Slovak Republic	Q1 92 - Q3 95	-0.11 (-0.06)	4.66 (0.08)	41.64 (1.14)	0.11	1.78	2.55	stable	unstable
Baltics	Estonia	Q3 92 - Q3 95	-1.39 (-1.34)	17.87 (1.93)*	-3.00 (-0.45)	0.15	1.95	2.26	stable	stable
	Latvia	Q1 93 - Q3 95	-0.50 (-0.52)	9.65 (1.13)	-0.99 (-0.24)	-0.02	0.91	2.26	stable	stable
	Lithuania	Q3 92 - Q3 95	1.28 (1.34)	1.93 (0.78)	10.23 (2.91)**	0.27	3.02	1.25	stable	unstable
FSU	Armenia	Q1 93 - Q3 95	0.50 (1.16)	-0.49 (-1.02)	0.63 (1.61)	0.13	1.68	2.02	stable	stable
	Azerbaijan	Q1 91 - Q3 95	2.11 (7.03)***	-1.58 (-2.74)**	0.58 (1.95)*	0.17	2.70	2.92	stable	unstable
	Belarus	Q1 92 - Q3 95	1.38 (1.34)	-0.60 (-0.38)	-0.69 (-0.49)	-0.06	0.65	2.10	unstable	stable
	Georgia	Q1 94 - Q3 95	0.07 (0.34)	0.77 (1.54)	-0.09 (-0.19)	0.29	2.04	1.71	n.a.	n.a.
	Kazakhstan	Q1 91 - Q3 95	-0.60 (-0.51)	2.09 (1.24)	-0.66 (-0.51)	0.01	1.11	2.04	unstable	unstable
	Krygyz Republic	Q1 92 - Q3 95	1.85 (3.01)**	-0.17 (-0.13)	1.51 (1.49)	0.00	0.99	2.01	unstable	unstable
	Moldova	Q1 92 - Q3 95	-0.45 (-0.58)	1.29 (1.17)	0.01 (0.01)	-0.03	0.83	1.48	stable	unstable
	Russia	Q1 92 - Q3 95	-0.50 (-0.35)	3.89 (1.31)	-1.80 (1.31)	0.18	2.42	1.58	stable	unstable
	Ukraine	Q1 91 - Q1 95	0.10 (0.16)	0.64 (0.62)	-0.46 (-0.77)	-0.11	0.23	1.42	stable	unstable
	Uzbekistan	Q1 94 - Q2 95	0.99 (1.65)	-0.84 (-0.73)	0.25 (0.44)	-0.63	0.22	2.40	n.a.	n.a.

1/ Refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

Table 17. Regression Estimates of the Effects of Inflation and Inflation Changes on Theil Variance

(OLS-HCSE Correction) 1/

Region	Country	Sample	Constant (t-stat)	Inflation rate (t-stat)	Change in inflation rate (t-stat)	R^2	F-test (zero slopes)	D.W.	Cusum test for parameter stability	Cusum of square test for parameter stability
East and Central Europe	Albania	Q1 92 - Q3 95	0.01 (2.75)**	0.01 (0.49)	0.03 (1.86)*	-0.02	0.87	1.93	stable	unstable
	Bulgaria	Q3 90 - Q3 95	-0.01 (-3.77)***	0.09 (6.49)***	-0.01 (-2.35)**	0.94	151.14***	0.86	stable	unstable
	Czech Republic	Q1 91 - Q3 95	-0.00 (-1.37)	0.18 (1.65)	-0.11 (-1.60)	0.65	16.68***	1.70	unstable	unstable
	Hungary	Q1 91 - Q3 95	-0.01 (-1.69)	0.16 (1.99)*	-0.06 (-1.05)	0.55	11.22***	1.66	stable	unstable
	Poland	Q1 90 - Q2 95	0.01 (1.14)	0.02 (0.42)	-0.01 (-0.71)	-0.04	0.62	1.13	unstable	unstable
	Romania	Q1 92 - Q3 95	-0.00 (-0.04)	0.20 (2.89)**	0.09 (0.55)	0.46	6.45**	2.02	stable	unstable
	Slovenia	Q1 92 - Q6 95	0.00 (3.56)***	0.02 (1.24)	-0.03 (-5.43)***	0.57	10.17***	3.36	stable	unstable
	Slovak Republic	Q1 92 - Q3 95	0.00 (3.77)***	0.02 (1.95)*	0.01 (0.90)	0.41	5.50**	2.43	stable	unstable
Baltics	Estonia	Q3 92 - Q3 95	-0.01 (-2.33)**	0.20 (7.20)***	-0.10 (-4.05)***	0.87	39.18***	2.96	stable	unstable
	Latvia	Q1 93 - Q3 95	0.01 (1.69)	0.05 (0.67)	0.01 (0.22)	-0.09	0.53	1.97	unstable	unstable
	Lithuania	Q3 92 - Q3 95	0.01 (1.02)	0.10 (1.66)	-0.03 (-0.37)	0.47	5.96**	2.31	stable	unstable
FSU	Armenia	Q1 93 - Q3 95	0.02 (0.79)	0.02 (0.96)	-0.00 (-1.22)	0.02	1.11	2.41	stable	unstable
	Azerbaijan	Q1 91 - Q3 95	0.03 (1.53)	0.12 (3.37)***	0.01 (0.61)	0.61	11.52***	1.54	stable	unstable
	Belarus	Q1 92 - Q3 95	0.04 (2.60)**	0.03 (1.22)	-0.03 (-1.04)	-0.00	0.99	1.77	stable	unstable
	Georgia	Q1 94 - Q3 95	0.04 (0.76)	0.32 (1.08)	-0.03 (-0.14)	0.10	1.29	2.06	n.a.	n.a.
	Kazakhstan	Q1 91 - Q3 95	0.01 (0.73)	0.09 (3.18)***	-0.03 (-1.06)	0.36	5.76**	0.90	unstable	unstable
	Krygyz Republic	Q1 92 - Q3 95	0.03 (1.29)	0.15 (2.28)**	-0.02 (-0.33)	0.22	2.83	2.48	stable	unstable
	Moldova	Q1 92 - Q3 95	0.02 (1.94)*	0.15 (3.68)***	-0.07 (-1.52)	0.58	9.93***	1.71	unstable	unstable
	Russia	Q1 92 - Q3 95	0.01 (0.95)	0.08 (4.12)***	-0.02 (-1.89)*	0.50	7.37***	2.16	stable	unstable
	Ukraine	Q1 91 - Q1 95	0.02 (1.86)*	0.02 (1.09)	-0.01 (-0.70)	-0.07	0.52	2.33	stable	unstable
	Uzbekistan	Q1 94 - Q2 95	-0.00 (-0.01)	0.13 (0.34)	-0.36 (-0.90)	-0.05	0.91	1.69	n.a.	n.a.

