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INTERNATIONAL MONETARY FUND

REPUBLIC OF BELARUS

Selected Issues

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Approved by the European Department

July 20, 2006

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I. Common and Idiosyncratic Determinants of Inflation[1]

A. Introduction

1. **Inflation has fallen across many Eastern European and transition countries over the past few years (Figure 1).** While starting from different levels, by end-2005, seasonally-adjusted monthly inflation had dropped on average by half in countries such as Belarus, Czech Republic, Estonia, Hungary, Poland, Romania, Russia, and the Slovak Republic. By contrast, inflation remains higher in Bulgaria, Latvia, Lithuania, and Ukraine when compared to 2001, with an average increase in seasonally-adjusted monthly inflation rates of about 65 percent. With regard to Belarus, a large output gap has allowed strong noninflationary growth; however, pervasive price controls are likely to have played a role in explaining inflation developments.

2. **Several factors can explain inflation over time.** *Money growth* is uncontroversially one of these factors. In transition economies, it fueled inflation early on when fiscal obligations were monetized and lack of a credible fiscal stance contributed to the deterioration of market confidence, thus increasing velocity. *Wage growth*, beyond productivity gains, impacts prices not only directly by increasing costs, but also indirectly by raising domestic demand. This is particularly relevant in countries in which the share of wages in household disposable income is relatively high, and household expenditure is biased toward basic items, which usually comprise the largest component in the CPI basket. The *output gap* would affect the likelihood that bottlenecks put upward pressures on prices in specific sectors. *Real exchange rate appreciation*, owing to Balassa-Samuelson effects and/or simply to surges in domestic absorption stemming from higher levels of income, would also trigger inflation in cases in which these pressures are not accommodated through nominal appreciation. Inflationary pressures could also result from *relative price adjustments* with downward price rigidity while structural reforms are being implemented and both supply and demand adjust during transition.

3. **Some factors are common across countries or sectors.** These factors are unobserved shocks that drive the underlying inflation process and are common (correlated) across countries or sectors, although their impact depends on their individual "load" and differences in economic structures and policies. In countries in which significant economic convergence has been achieved, a limited number of similar forces are likely to drive inflation at a certain point in time: an oil shock could be an example of the same exogenous force that affects countries/sectors. **Some factors are country- or sector-specific.** At any point in time, inflation may be driven by shocks that impact a single country—for instance, a correction in energy prices relative to international market prices—and by policies—

[1] Prepared by Marco Rossi.

monetary, fiscal and exchange rate policies—and/or conditions—price controls, relative price adjustments, degree of competition—that are specific to each country or sector. These idiosyncratic factors, by definition, are uncorrelated with common factors.

4. **The analysis of inflation developments in Belarus is hampered by widespread price controls.** The share of goods and services subject to direct price control reached over 35 percent in 2005, and included food items, and communal and transportation services. In 2005, the Council of Ministers issued a decree that set monthly marginal price increases (0.6–0.8 percent) for all goods and services produced and sold in Belarus, with very limited exceptions. All enterprises seeking higher than marginal price increases need to apply to the local authorities, who may reject the application. Violation of the price registration mechanism may result in fines, sanctions, and business closure. In addition, the government continues to limit profit margins on socially important goods and the majority of food articles in the consumer basket. This would clearly be a feature that is specific to Belarus. In these circumstances, actual inflation may not fully reflect underlying inflationary pressures. Therefore, distinguishing among common and idiosyncratic determinants of inflation appears a promising starting point for analyzing the inflation process.

The chapter is organized as follows. Section B briefly presents the data and the generalized dynamic factor model methodology. Section C reports the results. Section D focuses on inflation forecasts for Belarus, while Section E concludes.

B. Methodology and Data

5. **Factor analysis assumes that covariation among time series can be explained by a few unobserved shocks (factors)**. In factors models, therefore, a large number of covarying series are transformed into a smaller number of unobserved orthogonal series (common components) so as that each additional factor (component) explains as much as possible of the remaining variation in the observed series. The observed series is then represented as the sum of the common component, which can be interpreted as underlying inflation, and of a disturbance term (idiosyncratic component), which is uncorrelated with the common component.

6. **The analysis in this chapter is based on an application of the generalized dynamic factor model (GDFM) proposed by Forni and others (2000 and 2001).**[2] This is a statistical approach that extends principal component analysis and Stock and Watson's (1989) coincident and leading indicator approach. The basic framework is that of a dynamic factor model in which the assumption of mutually orthogonal idiosyncratic components is

[2] Applications of Forni and others (2000 and 2001) can be found in Nadal de Simone (2005) and van Elkan and others (2006).

relaxed to allow for some mild cross correlation. Underlying inflation is therefore assumed to be proxied by a common component, which is driven by a small number of common factors. These factors are the same across the countries, although potentially impacting inflation differently in each country (different coefficients or "loads").

7. **The dataset comprises a panel of 12 countries, and 223 monthly series of CPI indices and their components over the period 2001–05.** Factor models can accommodate large panels and overcome the problem inherent in multivariate analysis when the time dimension is smaller than the cross-country dimension. The data set contains seasonally adjusted monthly inflation from January 2001 through December 2005, both for headline CPI inflation and for its components, for 12 Eastern European and transition countries, with over 13,000 data points.[3] The sources are the Harmonized Index of Consumer Prices (HICP) and national statistics. All 223 series were tested for unit roots; 15 CPI components in various countries turned out to be nonstationary and were dropped from the dataset for the estimation.

8. **The first step in the analysis is to determine the number of common factors.** A principal component analysis of the spectral density matrices of the data (Figure 2) shows the share of the cumulative variance (cumulative eigenvalues) of the series that is explained by each successive principal components (eigenvector). Different thresholds can be set to identify the number of common factors (components): here, this is chosen by stopping at the factor (eigenvalue) that improves upon the explained cumulative data variability by less than 10 percent at all frequencies. This yields four dynamic common components, which explain bout 75 percent of the total data variability.

9. **The next step is to determine the number of static factors.** The relation among static and common factors, and lags is given by:

number of static factors=number of common factors * (1+number of lags).[4]

With 2 common factors and 12 as the number of lags (in light of the monthly frequency), the number of static factors are set at 26.

[3] The countries are: Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovak Republic, and Ukraine. Seasonal adjustment is done with X-11, which may not be the best seasonal adjustment for Belarus data.

[4] See Forni and others (2003) for a definition of the relationship.

C. Generalized Dynamic Factor Model Results

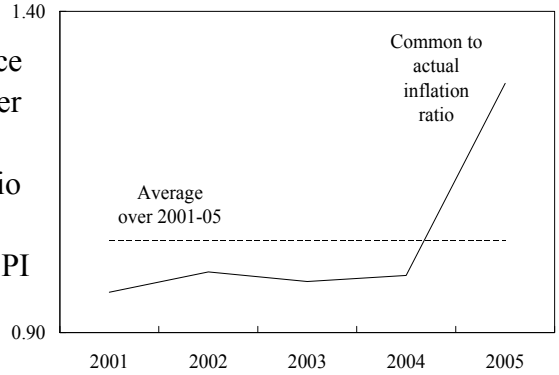
10. **Applying the GDFM to our dataset decomposes inflation in the 12 countries in the sample into common and idiosyncratic components.**[5] Figure 3 plots headline CPI common (underlying) and actual inflation for each country. The common component of each country's inflation—that is, that part of inflation that is explained by shocks that are shared across countries and sectors—tracks movements in headline inflation while smoothing it by eliminating cross-section and cross-country disturbances. Common inflation explain over 35 percent of the variability of actual inflation for the whole panel (Table 1). Across countries, however, common components tend to account for a somewhat larger share of actual inflation variability in Belarus, Russia, and Ukraine (Group A), indicating that idiosyncratic shocks are relatively less important in these countries.

11. **Persistence of common inflation is generally higher than that of actual inflation (Table 2).** Persistence is proxied by the half life of a unit shock, which indicates the length of time necessary to halve the magnitude of the original shock to inflation. It is calculated as:

$$Half life = \left| \frac{\log \frac{1}{2}}{\log \beta} \right|$$

where, β is derived by estimating a simple regression of the monthly seasonally-adjusted headline CPI inflation on its lag and a constant: $\pi_t = \alpha + \beta \pi_{t-1} + \varepsilon_t$. The fact that common inflation shows higher persistence suggests that relative price adjustments, Balassa-Samuelson effects, and, more generally, structural transformation may not have fully run their course.[6]

12. **Table 3 and Figure 4 report the difference between common and actual inflation in Belarus.** Several stylized facts are worth mentioning. First, while on average the difference between common and actual inflation is zero over the sample period, this is positive in 2005 and larger than in any of the previous years—the ratio between common and actual inflation shows a similar picture. This is true both for the whole CPI index and for the single CPI components. Second, as it is likely that the difference will revert to its zero mean (and to a ratio of one), actual inflation may pick up. Third, the CPI



[5] Nadal de Simone kindly shared the Matlab code used in Nadal de Simone (2005).

[6] See Coorey and others (1996) for a discussion of the role of relative price adjustments.

components that are the most above their past averages are those, such as housing, clothing, and alcoholic beverages, that are subject to extensive price controls.

D. Forecast

13. **The Bai and Ng's (2001) algorithm is used to determine the optimal number of static factors.** The algorithm is maximized at around 60 static factors. For the estimation, the number of static factors is set at 52, resulting from 4 common factors and 12 lags.

14. **An inflation forecast would need to incorporate a projection for both underlying (common component) inflation and idiosyncratic inflation.** Underlying inflation in Belarus is predicted by using the one-sided predictor proposed by Forni and others(2003). The idiosyncratic component, however, may have an important impact on inflation in the short term. A forecast of the latter is projected both by estimating a classic Box-Jenkins ARIMA model and by applying the same common component analysis to the idiosyncratic component of inflation.[7] Figure 5 shows monthly seasonally-adjusted inflation forecasts of both underlying inflation and headline inflation in Belarus, based on the two approaches to forecast the idiosyncratic component. To note is that headline and underlying inflation forecasts—when the forecast of the idiosyncratic component is predicted on the basis of the same framework that is used to predict underlying inflation—tend to increasingly overlap as the forecast horizon increases. This is consistent with the idea that the idiosyncratic component of inflation picks up the short-term impact of specific policy actions.