1/ Refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

Table 18. Regression Estimates of the Effects of Inflation and Inflation Changes on Theil Skewness

(OLS-HCSE correction) 1/

Region	Country	Sample	Constant (t-stat)	Inflation rate (t-stat)	Change in inflation rate (t-stat)	$\overline{R}^2$	F-test (zero slopes)	D.W.	Cusum test for parameter stability	Cusum of squares test for parameter stability
East and Central Europe	Albania	Q1 92 - Q3 95	0.00 (2.53)**	0.00 (2.88)**	0.00 (1.02)	0.29	3.64	2.17	stable	unstable
	Bulgaria	Q3 90 - Q3 95	0.09 (0.20)	-0.52 (-0.44)	-0.26 (-0.26)	-0.09	0.22	2.31	stable	unstable
	Czech Republic	Q1 91 - Q3 95	0.15 (0.15)	18.47 (0.61)	-4.03 (-0.22)	-0.09	0.31	2.23	stable	unstable
	Hungary	Q1 91 - Q3 95	-0.82 (-2.05)**	17.73 (3.06)***	-4.16 (-0.82)	0.26	3.97**	2.32	stable	unstable
	Poland	Q1 90 - Q2 95	-0.29 (-0.27)	11.66 (1.06)	1.71 (1.16)	0.01	1.11	2.46	stable	unstable
	Romania	Q1 92 - Q3 95	0.51 (0.48)	1.77 (0.47)	1.09 (0.24)	-0.13	0.25	1.42	stable	unstable
	Slovenia	Q1 92 - Q6 95	-0.79 (-1.49)	26.41 (3.63)***	23.95 (5.46)***	0.33	4.46**	2.24	stable	unstable
	Slovak Republic	Q1 92 - Q3 95	0.04 (0.01)	16.63 (0.20)	44.44 (0.86)	0.09	1.62	2.38	stable	stable
Baltics	Estonia	Q3 92 - Q3 95	-1.05 (-1.06)	14.22 (1.75)	-3.23 (-0.58)	0.07	1.42	2.09	stable	unstable
	Latvia	Q1 93 - Q3 95	-0.51 (-0.51)	9.63 (1.20)	1.20 (0.44)	-0.03	0.86	2.07	stable	stable
	Lithuania	Q3 92 - Q3 95	0.49 (0.57)	2.43 (1.07)	9.40 (2.89)**	0.27	2.98	1.10	stable	unstable
FSU	Armenia	Q1 93 - Q3 95	0.58 (1.27)	-0.46 (-0.70)	0.45 (1.06)	-0.17	0.33	2.32	stable	unstable
	Azerbaijan	Q1 91 - Q3 95	1.87 (5.46)***	-1.77 (-3.46)***	0.62 (1.98)*	0.26	4.01**	1.57	unstable	unstable
	Belarus	Q1 92 - Q3 95	-0.01 (-0.01)	1.02 (0.38)	-2.54 (-1.99)*	0.17	2.29	1.72	unstable	unstable
	Georgia	Q1 94 - Q3 95	0.07 (0.63)	0.75 (1.40)	-0.12 (-0.31)	0.30	2.09	2.06	n.a.	n.a.
	Kazakhstan	Q1 91 - Q3 95	-0.14 (-0.14)	1.65 (1.14)	-0.94 (-0.82)	-0.03	0.73	1.81	unstable	stable
	Krygyz Republic	Q1 92 - Q3 95	1.04 (2.90)**	1.38 (1.51)	1.38 (1.96)*	0.27	3.41	2.64	unstable	stable
	Moldova	Q1 92 - Q3 95	-0.59 (-0.84)	1.46 (1.50)	0.28 (0.33)	0.04	1.27	1.94	stable	stable
	Russia	Q1 92 - Q3 95	-1.10 (-1.00)	4.99 (2.01)*	-1.58 (-1.36)	0.26	3.26	1.91	stable	stable
	Ukraine	Q1 91 - Q1 95	0.26 (0.28)	0.75 (0.46)	-0.67 (-0.83)	-0.11	0.24	1.31	stable	unstable
	Uzbekistan	Q1 94 - Q2 95	0.62 (0.57)	-0.56 (-0.26)	1.07 (1.18)	-0.63	0.22	2.18	n.a.	n.a.

1/ Refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

First-order autoregression coefficients (all that was feasible given the small sample size) and correlograms on the five measures do not suggest inertia or strong time dependence. Finally, the Theil variance was decomposed into the proportions of total variance accounted for by variance between tradables and nontradables, and within tradables and nontradables, respectively.[8] In almost all cases, variance within tradables accounted for most of the total variance—on average about 65-75 percent—and variance within nontradables for about 15-25 percent of total variance.[9]

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[8]In general, goods (food and non-food) were classified as tradables and services as nontradables. The country-by-country classification of commodities into tradables and nontradables was maintained throughout the paper, including in the definition of the real exchange rate, measured as the ratio of the average price of nontradables to the average price of tradables (see equations (4), (5), and (8) above).

[9]These results are not reported in the paper but are available upon request.

ANALYTICAL FRAMEWORK UNDERLYING THE ESTIMATED EQUATION

The estimated equation for inflation can be derived and interpreted in terms of a simple static two-sector model of traded and nontraded goods and money market clearing. The model highlights the importance of two factors in determining the impact of relative price variability on inflation. First, the choice of exchange rate policy, specifically whether the exchange rate is fixed or floating. In particular, the model shows that even if relative price variability has a positive influence on inflation this can be completely offset by a nominal appreciation. Thus, relative price variability per se need not set a "floor" on inflation. Second, the stability of demand for real balances as represented by a constant velocity of circulation of money has a significant influence on the final effect of relative price variability on inflation under a pure exchange rate float. If velocity is constant in such a regime (where nominal money growth is exogenous), a positive impact on inflation from increased relative price variability must either be completely offset by nominal appreciation or create an excess demand for real balances, lower spending, and dampen real income growth. On the other hand, if agents economize on real balances (i.e., velocity tends to increase), relative price variability can have a positive impact of inflation without being offset by nominal appreciation or without affecting real income growth. In a fixed exchange regime, velocity does not influence the final effect of relative price variability on inflation; rather, it affects the extent of the endogenous increase in nominal money.

I. THE STRUCTURAL EQUATIONS OF THE MODEL

The model is confined to an analysis of comparative statics since the limited time coverage of data in the sample does not permit estimation of dynamic effects. Expectations are also introduced mainly as an illustrative device and are assumed to be fixed outside the model, again because the sample does not permit the estimation of any expectations effects. Nominal wages are assumed to be set exogenously implying the existence of unemployment. Other things equal, relative price variability has a direct positive impact on inflation, consistent with the asymmetric price adjustment hypothesis; overall inflation can thus be expressed as a function of relative price variability and the rate of underlying inflation (i.e., excluding relative price effects) of nontradable and tradable prices. The representative economy is assumed to be a price taker in world markets (i.e., it can sell all its tradable output at a given world market price). The structural equations, with all variables (other than relative price variability) expressed in rates of change, can be written in linearized form as:[1]

Inflation:

$$(1) \qquad \pi = \alpha_1 \pi_{NT} + \alpha_2 \pi_T + \alpha_3 V_\pi \quad \text{where} \quad \pi_T = e + \bar{\pi}^*$$

[1]All variables, other than inflation, are expressed in Roman letters and parameters in Greek letters.