E. Conclusions and Areas of Further Analysis

15. Based on the analysis of common and idiosyncratic components of inflation in Belarus, several preliminary conclusions are possible. First, inflationary pressures appear to have mounted in 2005. In fact, underlying inflation appears to be above actual inflation by more than at any time over the last five years. At the same time, price controls may now play a bigger role in masking these inflationary pressures.

16. From an analytical standpoint, it would be interesting to compare underlying inflation, as derived in this paper, with other concepts of underlying inflation such as "core" inflation, trimmed mean, and the median. All of these are useful indicators of inflationary pressures that could inform the NBRB's monetary policy stance.

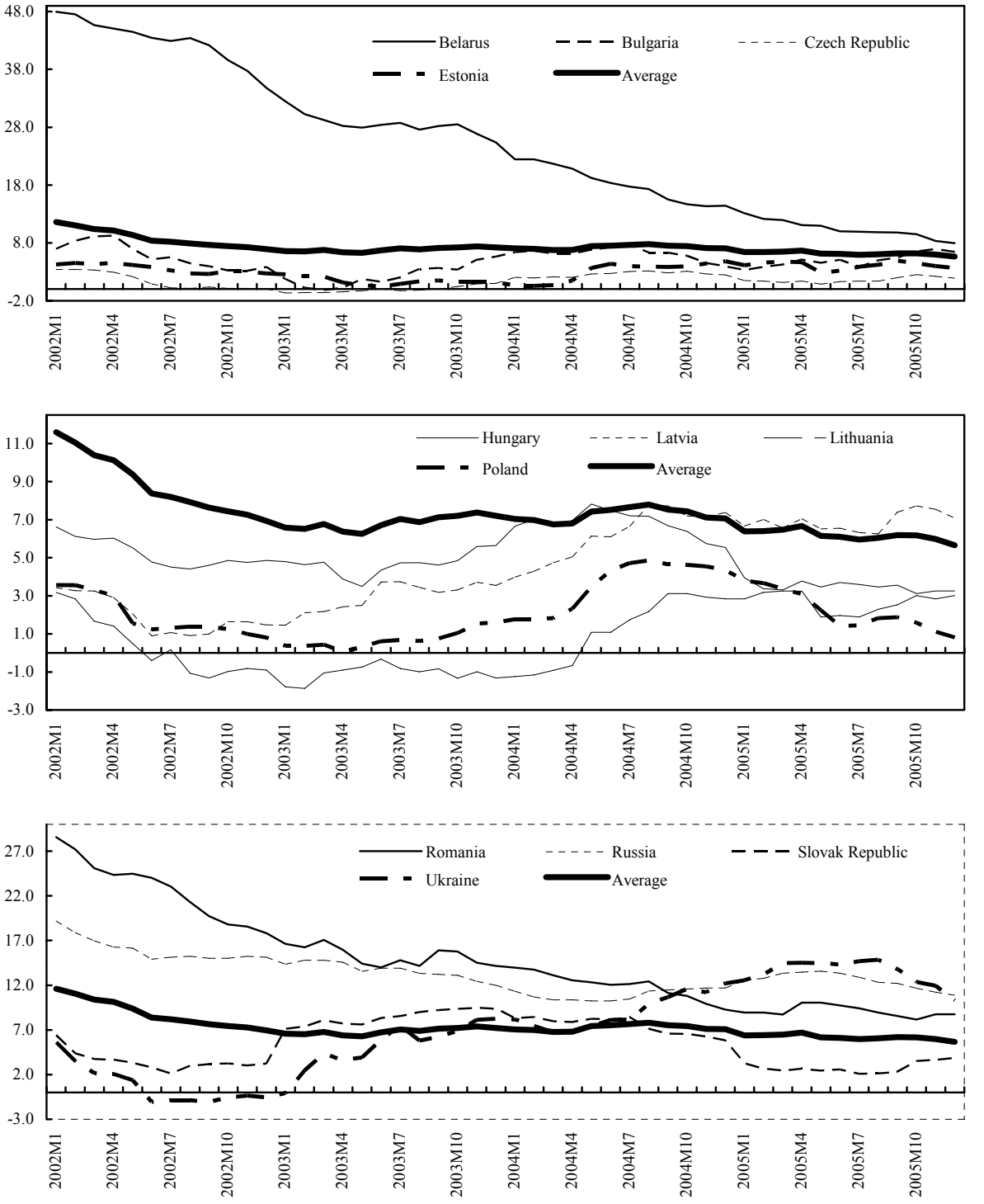
17. More generally, it would be interesting to regress underlying inflation, as derived in this paper, on demand and supply side variables and test their explanatory power. For

[7] The ARIMA specification includes a constant and the dependent variable (idiosyncratic inflation) with 1 and 12 lags.

instance, Chernookiy (2004) could be re-estimated with the common component series derived here.

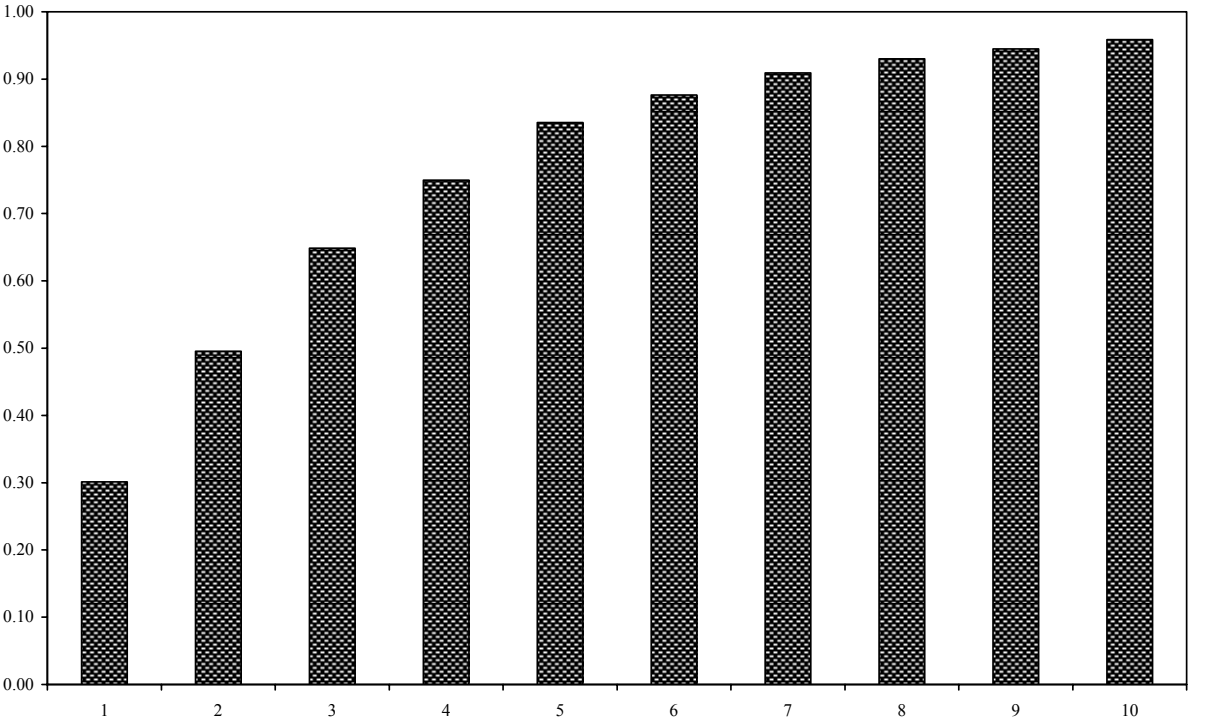
18. Finally, while common components explain roughly a similar proportion of inflation variability across countries in the panel, the levels of common inflation across countries differ. This could reflect the way (load) common factors impact inflation in each country, which ultimately depends on the structure of the economy, including the exchange rate regime, production technologies, relative prices, and other catching up issues. To assess these channels, a series of fixed-effects panel regressions could be performed, which would regress common inflation differentials on a series of explanatory variables that proxies the structural and policy framework.

Figure 1. Inflation in 12 Eastern European and Transition Countries, 2002-05
(Year-on-year change, in percent)



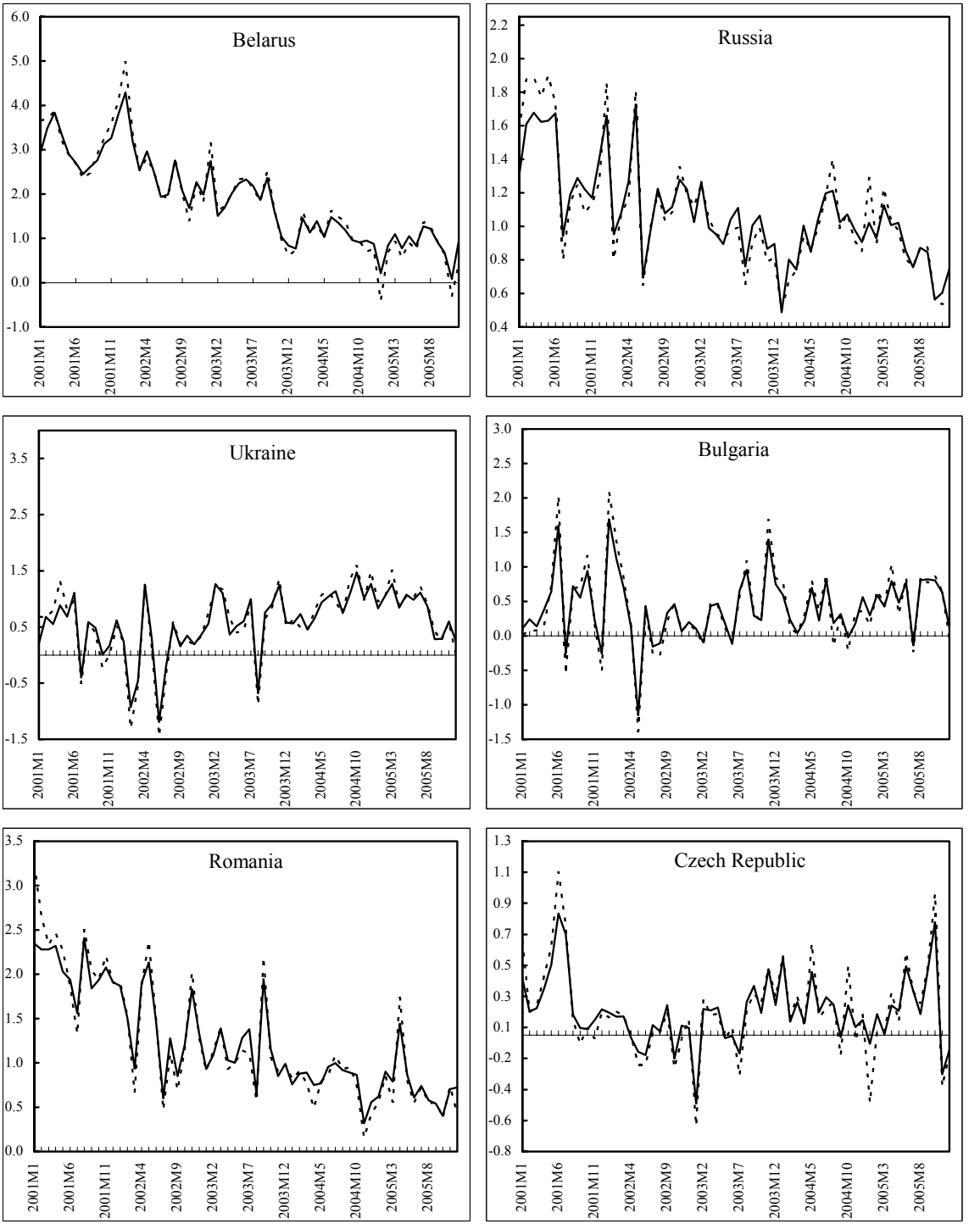
Source: Eurostat, national authorities; and Fund staff estimates.

Figure 2. Cumulative Data Variability Explained by the First Ten Common Factors
(In percent)



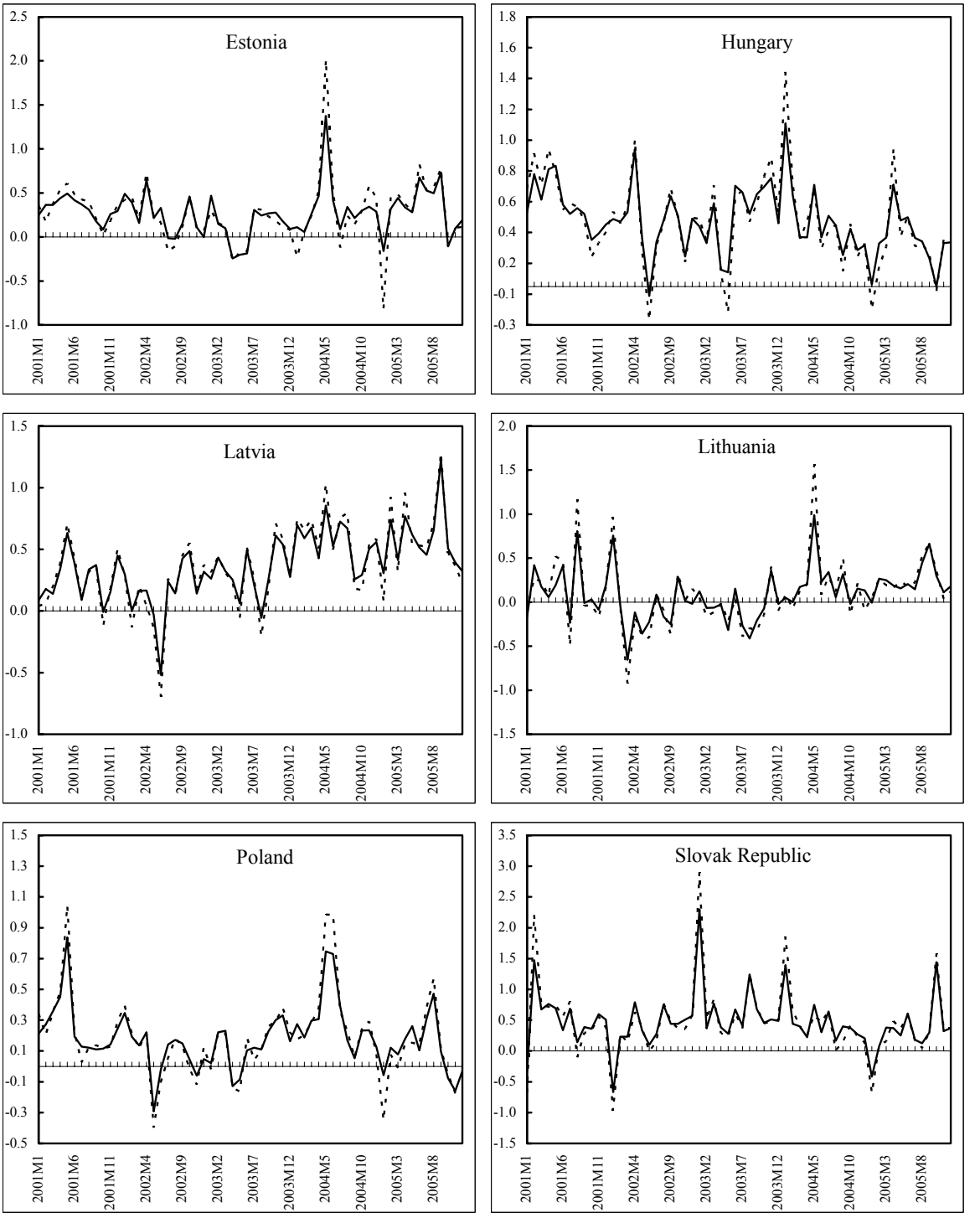
Source: Fund staff estimates

Figure 3. Measures of Headline CPI Inflation, 2001-05
(Monthly seasonally-adjusted, in percent)



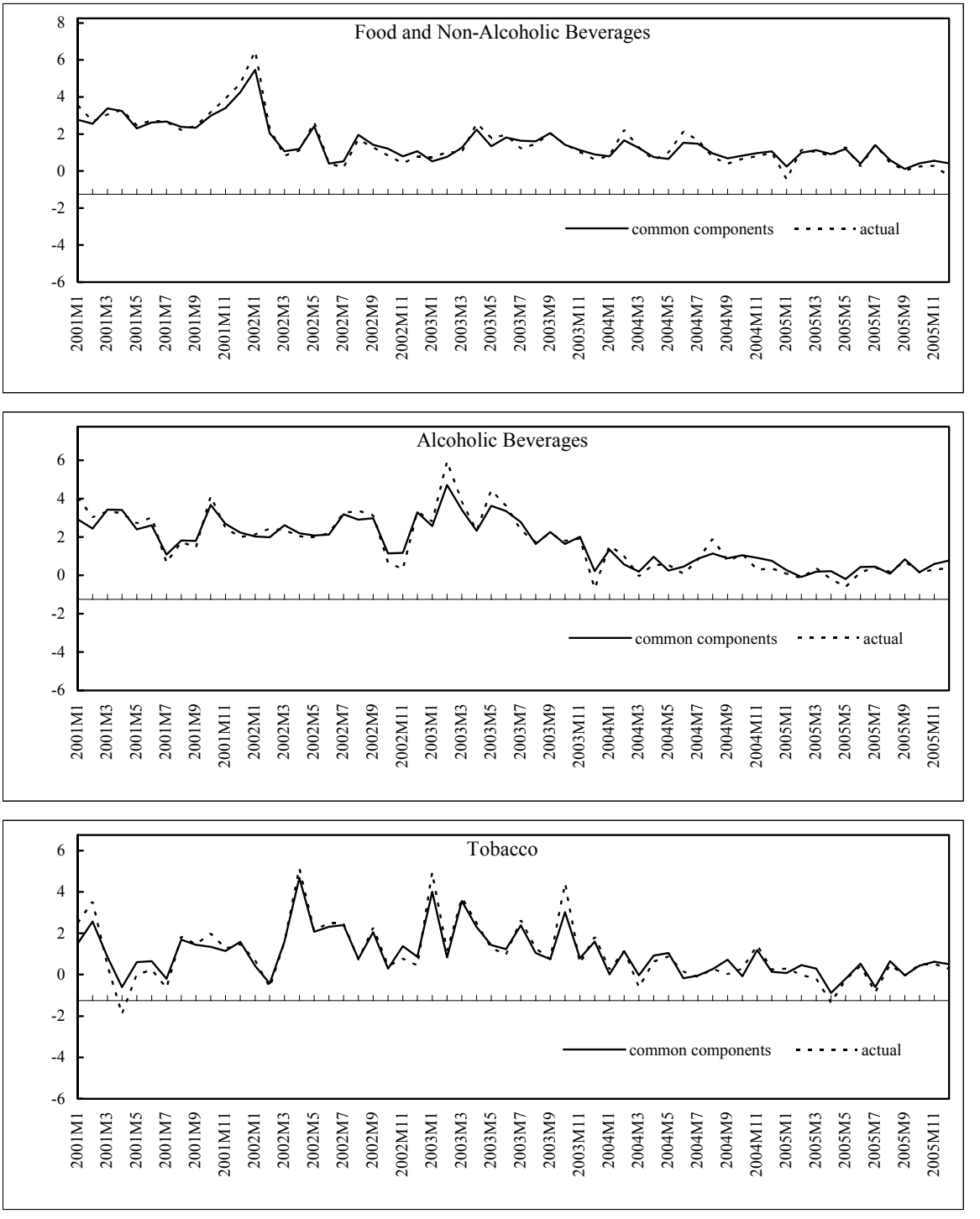
Source: Eurostat, national authorities; and Fund staff estimates.
_____ common components
---------- actual