Market for nontraded goods:

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

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

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

Money market equilibrium:

(5) $m + v = \pi + y$ where $v = \mu\pi^e$

Real income determination:

(6) $y_T^{s} = -\lambda_1(w - \pi_T) - \lambda_2(\pi_{NT} - \pi_T)$

(7) $y = y_{NT}^{s} + y_T^{s}$

where π = overall inflation rate

π_{NT} = underlying inflation rate of nontradables

π_T = underlying inflation rate of tradables

e = nominal exchange rate change

$\bar{\pi}^*$ = foreign inflation (assumed fixed)

V_π = relative price variability

y_{NT}^{d} = growth of demand for nontradables

y_{NT}^{s} = growth of supply of nontradables

y = real income growth

w = nominal wage growth

m = nominal money growth

v = change in velocity

π^e = expected inflation

y_T^{s} = growth of supply of tradables

The model has seven endogenous variables—π, π_{NT}, π_T or e, y_{NT}^{d}, y_{NT}^{s}, y_T^{s}, y—and four exogenous variables—V_π, w, π^e, m. Foreign price are assumed to unchanged, hence the movements in the nominal exchange rate represent movements in

tradable prices. Velocity is a function of the expected inflation rate where expectations are determined outside the model; i.e., velocity is assumed to be constant for a given set of expectations.[2] Money growth is initially treated as an exogenous policy variable, with the nominal exchange rate endogenous (i.e., fully floating); this assumption is later reversed to analyze a fixed exchange rate regime where money growth is endogenous. Although fiscal policy is not explicitly introduced, a money-financed fiscal expansion (which, in the absence of developed bond markets, is the most relevant for transition economies) can be represented by an increase in money supply growth, assuming no differences in the composition of expenditures between public and private spending. The real exchange rate is determined by the clearing of the market for nontraded goods.

II. ESTIMATED EQUATION FOR INFLATION

Substituting equations (1), (2), (3), and (5) in (4), yields a semi-reduced form equation for inflation in terms of money growth, real appreciation, relative price variability, nominal wage growth, and expected inflation:

$$(8) \qquad \pi = \left[\frac{\beta_2(\alpha_1+\alpha_2)}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right] m - \left[\frac{(\alpha_1+\alpha_2)(\beta_2+\delta_2)+\alpha_2\delta_1}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right](\pi_{NT} - \pi_T)$$

$$+\left[\frac{\alpha_3}{\delta_1+\beta_2(\alpha_1+\alpha 2)}\right]V_\pi + \left[\frac{(\alpha_1+\alpha_2)\delta_1}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right]w + \left[\frac{\beta_2(\alpha_1+\alpha_2)\mu}{\delta_1+\beta_2(\alpha_1+\alpha_2)}\right]\pi^e$$

Hence,

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

This semi-reduced form was selected for estimation, rather than the reduced form version (see below), because of the relevance of the real exchange rate term to the policy debate.[3] In addition, in the estimation, the real exchange rate term can also represent factors outlined in Section II, such as undervaluation, Balassa-Samuelson effects as well as demand shocks such as external terms of trade shocks or fiscal expansion (not financed by money growth). In the formulation above, a real appreciation has a negative impact on inflation for a given nominal money growth, because the real appreciation takes place through appreciation

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[2]A bond market is excluded because such markets are marginal in most transition economies. However, if a bond market were introduced, velocity would be expressed as a function of domestic interest rates which in turn would depend on world interest rates plus the expected depreciation of the nominal exchange rate plus a risk premium.

[3]The expected inflation term was not included in the estimated equation because of the difficulty of capturing expectations effects given the limited time coverage of the sample.

of the nominal exchange rate. However, if the exchange rate is fixed and money is endogenous, the real exchange terms may have a positive coefficient.[4]

III. INFLATION UNDER A FLOATING EXCHANGE RATE REGIME

In a floating exchange regime, money is exogenous and equations (1)-(7) can be solved to obtain a reduced form expression for the nominal exchange rate.

$$(9) \qquad e = [\frac{1-\beta_2\phi}{\theta}]m - [\alpha_3\frac{(1-\beta_2\phi)}{\theta}]V_\pi + [\frac{\lambda_1+\delta_1(1-\phi)}{\theta}]w + [\frac{\mu(1-\beta_2\phi)}{\theta}]\pi^e$$

where $\phi = \frac{(\alpha_1+\delta_1+\delta_2-\lambda_2)}{(\beta_1+\beta_2\alpha_1+\delta_1+\delta_2)} < 1$ and $\theta = \phi(\beta_1+\delta_2-\beta_2\alpha_2)+(\alpha_2+\lambda_1+\lambda_2-\delta_2) > 0$.

Sufficient conditions for these parameter restrictions are:

$$\alpha_1(1-\beta_2) < \beta_1+\lambda_2; \qquad \beta_1+\delta_2 > \beta_2\alpha_2; \qquad \delta_1+\delta_2 > \lambda_2; \qquad \lambda_1+\lambda_2 > \delta_2$$

Thus an increase in the money supply, depreciates the nominal exchange rate since the price level has to rise to clear the money market. An increase in relative price variability, on the other hand, appreciates the nominal exchange rate for a given money growth and expected inflation. In other words, the positive impact of increased variability on inflation is offset by reduction of traded prices through nominal appreciation given constant velocity (for given expectations) and money supply growth.

Equations (1)-(9) can be solved to obtain reduced form equations for the underlying inflation in nontradables and for overall inflation in a purely floating exchange rate regime (i.e., where money is a policy instrument):

$$(10) \qquad \pi_{NT} = [\frac{\beta_2}{\Omega}+\frac{\psi(1-\beta_2\phi)}{\theta\Omega}]m - [\frac{\alpha_3\beta_2}{\Omega} + \frac{\alpha_3\psi(1-\beta_2\phi)}{\theta\Omega}]V_\pi$$
$$+ [\frac{\delta_1}{\Omega} + \frac{\psi(\lambda_1+\delta_1(1-\phi))}{\theta\Omega}]w + [\frac{\beta_2\mu}{\Omega} + \frac{\psi(1-\beta_2\phi)\mu}{\theta\Omega}]\pi^e$$

where $\psi = (\beta_1+\delta_2-\beta_2\alpha_2)$.

$$(11) \qquad \pi = [\frac{\alpha_1\beta_2}{\Omega} + \frac{\alpha_1\psi(1-\beta_2\phi)}{\theta\Omega} + \alpha_2\frac{(1-\beta_2\phi)}{\theta}]m$$
$$+ [\alpha_3 - (\frac{\alpha_2\alpha_3\beta_2}{\Omega} + \frac{\alpha_2\alpha_3\psi(1-\beta_2\phi)}{\theta\Omega} + \alpha_1\alpha_3\frac{(1-\beta_2\phi)}{\theta})]V_\pi$$

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[4]Equation (8) also indicates that the inclusion of the nominal exchange rate as a separate variable would not be appropriate when nominal money and the real exchange rate are included in the estimation equation. If money, rather than the nominal exchange rate is thought to be endogenous, an instrumental variable technique could be used with the change in the nominal exchange rate as an instrument for money growth.

$$+ \left[\frac{\alpha_1\delta_1}{\Omega} + \frac{\alpha_1\psi(\lambda_1+\delta_1(1-\phi))}{\theta\Omega} + \alpha_2\frac{(\lambda_1+\delta_1(1-\phi))}{\theta}\right]w$$

$$+ \left[\frac{\alpha_1\beta_2\mu}{\Omega} + \frac{\alpha_1\psi(1-\beta_2\phi)}{\theta\Omega}\mu + \frac{(1-\beta_2\phi)}{\theta}\mu\right]\pi^e$$

Hence,

$$\frac{d\pi}{dm}>0; \qquad \frac{d\pi}{dV_\pi}<0 \text{ or } >0; \qquad \frac{d\pi}{dw}>0; \qquad \frac{d\pi}{d\pi^e} > 0$$

Thus an increase in money supply growth raises inflation; the nominal exchange rate depreciates and raises the prices of tradable and nontradable goods. Significantly, an increase in relative price variability may raise or lower inflation: the direct positive impact on overall inflation is offset by a decline in the underlying inflation rate of tradables and nontradables as the nominal exchange rate appreciates. Higher nominal wage growth raises nontradable inflation and also lowers real output and income and raises inflation to restore equilibrium to the money market. Higher expected inflation, raises velocity, lowers the demand for real balances, raises spending and inflation to clear the money market. If increased relative price variability is accompanied by higher expected inflation inducing consumers to economize on real balances and thus raising velocity, the positive impact on inflation of variability would be enhanced.

IV. INFLATION UNDER A FIXED EXCHANGE RATE REGIME

In a fixed exchange rate regime, money would be endogenous and a reduced form expression for money growth may be obtained from equation (9):

(9') $$m = \left[\frac{\theta}{1-\beta_2\phi}\right]e + \alpha_3 V_\pi - \left[\frac{\lambda_1+\delta_1(1-\phi)}{1-\beta_2\phi}\right]w - \mu\pi^e$$

Thus a nominal devaluation raises inflation and the output of tradables and endogenously increases money supply growth to clear the money market. An increase in relative price variability also increases money supply growth by placing upward pressure on inflation (since tradable prices are fixed by the nominal exchange rate).

Reduced form equations for nontradable and overall inflation in a fixed exchange regime (with money entirely endogenous) may be obtained by solving (1)-(9'):

(10') $$\pi_{NT} = \left[\frac{\beta_2\theta}{\Omega(1-\beta_2\phi)} + \frac{\psi}{\Omega}\right]e + \left[\frac{\delta_1}{\Omega} - \frac{\beta_2}{\Omega}\frac{(\lambda_1+\delta_1(1-\psi))}{(1-\beta_2\phi)}\right]$$

(11') $$\pi = \left[\frac{\alpha_1\beta_2\theta+\alpha_1\psi(1-\beta_2\phi)+\alpha_2\Omega(1-\beta_2\phi)}{\Omega(1-\beta_2\phi)}\right]e + \alpha_3 V_\pi$$

$$+ \left[\frac{\alpha_1\delta_1(1-\beta_2\phi)-\alpha_1\beta_2(\lambda_1+\delta_1(1-\phi)}{\Omega(1-\beta_2\phi)}\right]w$$

Hence,

$$\frac{d\pi}{de}>0; \qquad \frac{d\pi}{V_{\pi}}>0; \qquad \frac{d\pi}{dw}>0 \text{ or } <0; \qquad \frac{d\pi}{d\pi^{e}}=0.$$

Thus, a devaluation of the exchange rate or an increase in relative price variability increases inflation because the upward pressure on prices is totally accommodated by money growth (via the balance of payments). On the other hand, higher nominal wage growth may raise or lower inflation because the direct positive impact on nontradable prices is offset by a negative impact due to lower output and spending. An increase in expected inflation has no impact on current inflation because the decline in demand for real balances is met by lower nominal money growth. Thus, if that the upward pressure on inflation from increased relative price variability is matched by higher expected inflation and increased velocity, the endogenous adjustment of money would be limited. In other words, the decline in actual real balances would be matched by the decline in the demand for real balances from higher expected inflation, making it unnecessary for the nominal money supply to adjust.

ECONOMETRIC ESTIMATIONS

This appendix discusses the methodology underlying the econometric estimations on the determinants of inflation discussed in Section IV. The first section briefly discusses the principal characteristics of the sample. The second section reviews the main elements of the empirical methodology underlying the pooled sample estimates, followed by an assessment in the third section of the validity of the assumption of homogeneous parameters and functional form across regions. The final section reviews the empirical methodology, including tests of robustness, underlying the three separate regional estimations.

I. SAMPLE CHARACTERISTICS OF THE PANEL DATA

The sample of panel data has a different time coverage than the disaggregated CPI data examined in Appendix I, because of differences in the availability of data for other macroeconomic variables.[1] The sample period covered by the panel regression and the classification of countries into three regional blocks are shown in Table 19. The dependent variable in the regressions is the quarterly end-of-period rate of change of the CPI (based on the macroeconomic data rather than calculated on the basis of the disaggregated CPI data). Among the regressors, broad money covers the liabilities of the banking system including foreign currency deposits (a definition excluding these deposits was also tested). Although a unit labor cost measure (in domestic currency terms) was sought as an indicator of labor cost pressure, this was available only for Eastern and Central European countries (other than Albania) because reliable data on labor productivity are not available for Albania, the Baltics, and the FSU. Therefore, the indicator of labor cost pressure consists of nominal unit labor costs (in domestic currency terms) for the former group of countries and nominal wages (in domestic currency terms) for the latter group. The real exchange rate is measured as the relative price of tradables to nontradables calculated from the disaggregated CPI data (see Appendix I), rather in terms of the commonly used CPI-based measure (such a measure is in any case not available for many FSU countries). The former is closer to the concept of the price of nontradables relative to tradables which underlies most theoretical work and also suffers less from the underrepresentation of nontradables in the CPI weights of many countries.[2] Two indicators of relative price variability were used—the Theil variance and the Theil skewness—which reflect different characteristics of the disaggregated price distributions (see Appendix I).

All variables, other than the indicators of variance and skewness, were defined as quarterly, end-of-period rates of change in percentage terms. A percentage change, rather than a log difference form, was preferred because the sample includes both high and low inflation cases (log differences tend to understate high inflation). For reasons discussed in

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[1]The macroeconomic data for the Baltics and the FSU were obtained from the EU2 database and were finalized after consultation with the respective desks for the individual countries. Data for Central and Eastern Europe were obtained from the respective country desks.