Figure 3 (continued). Measures of Headline CPI Inflation, 2001-05
(Monthly seasonally adjusted, in percent)



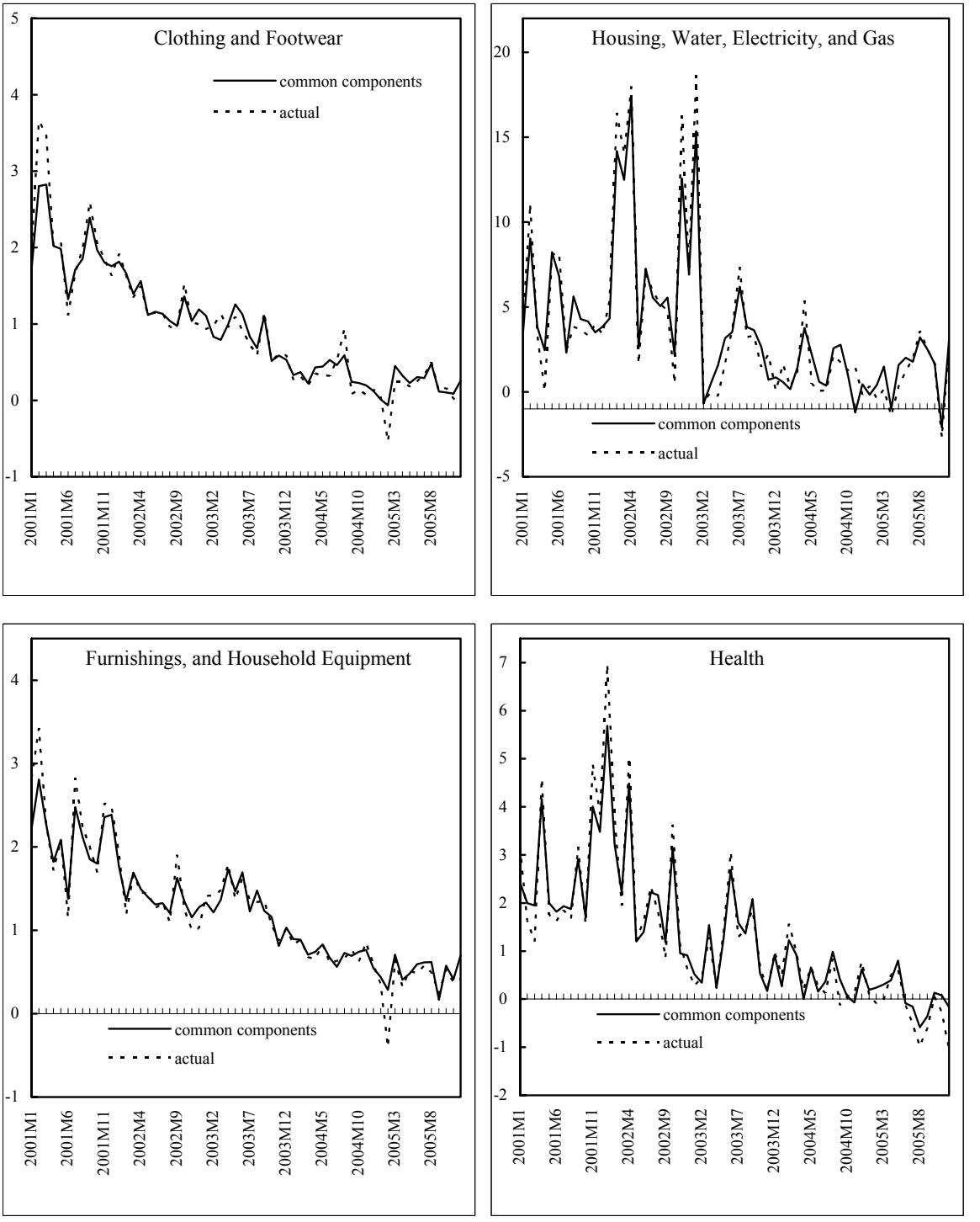
Source: Eurostat, national authorities; and Fund staff estimates.
_____ common components
---------- actual

Figure 4. Belarus: Measures of Inflation for CPI Components, 2001-05
(Monthly seasonally adjusted, in percent)



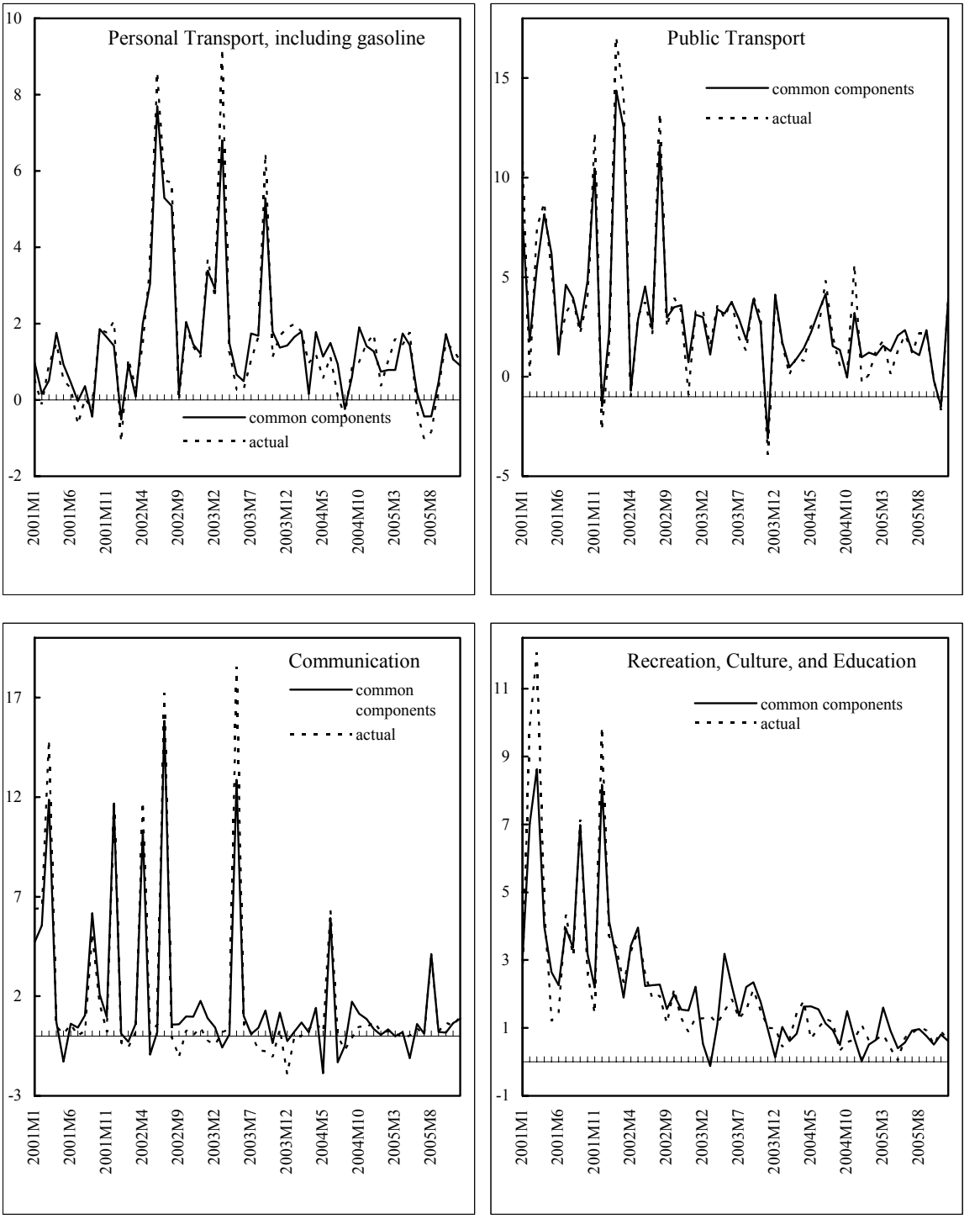
Source: Eurostat, national authorities; and Fund staff estimates.
_____ common components
---------- actual

Figure 4 (continued). Belarus: Measures of Inflation for CPI Components, 2001-05
(Monthly seasonally adjusted, in percent)