[2]Nontradables may not be "underrepresented" from a consumer expenditure point of view if the weights reflect the low prices of public services in many transition economies. However, for the purpose of computing a real exchange rate, particularly in a cross-country setting, the commonly used CPI-based measure would understate the extent of real appreciation if the CPI weight of nontradables, as a group, is very small.

APPENDIX III

Table 19. Sample Size

(Full Sample and Post-Liberalization Periods)

Region	Country	Full Sample		Post-Liberalization	Exchange Rate Anchor
		Period	No. of Quarters	Period	
East and Central Europe	Albania	Q2:92 - Q3:95	14	Q1:93 - Q3:95	No
	Bulgaria	Q3:91 - Q3:95	17	Q2:92 - Q3:95	No
	Czech Republic	Q3:92 - Q3:95	13	Q3:92 - Q3:95	Yes
	Hungary	Q2:91 - Q3:95	18	Q1:93 - Q3:95	Yes, since March, 95
	Poland	Q2:90 - Q2:95	21	Q2:91 - Q2:95	Yes
	Romania	Q3:92 - Q3:95	13	Q4:93 - Q3:95	No
	Slovak Republic	Q3:92 - Q3:95	13	Q3:92 - Q3:95	Yes
	Slovenia	Q3:92 - Q3:95	13	Q3:92 - Q3:95	No
Baltics	Estonia	Q4:92 - Q3:95	12	Q1:93 - Q3:95	Yes
	Latvia	Q4:92 - Q3:95	12	Q1:93 - Q3:95	Yes, since February, 94
	Lithuania	Q3:93 - Q3:95	9	Q3:93 - Q3:95	Yes, since April, 94
FSU	Armenia	Q2:93 - Q3:95	10	n.a.	No
	Azerbaijan	Q3:92 - Q3:95	13	n.a.	No
	Belarus	Q3:92 - Q3:95	13	n.a.	No
	Georgia	Q2:94 - Q3:95	6	n.a.	No
	Kazakstan	Q3:92 - Q3:95	13	n.a.	No
	Kyrgyz Republic	Q1:93 - Q3:95	11	n.a.	No
	Moldova	Q3:92 - Q3:95	13	n.a.	No
	Russia	Q2:93 - Q3:95	10	n.a.	Yes, since June, 95
	Ukraine	Q3:92 - Q1:95	11	n.a.	No
	Uzbekistan	Q2:94 - Q2:95	5	n.a.	No

Appendix I, measures of variance and skewness were calculated on the basis of quarterly end-of-period inflation rates, defined in log difference terms.

II. EMPIRICAL METHODOLOGY FOR THE POOLED SAMPLE

The preferred, final equations—based on the semi-reduced form inflation specification shown in Equation (8) in Appendix II—for the full-sample pooled model were derived from a specification search which involved selecting a more parsimonious specification from a larger initial set of explanatory variables. The "general to specific" modeling strategy—implemented by successively eliminating statistically insignificant regressors in order of least significance—a priori minimizes omitted variable bias, at the price of accuracy in case regressors in the initial overparametrized model are highly collinear. The model was estimated by ordinary least squares (OLS), which provides unbiased and consistent parameter estimates under the simplifying assumption of weak exogeneity of the explanatory variables.[3] However, because in models that combine time-series and cross-country data the assumption of identically distributed error terms is often unduly restrictive, the estimations were tested for the presence of heteroschedasticity, and the bias of least squares standard errors and t-statistics was corrected using a heteroschedasticity-consistent variance-covariance estimator that provides consistent estimates even when the exact form of heteroschedasticity is unknown.[4]

The results for the equation including all potential regressors pointed to the need to select a more parsimonious and robust model (Table 20, Eq.1). Despite the high explanatory power and the rejection of the hypothesis of all slopes equal to zero by the F-test, several variables were individually insignificant, possibly as a result of high collinearity, or with an implausible negative sign.[5] Taking the general specification as a starting point, insignificant regressors were eliminated sequentially in order of least significance. These steps improved the statistical significance of the estimated equation, while preserving its high explanatory power. However, in the pooled sample and the regional block for the FSU (see below), the wage cost term and the Theil variance turned out to be highly collinear, so that both terms could not be individually significant at the same time. Hence, although the pooled sample

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[3]A fixed effects estimator would give inconsistent estimates without the very strong assumption of strict exogeneity of the regressors. In the absence of good instruments (see below), OLS estimates would be preferable.

[4]The use of a heteroschedasticity-consistent variance-covariance estimator is also justified because the power of heteroschedasticity tests such as the Breusch-Pagan test may depend on a correct specification of the variables used in an auxiliary regression, a condition which in practice may not be satisfied. Because of this problem, the results of the White heteroschedasticity test are also reported, when available. (Since the auxiliary regression for the latter test includes the cross products of all explanatory variables, it sometimes lacks sufficient degrees of freedom).

[5]Since the residuals of this and other regression equations failed to pass the Jarque-Bera test for normality, t-tests and other regression diagnostics should be interpreted with caution, their usefulness being justified by the relatively large sample (260 observations).

APPENDIX III

Table 20. Specification Search 1/
(OLS-HCSE estimates; dependent variable: quarterly CPI inflation rate)

Variable	Full sample pooled estimates				
	Eq. 1	Eq. 2	Eq. 3	Eq. 4	Eq. 5
Constant	18.86 (2.42)**	18.91 (2.16)**	18.89 (2.55)**	19.15 (2.84)***	18.45 (3.00)***
Money growth, t	0.24 (2.06)**	0.24 (2.26)**	0.24 (3.06)***	0.24 (3.07)***	0.24 (3.08)***
Money growth, t-1	0.33 (3.89)***	0.33 (2.75)***	0.33 (3.90)***	0.33 (3.96)***	0.33 (3.98)***
Money growth, t-2	0.11 (2.00)**	0.11 (1.53)	0.11 (2.03)**	0.11 (2.02)**	0.11 (2.00)**
Variance of relative prices 2/	0.01 (1.33)	0.01 (1.24)	0.01 (1.34)	0.01 (1.36)	0.01 (1.34)
Additive dummy for exchange rate anchors	-5.49 (-1.94)*	-5.51 (-1.66)*	-5.53 (-2.09)**	-5.64 (-2.17)**	-5.84 (-2.20)**
Skewness of relative prices, lagged 1 quarter 2/	1.10 (1.19)	1.10 (1.16)	1.12 (1.25)	1.16 (1.25)	1.31 (1.51)
Nominal wage growth, t	0.15 (2.70)***	0.15 (1.24)	0.15 (2.69)***	0.15 (2.61)***	0.15 (2.60)***
Nominal wage growth, t-1	-0.04 (-0.80)	-0.04 (-0.36)	-0.04 (-0.89)	-0.04 (-1.00)	-0.03 (-0.98)
Real exchange rate change, t	0.06 (0.75)	0.06 (0.70)	0.06 (0.79)	0.06 (0.77)	0.05 (0.64)
Skewness of relative prices 2/	-0.89 (-0.71)	-0.89 (-0.68)	-0.88 (-0.70)	-0.87 (-0.68)	—
Variance of relative prices, lagged 1 quarter 2/	0.00 (0.09)	0.00 (0.09)	0.00 (0.17)	—	—
Real exchange rate change (PNT/PT) t-1	0.007 (0.09)	0.007 (0.08)	—	—	—
Lagged inflation rate	-0.002 (-0.03)	—	—	—	—
Seasonal dummies	some significant	some significant	some significant	all significant	all significant
Outlier dummy	1509.63 (70.93)***	1509.89 (74.22)***	1509.98 (91.15)***	1509.41 (98.74)***	1508.76 (97.8)***
R-squared corrected	0.93	0.93	0.93	0.94	0.93
F-statistics (zero slopes)	210.79***	224.89***	240.86***	259.07***	279.42***
Breusch-Pagan test for heteroschedasticity	119.49***	119.73***	119.75***	119.89***	118.17***
White test for heteroschedasticity	254.54***	246.32***	239.43***	231.95***	221.49***
Jarque-Bera test for normality of residuals	2691.16***	2687.27***	2692.85***	2633.46***	2837.88***
Number of observations	260	260	260	260	260

Table 20. Specification Search (concluded)
(OLS-HCSE estimates; dependent variable: quarterly CPI inflation rate)

Variable	Full sample pooled estimates					
	Eq. 6	Eq. 7	Eq. 8	Eq. 9	Eq. 10 (final)	Eq. 11 (final-OLS)
Constant	18.22 (2.38)**	17.46 (2.25)**	14.72 (2.33)**	14.75 (2.18)**	13.80 (2.35)**	13.80 (3.07)***
Money growth, t	0.24 (2.27)**	0.24 (2.28)**	0.25 (2.91)***	0.25 (2.25)**	0.26 (2.94)***	0.26 (6.95)***
Money growth, t-1	0.33 (2.80)***	0.32 (2.99)***	0.38 (4.05)***	0.38 (3.24)***	0.38 (4.08)***	0.38 (10.32)***
Money growth, t-2	0.11 (1.53)	0.09 (1.47)	0.09 (1.75)*	0.09 (1.54)	0.09 (1.78)*	0.09 (2.64)***
Variance of relative prices 2/	0.02 (1.68)*	0.01 (1.57)	0.04 (6.27)***	0.04 (5.11)***	0.04 (6.54)***	0.04 (10.80)***
Additive dummy for exchange rate anchors	-5.87 (-1.74)**	-5.78 (-1.81)*	-2.35 (-0.94)	-2.30 (-0.81)	—	—
Skewness of relative prices, lagged 1 quarter 2/	1.35 (1.51)	1.26 (1.43)	0.65 (0.69)	—	—	—
Nominal wage growth, t	0.15 (1.19)	0.16 (1.30)	—	—	—	—
Nominal wage growth, t-1	-0.03 (-0.34)	—	—	—	—	—
Real exchange rate change, t	—	—	—	—	—	—
Skewness of relative prices 2/	—	—	—	—	—	—
Variance of relative prices, lagged 1 quarter 2/	—	—	—	—	—	—
Real exchange rate change (PNT/PT) t-1	—	—	—	—	—	—
Lagged inflation rate	—	—	—	—	—	—
Seasonal dummies	some significant	some significant	some significant	all significant	all significant	all significant
Outlier dummy	1508.5 (80.6)***	1510.78 (80.92)***	1516.84 (89.60)***	1517.46 (73.63)***	1517.32 (89.16)***	1517.32 (45.86)***
R-squared corrected	0.93	0.93	0.92	0.92	0.92	0.92
F-statistics (zero slopes)	303.52***	326.63***	302.57***	337.13***	380.40***	380.40***
Breusch-Pagan test for heteroschedasticity	118.48***	112.04***	100.78***	101.57***	101.49***	101.49***
White test for *heteroschedasticity*	219.65***	213.94***	177.66***	176.29***	174.68***	174.68***
Jarque-Bera test for normality of residuals	2842.62***	2406.84***	3806.94***	3761.68***	3780.98***	3780.98***
Number of observations	260	260	260	260	260	260

1/ For the t-statistics reported in parenthesis, three asterisk indicates statistical significance at 1 percent level; two asterisks at the 5 percent level; and one asterisk indicates significance at the 10 percent level; — indicates that the variable was not included because of lack of significance in the specification search. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ Theil variance and skewness, respectively.

results are driven mainly by the FSU, the procedure followed in the specification search resulted in the wage cost term being eliminated from the pooled sample (and the Theil variance retained) and vice versa for the FSU. Alternative specifications if the wage term is retained in the pool (and vice versa in the FSU estimation) are reported in Table 6 of Section IV. The "final" specification estimates for the pooled model confirm the importance of the heteroschedasticity correction to avoid misleading inferences based on OLS standard errors, which are biased downwards (Table 20).

The sensitivity of the final specification estimates was examined with respect to alternative definitions of the two most important regressors: a) a change in the definition of the monetary aggregate from broad money including the domestic currency value of foreign currency deposits to broad money excluding foreign currency deposits and to domestic banking system credit (Table 21); b) a change in the definition of relative price variability from the Theil variance to the unweighted variance (Table 7 in Section IV).

III. VARIATION OF THE POOLED ESTIMATES ACROSS REGIONAL SUBSAMPLES

The reliability of the results was further tested by examining the assumption of identical parameters for the panel. Specifically, given the limited degrees of freedom at the individual country level, the potential for regional differentiation of both the estimated coefficients and the functional form was considered for three regional groups: Eastern Europe, the Baltics, and the FSU. However, formal testing of parameter stability was made difficult by the fact that residuals tended to be heteroschedastic and non-normal. As is well known, standard Chow/F-tests perform poorly in these conditions (Baltagi (1995)) and recursive procedures that also rely on normality assumptions may be misleading. On the other hand, standard F-type tests based on point estimates fail to capture the trade-off in the pooled sample between the bias in the coefficient estimates due to unwarranted assumptions of homogeneous parameters and the reduction in variance deriving from a larger sample of observations. In light of these considerations, weaker criteria—based on the standard decomposition of the mean-square-error and other measures of in-sample predictive ability—were used to assess the validity of the pooled estimate against the alternative of separate regional blocks.

This assessment was based on comparing the predictive performance of the pooled model in the each of regional subsamples with the predictive performance of the model maintaining the same functional form, but allowing regional parameters to vary. The results from allowing regional variation in the parameter estimates indicate that the final specification performs better for the FSU than for Eastern Europe and the Baltics, suggesting that the pooled results are being driven mainly by the FSU (Table 3 in Section IV). This suggestion is confirmed by a comparison between the in-sample predictive performance in each of the three regions based on common parameters (obtained from the pooled estimate) and the predictive performance based on regional parameters (Table 22). Three criteria are used: the correlation coefficient between actual and predicted values, Theil's U statistic for measuring forecast accuracy, and the decomposition of the mean-square error (see Maddala (1977)). All three criteria suggest that the in-sample predictive ability of the common specification could be noticeably improved by relaxing the assumption of identical parameters, particularly for Eastern Europe and the Baltics, and that the assumption of identical parameters is too restrictive.