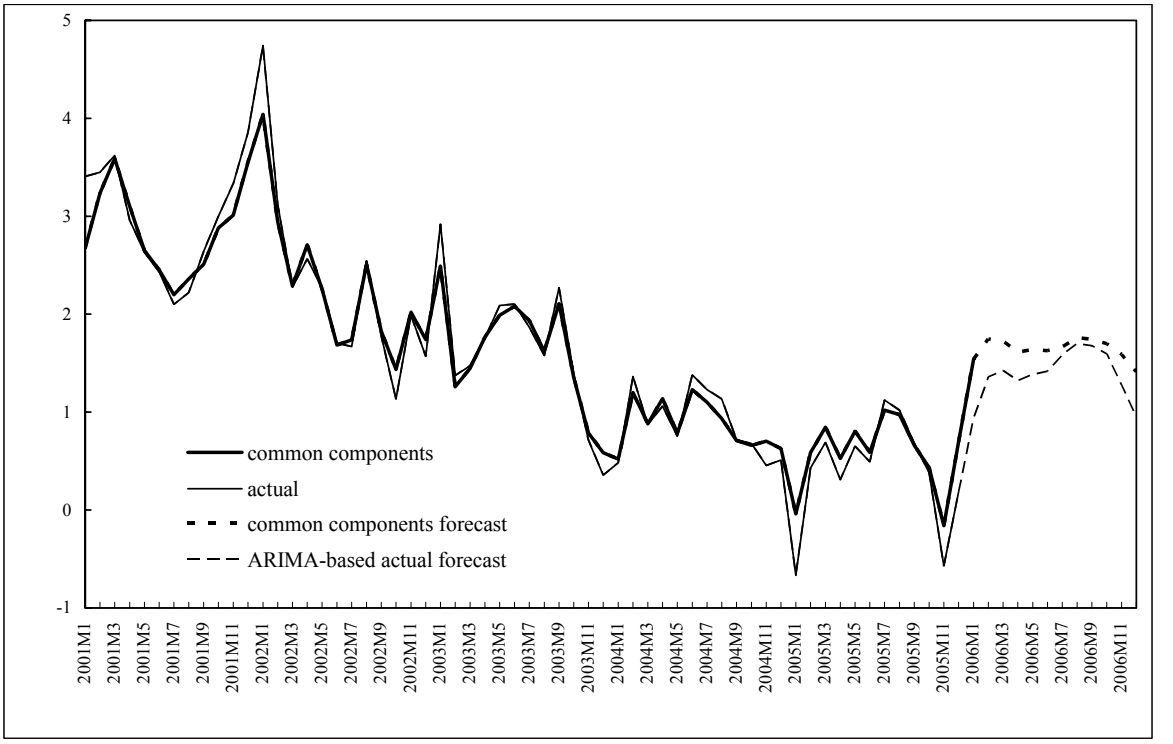
Source: Eurostat, national authorities; and Fund staff estimates.
_____ common components
---------- actual

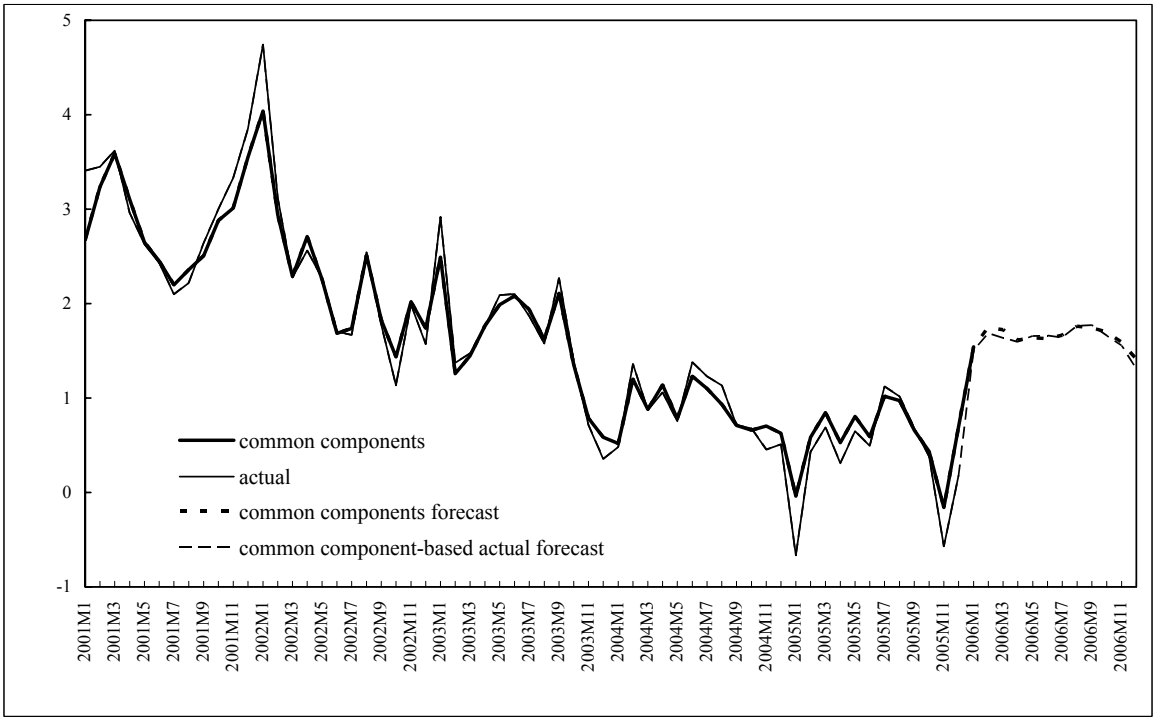
Figure 4 (continued). Belarus: Measures of Inflation for CPI Components, 2001-05
(Monthly seasonally adjusted, in percent)



Source: Eurostat, national authorities; and Fund staff estimates.
_____ common components
---------- actual

Figure 5. Belarus: Actual Inflation and Inflation Forecasts, 2001-06
(Monthly change, seasonally adjusted)





Source: National authorities; and Fund staff estimates.

Table 1. Inflation Variance

	Common components	Actual	Common components' share of actual inflation
		(In percent)	
GROUP A			
Belarus	0.96	1.27	76
Russia	0.08	0.12	65
Ukraine	0.30	0.41	73
Average group A	0.45	0.60	74
GROUP B			
Bulgaria	0.22	0.35	62
Romania	0.33	0.49	68
Average group B	0.27	0.42	65
GROUP C			
Czech Republic	0.05	0.09	55
Estonia	0.07	0.13	49
Hungary	0.05	0.08	56
Latvia	0.07	0.11	66
Lithuania	0.08	0.15	56
Poland	0.04	0.07	57
Slovak Republic	0.20	0.34	57
Average group C	0.08	0.14	57
Sample average	0.20	0.30	67

Source: Eurostat, national authorities; and Fund staff calculations.

Table 2. Inflation Persistence: Half Life

	Common components	Actual	Common components' share of actual inflation
		(In months)	
GROUP A			
Belarus	5.56	4.05	137
Russia	1.26	1.20	105
Ukraine	0.66	0.79	84
Average group A	2.49	2.01	124
GROUP B			
Bulgaria	0.26	0.23	112
Romania	2.00	1.49	134
Average group B	1.13	0.86	131
GROUP C			
Czech Republic	0.61	0.51	120
Estonia	0.61	0.51	119
Hungary	0.67	0.63	107
Latvia	0.83	0.66	127
Lithuania	0.43	0.29	145
Poland	1.16	1.11	105
Slovak Republic	0.08	0.21	40
Average group C	0.63	0.56	112
Sample average	1.18	0.97	121

Source: Eurostat, national authorities; and Fund staff calculations.

Table 3. Belarus: Difference between Common and Actual Inflation, 2001-05

	2001	2002	2003	2004	2005	Average over sample period
	(In percent, differences in yearly averages)					
CPI Index	-0.12	-0.01	-0.04	-0.01	0.18	0.00
Components						
Food and non-alcoholic beverages	-0.16	0.06	-0.02	-0.05	0.18	0.00
Alcoholic beverages	-0.11	0.04	-0.14	0.04	0.16	0.00
Tobacco	0.03	-0.01	-0.25	0.05	0.18	0.00
Clothing and footwear	-0.16	0.02	0.02	0.04	0.09	0.00
Housing, water, electricity, gas and other fuels	0.17	-0.53	0.03	-0.07	0.39	0.00
Furnishing, household equipment and routine maintenance of the house	-0.14	0.03	-0.03	0.01	0.12	0.00
Health	-0.06	-0.18	0.01	-0.03	0.27	0.00
Personal transportation (incl. benzene)	0.10	-0.11	-0.18	0.13	0.06	0.00
Public transportation	-0.11	-0.15	0.09	-0.01	0.18	0.00
Communication	-0.30	0.18	0.17	0.03	-0.09	0.00
Recreation, culture, and education	-0.40	0.13	0.09	0.08	0.10	0.00
	(In percent, ratios of yearly averages)					
CPI Index	0.96	0.99	0.98	0.99	1.29	1.04
Components						
Food and non-alcoholic beverages	0.95	1.03	0.99	0.96	1.24	1.03
Alcoholic beverages	0.96	1.02	0.95	1.04	1.41	1.08
Tobacco	1.03	1.00	0.90	1.08	1.77	1.15
Clothing and footwear	0.93	1.01	1.02	1.14	1.69	1.16
Housing, water, electricity, gas and other fuels	1.04	0.94	1.01	0.95	1.48	1.08
Furnishing, household equipment and routine maintenance of the house	0.94	1.02	0.98	1.02	1.32	1.06
Health	0.98	0.93	1.01	0.94	-0.33	0.71
Personal transportation (incl. benzene)	1.14	0.96	0.93	1.12	1.09	1.05
Public transportation	0.98	0.97	1.04	0.99	1.15	1.03
Communication	0.93	1.08	1.14	1.05	0.85	1.01
Recreation, culture, and education	0.92	1.05	1.07	1.09	1.15	1.06

Source: Eurostat, national authorities; and Fund staff calculations.

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II. The Impact on Growth of Terms-of-Trade Fluctuations:

Empirical Evidence for the Transition Economies in Europe and Central Asia[8]

A. Introduction

1. **Belarus's recent run of continued terms-of-trade improvements is unlikely to continue.** As pointed out in the Article IV staff report, prices of energy imports from Russia may in fact increase dramatically from 2007, while in the medium term only small changes can be expected in export prices for petroleum products and fertilizers, according the World Economic Outlook.

2. **This chapter aims at giving an econometric assessment of the potential impact on Belarusian growth of a deterioration in the terms of trade.** We employ panel data techniques to study the effect on growth of fluctuations in the terms of trade in the transition economies of Europe and Central Asia (ECA). The panel data results for the region are used to determine the magnitude of the impact on growth in Belarus, in light of the specific conditions affecting its outlook. The estimated growth impact forms part of the analysis in Box 4 in the staff report.

3. **The results show that growth in the ECA region, and in the CIS countries excluding Russia in particular, is more sensitive to terms-of-trade fluctuations than in other regions across the world.** Part of the explanation is that the CIS excluding Russia (CIS-11) consists of small economies with a higher degree of openness and a less advanced regulatory framework than other countries.

B. Previous Literature

4. **Several empirical studies have documented a significant and positive relation between growth and the terms of trade**—measured as the ratio of export to import prices. Easterly and others (1993) and Barro (1997) both find that changes in the terms of trade help explain average growth over 10-year periods. This is confirmed by Blattman and others (2006), and by Turnovsky and Chattopadhyay (2003). Both papers, however, point out that terms-of-trade volatility is more important for explaining long-run growth than the trend in the terms of trade. The result that high frequency fluctuations in the terms of trade is what really matters for growth is consistent with Fischer (1993) and Mendoza (1997), who find a larger real impact of changes in the terms of trade in panel regressions on yearly data than in cross country regressions on average growth rates. Mendoza also establishes the importance

[8] Prepared by Kristian Hartelius

of terms-of-trade volatility for long-run growth in separate regressions. Using a panel VAR, Broda (2004) finds that the short-run growth impact of changes in the terms of trade is significantly larger for countries with fixed exchange rate regimes.

5. **The effect of a terms-of-trade change on growth is by no means mechanical.** Barro (1997) notes that if the quantities of domestically produced goods do not change, then an improvement in the terms of trade raises real gross domestic income, but does not affect real GDP. Movements in real GDP occur only if the shift in the terms of trade brings about a change in domestic employment and output.

6. **Economic theory, however, has pointed to several links between the terms of trade and growth.** Using a stochastic endogenous growth model, Mendoza (1997) shows that we can expect growth to be slower on average in economies in which the terms of trade grow at a slower rate, because slow terms-of-trade growth reduces the expected real rate of return on investment and thus reduces the savings rate. Mendoza (1997) also derives the result that terms-of-trade volatility, under certain assumptions on risk aversion, discourages saving by creating uncertainty about the real return on investments. Another theoretical explanation of the link between average growth and average terms-of-trade changes in developing and emerging countries has been put forward by Basu and McLeod (1992), who argue that an increase in the purchasing power of exports encourages the purchase of productivity enhancing intermediate goods and equipment, which must often be imported. Friedman (1953) provides an explanation of why countries with fixed exchange rates should experience larger growth effects of terms of trade changes. Friedman points out that countries that can change relative prices quickly in response to a real shock should have smoother adjustment in terms of quantities. If prices are sticky, as they are in an economy with pervasive administrative intervention in price formation, flexibility in the nominal exchange rate becomes crucial for reducing the adjustment needed in the real economy.

C. Methodology

7. **The econometric analysis in this paper is based on panel regressions using annual data.** The method follows Fischer (1993) and Mendoza (1997) and is well suited to gauge the importance of fluctuations in the terms of trade for growth. However, it does not allow a decomposition into growth effects owing to trend and volatility in the terms of trade.

8. **The dependent variable in our estimations is growth in real GDP per capita in PPP terms, while the explanatory variable of interest is the annual rate of change in the terms of trade.** We follow Schadler and others (2006) and include control variables that were found to be important for growth by Sala-i-Martin and others (2004), who conduct a meta study of the growth regression literature. The controls are initial income per capita, population growth, partner country growth, the relative price of investment, and human

capital accumulation (proxied by average years of higher education). The empirical analysis also explores the significance of openness and regulatory quality for the relation between growth and the terms of trade.

D. Data

9. **The data set is an extension of the data used in Schadler and others (2006) and comprises annual observations for 178 countries between 1960 and 2004** (see Appendix Table A1 for a complete list of countries). Because of gaps in the data, however, the number of countries included in the different regressions vary with the specification. Importantly, the data set contains observations for 28 developing countries in Europe and Central Asia (ECA, italicized in Appendix Table A1). Since this region includes Belarus, the econometric analysis specifically explores the impact of terms of trade on growth in the ECA countries. For a definition of the variables and data sources, please see Appendix Table A2.

E. Empirical Analysis

10. **An informal documentation of the empirical regularities in ECA countries points to a positive relation between changes in the terms of trade and growth.** Figure 1 plots the averages of GDP growth against average terms-of-trade changes between 1990 and 2004, including a simple regression line. The positive slope of the regression line accords with the finding in previous studies that growth tends to be faster in countries where the terms of trade develop more favorably. Figure 2 plots the unweighted averages of real GDP and the terms of trade across the ECA countries between 1989 and 2004. The graph illustrates some of the time series variation in the sample, and suggests that real GDP and the terms of trade have covaried to a considerable degree in the ECA countries over the past 15 years, although post-Soviet recession and subsequent recovery growth probably are the most important explanatory factors behind the GDP graph in figure 2.

11. **A fixed effects regression of growth on the terms of trade shows that the terms of trade matter more for growth in the ECA countries than in the global sample on average**. Column (1) of Table 1 presents the estimates, which are robust to changing the specification to random effects instead.[9] As in Mendoza (1997), the R^2 is low, since there is a vast number of idiosyncratic factors that every year influence growth in each of the 178 countries included in the sample. We are, however, not trying to explain growth *per se*, but focus on examining the link between terms-of-trade fluctuations and growth. A significant

[9] A Hausman specification test, however, favors fixed effects.

Figure 1. Average Growth and Terms-of-Trade Changes in the ECA Region, 1990-2004

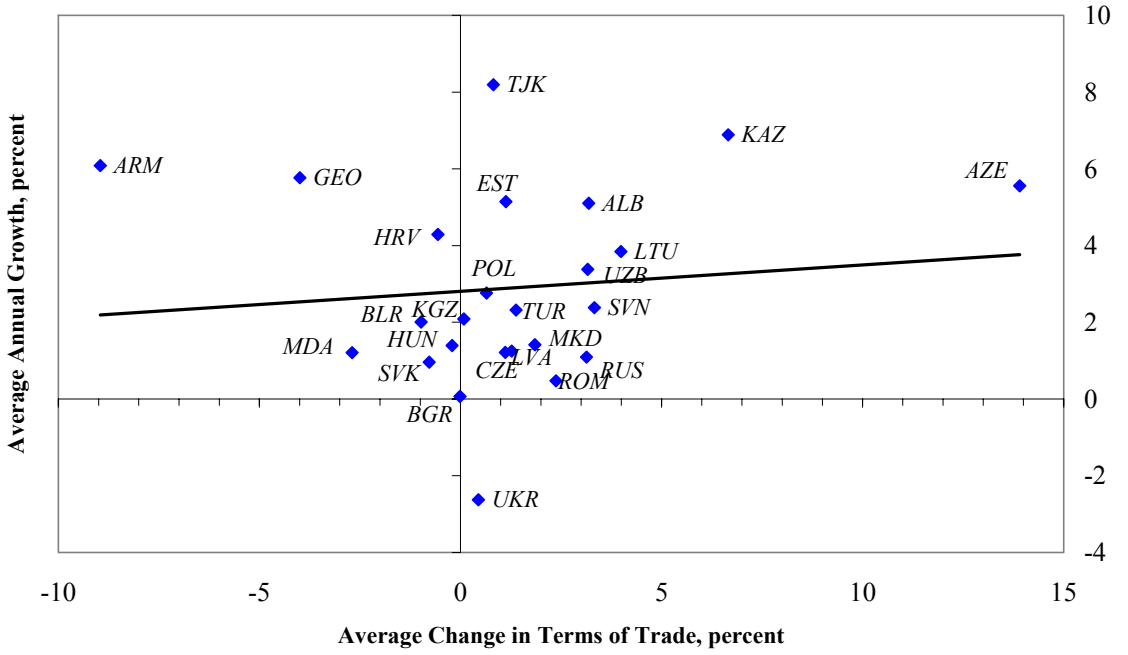
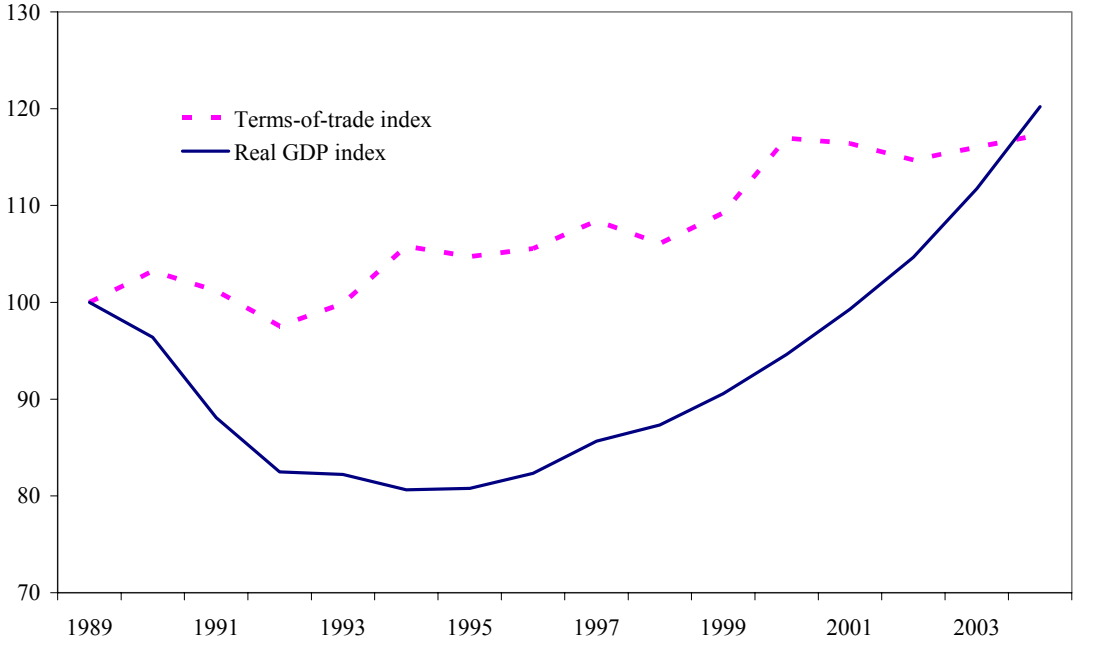


Figure 2. Terms of Trade and Real GDP in the ECA Region, Index, 1989=100



positive coefficient is estimated for the interaction between changes in the terms of trade and a regional dummy for the ECA countries.[10] All of the standard errors and significance levels reported in Table 1 have been calculated using the covariance estimator of Newey and West (1987), and are thus robust to heteroskedasticity and autocorrelation of the error terms.[11] None of the other regions defined in the World Development Indicators (WDI) shows as high an impact of the terms of trade on growth. For Sub-Saharan Africa, represented by 46 countries in the sample, we also estimate a significant impact of terms of trade on growth, but the impact, indicated by the coefficient on the regional interaction term, is only half as strong as in the ECA countries.