Table 21. Sensitivity to Specification of Monetary Aggregates 1/

(OLS-HCSE estimates; dependent variable: quarterly CPI inflation rate)

Variable	Full sample pooled estimates		
	Final Specification	Alternative Definition of Money	Domestic Credit
Constant	13.80 (2.35)**	18.43 (2.74)***	14.14 (2.43)**
Money growth, t 2/	0.26 (2.94)***	-	-
Money growth, t-1 2/	0.38 (4.08)***	-	-
Money growth, t-2 2/	0.09 (1.78)*	-	-
Money growth, t 3/	-	0.19 (5.21)***	-
Money growth, t-1 3/	-	0.23 (3.07)***	-
Money growth t-2 3/	-	0.05 (1.00)	-
Domestic credit growth, t	-	-	0.38 (3.14)***
Domestic credit growth, t-1	-	-	0.35 (2.74)***
Domestic credit, growth, t-2	-	-	0.05 (0.54)
Variance of relative prices 4/	0.04 (6.54)***	0.05 (8.87)***	0.03 (6.05)***
Seasonal dummies	All significant	Some significant	Some significant
Outlier dummy	1517.32 (89.16)***	1572.87 (128.97)***	1568.03 (125.63)***
R-squared corrected	0.92	0.90	0.90
F-statistics (zero slopes)	380.40***	296.37***	299.21***
Breusch-Pagan test for heteroschedasticity	101.49***	119.32***	0.31
White test for heteroschedasticity	174.68***	184.46***	114.53***
Jarque-Bera test for normality of residuals	3780.98***	3120.48***	2896.82***
Number of observations	260	260	255

1/ For the t-statistics reported in parenthesis, three asterisk indicates statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level; - indicates that the variable was not included because of lack of significance in the specification search. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.
2/ Broad money including foreign currency deposits.
3/ Broad money excluding foreign currency deposits.
4/ Theil variance.

Table 22. Predictive Ability of Pooled and Regional Estimates of the Final Specification

Measures of predictive ability	Full Sample	East and Central Europe Subsample		Baltics Subsample		FSU Subsample	
	Pooled parameters	Pooled parameters	Regional parameters	Pooled parameters	Regional parameters	Pooled parameters	Regional parameters
1. Correlation coefficient between actual and predicted values	0.96	0.57	0.74	0.78	0.83	0.96	0.96
2. Theil's U statistics (1966) 1/	0.26	0.79	0.50	0.94	0.36	0.25	0.24
3. Root-mean-square-error	31.50	11.15	7.06	11.80	4.48	47.63	45.79
Regression coefficient of actual on predicted values	1.00	0.47	1.00	0.42	1.00	1.00	1.00
Decomposition of mean-square error into: 2/							
a) Proportion due to bias	0.00	0.01	0.00	0.28	0.00	0.01	0.00
b) Proportion due to difference of regression coefficient of actual on predicted values	0.00	0.38	0.00	0.54	0.00	0.00	0.00
c) Proportion due to residual variance	1.00	0.61	1.00	0.18	1.00	0.99	1.00
Number of observations	260	122	122	33	33	105	105

1/ Ranges between 0 and 1 with 0 indicating a perfect forecast.
2/ Based on the regression of actual (A_t) on predicted values (P_t): $A_t = \alpha + \beta P_t + \epsilon_t$. Proportion due to bias = 0 when $\hat{\alpha} = 0$; proportion due to difference of regression coefficient from unity = 0 when $\beta = 1$; the remaining proportion is due to variance of ϵ_t. See Maddala (1977).

IV. EMPIRICAL METHODOLOGY FOR THE REGIONAL ESTIMATIONS: TESTS OF ROBUSTNESS

In light of the evidence of regional heterogeneity, specification searches were carried out on each of the regional blocks to arrive at three separate regional specifications. The robustness of the results were tested in a variety of ways (Tables 23-25):

- since diagnostic tests indicated the presence of heteroschedasticity, OLS estimates are reported with and without a heteroschedasticity-consistent standard error correction.[6] In addition, the robustness of the estimated coefficients was further examined by a weighted least squares procedure, under the assumption that the variance of the stochastic disturbance varies across countries, but not within each country.[7]

- In order to assess the stability of the estimated parameters over time and the validity of the estimations when the initial period of liberalization is excluded, the preferred regional specifications were re-estimated over a more recent post-liberalization period for Eastern Europe and the Baltics.[8]

- The sensitivity of the results to a change in the definition of the relative price variability indicator was examined by substituting the unweighted variance and skewness for the Theil variance and skewness (Table 7 in Section IV).

- To address the issue of simultaneity, a full instrumental variables procedure was attempted. However, given data limitations, good instruments for the variance and skewness terms (i.e., variables that are highly correlated with these two terms) proved difficult to find.[9] Hence, a more limited exercise was undertaken to eliminate an obvious source of simultaneity

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[6]First-order autocorrelations and correlograms for individual countries did not indicate significant problems of serial correlation in most cases.

[7]This assumption corresponds to the common weighted least squares procedure in which the observations for each country are weighted by the inverse of the standard deviation of the corresponding estimated residuals. The primacy of one weighting scheme over another is unknown when information over the form of heteroschedasticity is limited,

[8]The post-liberalization period was defined separately for each country to exclude the initial period of price liberalization (see Table 19). Such an estimation could not be carried out for the FSU because the delayed and gradual nature of price liberalization in many countries limited the sample period excessively.

[9]Given the low time persistence of these variables (see Appendix I), the lagged values of these variables turned out to be poor instruments.

Table 23. Regional Specification: Alternative Estimation Methods for East and Central Europe 1/

(Dependent variable: quarterly CPI inflation rate)