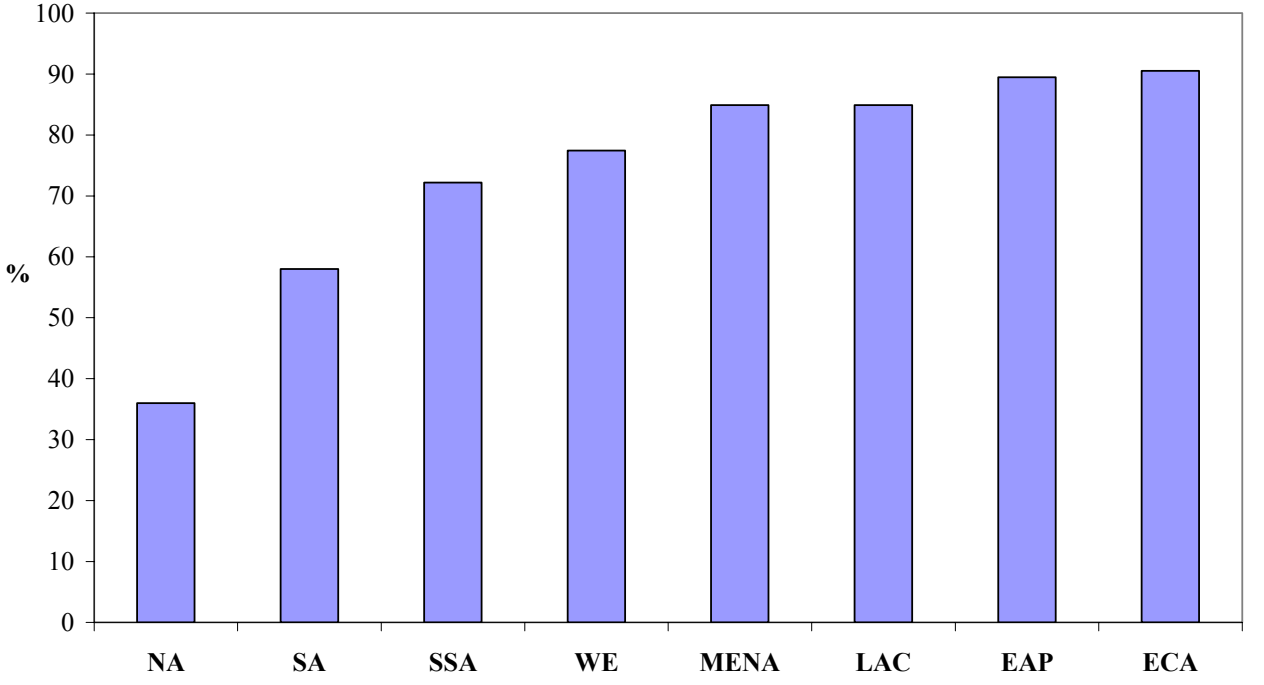
12. **The finding that growth in ECA countries has been more affected by changes in the terms of trade than the global average remains when we include standard control variables from the growth regression literature.** The second column (2) in Table 1 reports the results from a fixed effects regression that includes initial income per capita, population growth, partner country growth, the relative price of investment, and schooling as controls. For our purposes, it is of particular interest to note that the significance of the interaction term between the terms of trade and the ECA dummy increases when the controls are included.

13. **Why is growth in the ECA countries more sensitive to terms-of-trade fluctuations than in other regions of the world?** One possible answer is indicated by Blattman et al. (2006), who find that growth in countries with higher ratios of exports to GDP are more sensitive to changes in the terms of trade. Since it seems plausible that also imports in relation to GDP should matter for the impact of terms of trade on growth, we explore the significance of openness—measured as the ratio of exports plus imports to GDP—in our regressions. Figure 3 shows that the ECA region in fact is the most open region in the global sample (albeit closely followed by the East Asia and Pacific region).

[10] The coefficients on the interaction terms in this paper show how the growth impact of changes in the terms of trade depends on other variables. The coefficient reported for "TOT change" is conditional on the variables included in the interaction terms being equal to zero, and therefore varies with the specification.

[11] In estimating the standard errors, the lag length is set to a maximum of five years.

Figure 3. Average Openness by Region, Exports plus Imports as percent of GDP



NA =North America, SA=South Asia, SSA=Sub-Saharan Africa, WE=Western Europe, MENA=Middle East and North Africa, LAC=Latin America and Caribbean, EAP= East Asia and Pacific, ECA=Europe and Central Asia

14. **Including openness among the explanatory variables shows that the impact of terms of trade on growth is higher in economies with a higher degree of openness.** In column (3) of Table 1, the significant positive coefficient on the interaction term between terms-of-trade changes and openness indicates this.[12] Note, however, that the interaction term between the terms of trade and the ECA dummy remains significant (the *p*-value is 0.66), indicating that there must also be some other dimension in which the ECA countries are different and which explains their sensitivity to fluctuations in the terms of trade.

15. **We next explore the growth impact of terms-of-trade fluctuations in the CIS countries excluding Russia (CIS-11).** The 11 countries in this group (underlined in Appendix Table A1) are all small and open economies that depend heavily on relatively undiversified trade with Russia. We focus on this country group in order to better understand

[12] The negative coefficient on "TOT change" is for a notional country that is totally closed and outside of the ECA region (see footnote 3). Let TOT change = X_1. The country-specific terms of trade elasticity can be calculated as -0.067* X_1 + 0.08* X_1*ECA+ 0.0013* X_1*$openness$.

Table 1. Fixed Effects Regressions of GDP Growth on the Terms of Trade and Control Variables
Dependent variable: GDP per capita annual growth

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
TOT change	0.008	0.013	-0.067	-0.066	0.011	-0.067
	(0.012)	(0.011)	(0.031)**	(0.032)**	(0.009)	(0.033)**
TOT change*ECA	0.069	0.104	0.080			
	(0.035)*	(0.037)***	(0.043)*			
Initial GDP		-4.301	-4.875	-4.887		-4.888
		(0.732)***	(0.738)***	(0.738)***		(0.737)***
Population growth		0.561	0.602	0.598		0.595
		(0.302)*	(0.288)**	(0.290)**		(0.292)**
Partner growth		0.515	0.525	0.518		0.522
		(0.063)***	(0.064)***	(0.063)***		(0.064)***
Schooling		0.974	1.191	1.191		1.194
		(0.307)***	(0.305)***	(0.306)***		(0.307)***
Relative price of investment		0.710	0.622	0.627		0.621
		(0.282)**	(0.329)*	(0.329)*		(0.331)*
Openness			0.009	0.009		0.009
			(0.007)	(0.007)		(0.007)
TOT change*openness			0.0013	0.0013		0.0013
			(0.0006)**	(0.0006)**		(0.0006)**
TOT change*CIS-11				0.181		0.175
				(0.085)**		(0.087)**
TOT change*Regulatory Quality					-0.028	-0.009
					(0.016)*	(0.016)
Observations	5356	3282	3056	3056	5356	3056
R^2 - within	0.0016	0.0691	0.0964	0.0972	0.006	0.0976

Newey-West standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
For definitions of the variables and data sources, see Appendix.

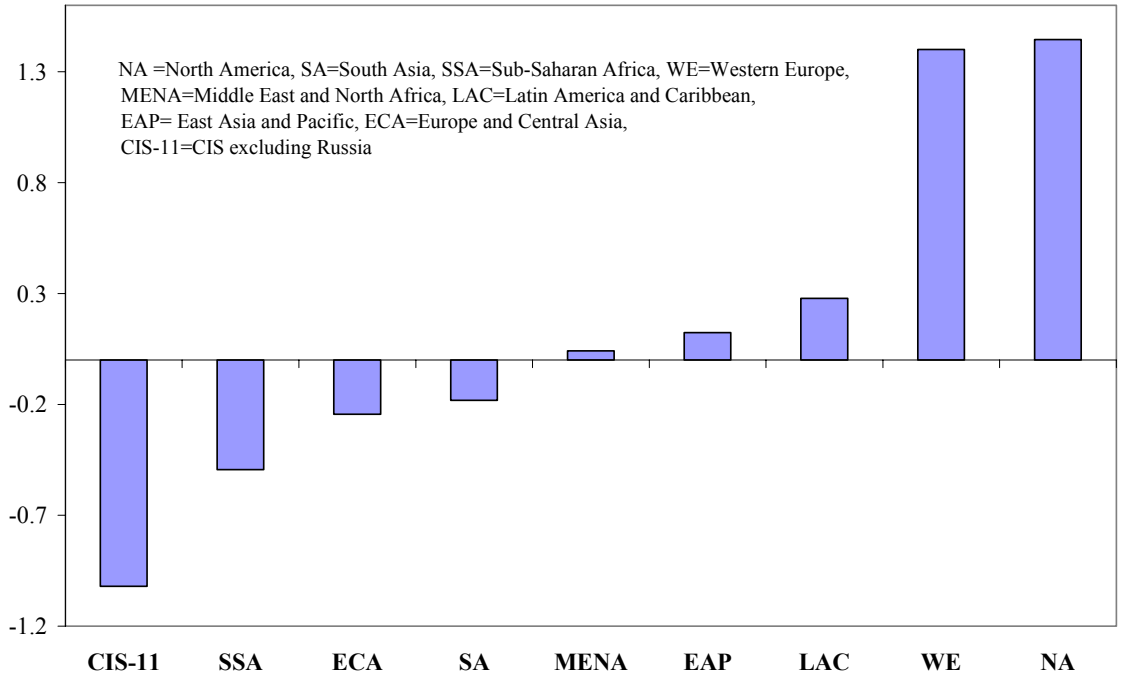
what lies behind the results for the ECA region, and to get a better estimate of the medium-term impact on growth that we can expect in Belarus.

16. **The results presented in column (4) of Table 1 show that growth in the CIS-11 countries is more sensitive to changes in the terms of trade than in ECA as a whole.** The

coefficient on the interaction between terms of trade and the regional dummy for the CIS-11 is considerably larger than the coefficient for the whole of ECA reported in column 3.[13]

17. **What could be different about the CIS-11 countries that causes their economies to be so sensitive to fluctuations in the terms of trade?** Figure 4 shows that the CIS-11 economies show greater signs of economic rigidity and score lower in market-conform regulatory attainment than other regions on average.[14] One conjecture is that price controls, and excessive regulation in foreign trade and business, could make it harder for the CIS-11 to achieve smooth real adjustments in response to terms-of-trade fluctuations.

Figure 4. Average Regulatory Quality by Region



[13] A regression (not reported) including both the ECA and the CIS dummies further indicates that the results for the ECA region to a large extent are driven by the CIS countries excluding Russia.

[14] As a proxy in the regressions, we use the "Regulatory Quality" indicator developed by Kaufmann and others (2005), which measures the incidence of market-unfriendly policies, such as price controls or inadequate bank supervision, as well as perceptions of the burdens imposed by excessive regulation in areas such as foreign trade and business development.

18. **The regression in column (5) of Table 1 shows that growth in countries that are more rigid and have lower regulatory quality is more sensitive to terms-of-trade fluctuations.** The *p*-value for the interaction term between the terms of trade and regulatory quality is 0.07. However, when adding the same interaction term to our main regression in column (4), the sign of the coefficient remains, but it loses its significance, as reported in column (6). The interaction term for the CIS-11 furthermore remains large and significant in column (6), implying that there is something else about the CIS countries that makes growth more sensitive to terms-of-trade fluctuations.

19. **Based on the regression results, we estimate the elasticity of growth with respect to the terms of trade to be around 0.3 for Belarus.** Combining the coefficients in column (4) of Table 1 with the fact that exports plus imports on average amounted to 120.6 percent of GDP in Belarus between 1993 and 2004, we arrive at an estimated elasticity of growth with respect to the terms of trade of 0.27. This implies that the 11.3 percent deterioration in the terms of trade projected for 2007 in the risk scenario in the staff report—where staff tentatively assume that gas prices rise to $95/tcm while effective oil prices start converging to world market levels—can be expected to reduce growth by 3.1 percent. In light of the medium-term price projections in the risk scenario—with gas and oil prices converging to world market levels by 2012—we would expect a cumulative growth loss of roughly 10 percentage points by 2011.

F. Conclusions and Policy Implications

20. **The analysis has shown that the transition economies in Europe and Central Asia, and in particular the CIS-11, are more sensitive to terms-of-trade fluctuations than other regions of the world.** The results are robust to changing the countries in the sample, to changing the time period considered, as well as to the econometric specification.

21. **Part of the explanation is that the ECA countries are extremely open to trade, and that the CIS-11 in addition are more economically rigid than other regions.** While openness and economic rigidity provide a part of the explanation, controlling for these variables does not fully explain why growth in the CIS-11 is more sensitive to terms of trade fluctuations than in other regions. We leave it for future research to investigate other characteristics of the CIS-11 that can further explain the high sensitivity of growth to terms-of-trade fluctuations.

22. **The estimated elasticity of growth to the terms of trade for Belarus is likely to be a lower bound for the actual elasticity.** First, the estimated elasticity of roughly 0.3 does not take into account that Belarus has a fixed exchange rate regime, which according to Broda (2004) makes growth more sensitive to fluctuations in the terms of trade. Second, the estimated elasticity does not include the effects of regulatory quality and economic rigidity,

which are likely to be particularly large in Belarus. According to the World Bank Governance Indicators in Kaufmann and others (2005), the regulatory quality in Belarus is much lower than in the CIS-11 on average, and ranks as the third worst among the 178 countries in the sample (after Turkmenistan and Libya). A third factor is that Belarus has a higher degree of export concentration than its neighbors, both in terms of companies and goods (World Bank, 2005).

23. **In light of the results, policies aimed at enhancing the flexibility of the Belarusian economy could usefully be combined with a countercyclical stance in the overall policy mix as discussed in the staff report.** In addition, it would be desirable to further develop fiscal and monetary policy tools to augment their shock-absorbing abilities. Perhaps more importantly, Belarus would need to implement wide-ranging structural reforms to decentralize and deregulate the economy so as to enhance its flexibility.

APPENDIX I. Table A1. Countries in the Sample

Albania	Dominica	Lao People's Dem.Rep	Samoa
Algeria	Dominican Rep.	*Latvia*	Sao Tome and Principe
Angola	Ecuador	Lebanon	Saudi Arabia
Antigua and Barbuda	Egypt	Lesotho	Senegal
Argentina	El Salvador	Libya	*Serbia and Montenegro*
Armenia	Equatorial Guinea	*Lithuania*	Seychelles
Australia	Eritrea	Luxembourg	Sierra Leone
Austria	*Estonia*	*Macedonia, FYR*	Singapore
Azerbaijan	Ethiopia	Madagascar	*Slovak Rep.*
Bahamas, The		Malawi	*Slovenia*
Bahrain	Fiji	Malaysia	Solomon Islands
Bangladesh	Finland	Maldives	South Africa
Barbados	France	Mali	Spain
Belarus	Gabon	Malta	Sri Lanka
Belgium	Gambia, The	Mauritania	St. Kitts and Nevis
Belize	***Georgia***	Mauritius	St. Lucia
Benin	Germany	Mexico	St. Vincent and the Grenadines
Bhutan	Ghana	***Moldova***	Sudan
Bolivia	Greece	Mongolia	Suriname
Bosnia and Herzegovina	Grenada	Morocco	Swaziland
Botswana	Guatemala	Mozambique	Sweden
Brazil	Guinea	Myanmar	Switzerland
Brunei Darussalam	Guinea-Bissau	Namibia	Syrian Arab Rep.
Bulgaria	Guyana	Nepal	Taiwan Prov.of China
Burkina Faso	Haiti	Netherlands	***Tajikistan***
Burundi	Honduras	Netherlands Antilles	Tanzania
Cambodia	Hong Kong, China	New Zealand	Thailand
Cameroon	*Hungary*	Nicaragua	Togo
Canada	Iceland	Niger	Tonga
Cape Verde	India	Nigeria	Trinidad and Tobago
Central African Rep.	Indonesia	Norway	Tunisia
Chad	Iran, Islamic Rep.	Oman	*Turkey*
Chile	Ireland	Pakistan	***Turkmenistan***
China,P.R.: Mainland	Israel	Panama	Uganda
Colombia	Italy	Papua New Guinea	***Ukraine***
Comoros	Jamaica	Paraguay	United Arab Emirates
Congo, Dem. Rep.	Japan	Peru	United Kingdom
Congo, Rep.	Jordan	Philippines	United States
Costa Rica	***Kazakhstan***	*Poland*	Uruguay
Croatia	Kenya	Portugal	***Uzbekistan***
Cyprus	Kiribati	Qatar	Vanuatu
Czech Rep.	Korea, Rep.	*Romania*	Venezuela, Rep. Bol.
Cote d'Ivoire	Kuwait	*Russian Federation*	Vietnam
Denmark	***Kyrgyz Rep.***	Rwanda	Yemen, Rep.
Djibouti	Lao People's Dem.Rep	Samoa	Zambia
			Zimbabwe

Table A2. Data Sources and Definitions of the Variables Used in the Econometric Analysis

Growth is annual percentage growth in real GDP per capita in PPP terms (chain weighted) from the Penn World Tables (PWT) Version 6.1 (http://pwt.econ.upenn.edu), supplemented and extended by data from the World Development (WDI) and World Economic Outlook (WEO) databases.

Rate of change in the terms of trade (TOT change) is from the WEO, calculated as the annual percentage change in the ratio of the export price deflator to the import price deflator.

Initial GDP is the log of lagged real GDP per capita in PPP terms from the PWT.

Population growth is from the WDI data, supplemented when missing with PWT data.

Partner growth is from the WEO, calculated as the average growth in partner countries, weighted by their shares in total exports

Schooling is taken from the Barro-Lee educational attainment data set (http://post.economics.harvard.edu/faculty/barro/data.html), and is defined as the average number of years of secondary and higher education in the male population. For countries not covered by Barro and Lee, we follow Schadler and others (2006) and regress the Barro-Lee data on secondary and tertiary enrollment rates from the WDI and use predicted values from that regression.

Relative price of investment is taken from the PWT, calculated as the ratio of the investment price deflator to the GDP deflator.

Openness is from the WEO, and is calculated as the sum of exports and imports as a percentage of GDP.

Regulatory Quality is the sample average of the Regulatory Quality indicator from the World Bank governance indicators in Kaufmann and others (2005), and measures the incidence of market-unfriendly policies, such as price controls or inadequate bank supervision, as well as perceptions of the burdens imposed by excessive regulation in areas such as foreign trade and business development.

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