Variable	Final Specification OLS	Final Specification Full Sample OLS-HCSE	Weighted Least Squares 2/	Post-Liberalization Sample OLS-HCSE	Adjusted Variance and Skewness 3/ OLS-HCSE	Instrumental Variables HCSE 4/	Instrumental Variables HCSE 5/
Constant	0.36 (0.38)	0.36 (0.29)	1.44 (2.98)***	1.18 (1.24)	1.10 (0.79)	0.12 (0.11)	1.12 (0.86)
Multiplicative dummy for exch. rate anchor effects on inflation inertia	-0.15 (-2.16)*	-0.15 (-1.44)	-0.12 (-1.79)*	0.03 (0.26)	-0.11 (-1.03)	-0.14 (-1.65)*	-0.12 (-1.45)
Lagged inflation rate	0.23 (3.51)***	0.23 (3.30)***	0.22 (3.14)***	0.41 (4.68)***	0.21 (3.52)***	0.21 (3.06)***	0.21 (3.20)***
Money growth, t-1	0.33 (4.12)***	0.33 (2.28)**	0.20 (3.56)***	0.21 (1.99)**	0.34 (2.26)**	0.32 (2.20)**	0.34 (2.27)**
Unit labor cost growth, t	0.21 (4.07)***	0.21 (3.21)***	0.14 (3.91)***	0.13 (1.91)*	0.20 (3.01)***	0.27 (1.46)	0.19 (1.07)
Unit labor cost growth, t-1	0.08 (2.02)**	0.08 (2.72)***	0.08 (2.41)**	-0.008 (-0.15)	0.06 (1.42)	0.08 (2.83)***	0.06 (1.59)
Real exchange rate change, t-1	-0.15 (-2.50)**	-0.15 (-2.08)**	-0.14 (-2.46)**	-0.26 (-5.19)***	-0.19 (-3.21)***	-0.14 (-2.33)**	-0.19 (-3.74)***
Variance of relative prices 6/	0.02 (4.64)***	0.02 (5.65)***	0.02 (4.81)***	0.005 (0.57)	0.008 (3.48)***	0.02 (3.71)***	0.008 (3.51)***
R-squared corrected	0.66	0.66	0.59	0.58	0.66	0.67	0.68
F-statistics (zero slopes)	34.07***	34.07***	26.31***	20.50***	35.12***	33.27***	35.12***
Breusch-Pagan test for heteroschedasticity	105.59***	105.59***	n.a.	75.50***	111.21***	--	--
White test for heteroschedasticity	80.60***	80.60***	n.a.	53.36***	80.82***	--	--
Jarque-Bera test for normality of residuals	407.26***	407.26***	n.a.	91.84***	848.43***	--	--
Number of observations	122	122	122	100	122	122	122

1/ For the t-statistics reported in parenthesis, three asterisks indicate statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ The F-statistic for weighted least squares estimates is for transformed data.

3/ With Theil variance and skewness calculated on a basket excluding price-controlled goods.

4/ With contemporaneous unit labor cost growth instrumented using money growth lagged two periods, unit labor costs, Theil variance and skewness—all lagged one period, and a time trend.

5/ With contemporaneous unit labor cost growth instrumented using money growth lagged two periods, unit labor costs, Theil variance and skewness—all lagged one period, and a time trend; contemporaneous Theil variance and skewness calculated on a basket excluding price-controlle goods.

6/ Theil variance.

Table 24. Regional Specification: Alternative Estimation Methods for the Baltics 1/

(dependent variable: quarterly CPI inflation rate)

Variable	Final Specification OLS	Final Specification Full Sample OLS-HCSE	Weighted Least Squares 2/	Post Liberalization Sample OLS-HCSE	Adjusted Variance and Skewness 3/ OLS-HCSE
Constant	1.56 (1.32)	1.56 (0.96)	2.49 (2.33)**	4.18 (4.80)***	1.61 (1.02)
Lagged inflation rate	0.25 (5.05)***	0.25 (3.27)***	0.23 (5.25)***	0.09 (1.36)	0.25 (3.48)***
Money growth, t-1	0.32 (5.93)***	0.32 (3.82)***	0.27 (6.05)***	0.23 (4.77)***	0.33 (4.23)***
Skewness of relative prices 4/	0.90 (2.37)**	0.90 (2.59)**	0.92 (2.82)***	0.89 (2.93)***	0.93 (3.07)***
R-squared corrected	0.73	0.73	0.73	0.53	0.75
F-statistics (zero slopes)	30.05***	30.05***	29.54	12.04***	32.89***
Breusch-Pagan test for heteroschedasticity	5.95*	5.95*	n.a.	9.55***	5.18*
White test for heteroschedasticity	9.50	9.50	n.a.	6.25	10.44
Jarque-Bera test for normality of residuals	0.66	0.66	n.a.	8.84**	0.79
Number of observations	33	33	33	31	33

1/ For the t-statistics reported in parenthesis, three asterisks indicate statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ The F-statistic for weighted least squares estimates is for transformed data.

3/ With Theil skewness calculated on a basket excluding price-controlled goods.

4/ Theil skewness.

Table 25. Regional Specification: Alternative Estimation Methods for the FSU 1/

(Dependent variable: quarterly CPI inflation rate)

Variable	Final Specification OLS	Final Specification Full Sample OLS-HCSE	Weighted Least Squares 2/	Instrumental Variables OLS-HCSE 3/	Instrumental Variables OLS-HCSE 4/
Constant	57.51 (5.66)***	57.51 (3.61)***	49.74 (6.74)***	42.94 (1.70)*	27.62 (0.88)
Money growth, t	0.20 (3.79)***	0.20 (2.14)**	0.16 (4.55)***	0.11 (1.47)	0.39 (0.99)
Money growth, t-1	0.30 (5.39)***	0.30 (2.94)***	0.27 (7.59)***	0.11 (0.77)	0.05 (0.39)
Nominal wage growth, t	0.21 (8.78)***	0.21 (2.34)**	0.24 (6.91)***	0.47 (1.78)*	0.50 (1.99)**
Skewness of relative prices, t-1 5/	5.40 (1.56)	5.40 (1.96)*	8.78 (3.65)***	6.69 (2.82)***	6.11 (2.45)**
Seasonal dummies	All significant	All significant	All significant	Some significant	Some significant
Outlier dummy	1489.27 (33.26)***	1489.27 (82.19)***	1497.39 (78.68)***	1491.78 (112.31)***	1453.45 (28.62)***
R-squared corrected	0.94	0.94	0.93	0.87	0.85
F-statistics (zero slopes)	187.46***	187.46***	1071.43***	78.45***	60.53***
Breusch-Pagan test for heteroschedasticity	37.18***	37.18***	n.a.	--	--
White test for heteroschedasticity	77.11***	77.11***	n.a.	--	--
Jarque-Bera test for normality of residuals	52.72***	52.72***	n.a.	--	--
Number of observations	105	105	105	105	105

1/ For the t-statistics reported in parenthesis, three asterisks indicates statistical significance at 1 percent level; two asterisks at the 5 percent level; one asterisk at the 10 percent level. OLS-HCSE refers to correction of bias in least squares standard errors and t-statistics using a heteroschedasticity-consistent variance-covariance estimator.

2/ The F-statistic for weighted least squares estimates is for transformed data.

3/ With contemporaneous nominal wage growth instrumented using money growth lagged two periods, nominal wage growth and variance—both lagged one period.

4/ With contemporaneous money growth and nominal wage growth instrumented using money growth lagged two periods, and nominal wage growth and real exchange rate lagged one period.

5/ Theil skewness.

arising from the presence of controlled goods in the CPI:[10] the regional equations were re-estimated substituting the contemporaneous variance and skewness terms with the same measures calculated on a limited basket excluding controlled goods and using instruments for contemporaneous money growth and nominal wage growth.[11]

[10]Relative price variance could increase when inflation rises (due to an exogenous shock) if the prices of controlled goods are not adjusted in line with market conditions.

[11]This basket was obtained by eliminating public services, such as rents, utilities, transport, communications, and any commodity or service whose price did not change for three consecutive quarters. While this procedure is admittedly rough, it should at least significantly reduce, if not eliminate, the controlled element from the CPI for most countries.

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