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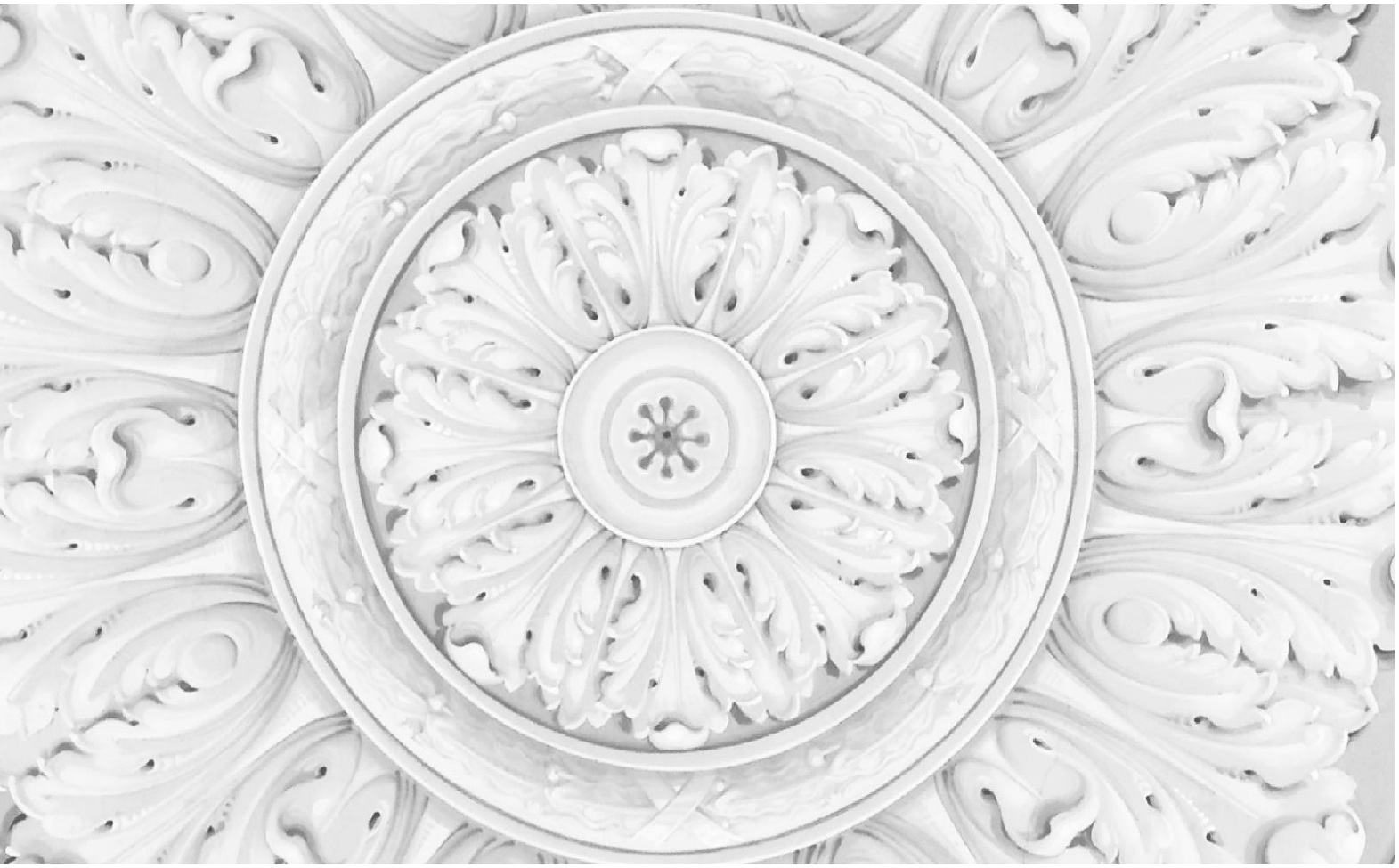

## WORKING PAPER SERIES

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# The role of regional and sectoral factors in Russian inflation developments

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**Abstract**

This paper examines the relative roles of region-specific and commodity-specific developments in the consumer price setting in Russia. For this purpose, we estimate a dynamic hierarchical factor model using inflation rates across regions and sectors. We found little evidence of association between region-specific factors and inflation developments, although there are several regions (mostly located in the Far East and North Caucasus) where the idiosyncratic component may contribute substantially. Conversely, the role of cross-commodity relative price changes in inflation developments in Russia is substantial.

**Keywords:** dynamic hierarchical factor model, regional inflation, relative prices, Russia

**JEL classification: C38, E31, D4.**

# Contents

## INTRODUCTION

Identification of cross-regional and cross-commodity inflation patterns provides monetary policymakers with crucial knowledge on the background mechanisms driving aggregate inflation. There are several reasons why cross-regional inflation heterogeneity may be important for monetary policymaking. As Yilmazkuday (2013) notes, persistent differences in inflation across regions can suppress output growth in relatively low-inflation regions due to a higher real interest rate in the presence of common monetary policy. Consequently, inflationary pressure can keep falling in low-inflation regions and rising in high-inflation regions due to this feedback loop. Regional inflation divergence can thus be a self-reinforcing mechanism that impacts the regional development processes that policymakers might be interested in monitoring and shaping. Additionally, if inflation differentials are caused by discrepancies in price stickiness, then regions with stickier prices bear a disproportionally large share of the adjustment after a monetary shock. Benigno (2004) suggests that central banks should overweigh regions with higher nominal rigidity and underweigh more flexible regions to avoid excessive total welfare loss.

Another key question for monetary policymakers is how to address 'relative price' shocks, i.e., movements in commodity-specific prices that do not reflect aggregate inflationary pressure but that can lead to temporary changes in inflation. The welfare effects of these price changes are potentially large and may have important implications for the design of monetary policy. For example, in one-sector models, optimal monetary policy involves stabilizing the aggregate price level, but research by Aoki (2001), Benigno (2004), Huang and Liu (2005) and Erceg and Levin (2006) indicates that this strategy may be suboptimal in an economy where sectors are characterized by different degrees of nominal rigidity.

It is therefore not surprising that there is ample empirical literature investigating the role of the aforementioned factors in inflation developments (García-Cintado et al. 2015; Beck et al. 2016). In this study, we analyzed inflation rates across different regions and sectors in Russia using a multilevel factor model suggested by Moench et al. (2013). This newly developed methodology achieves dimension reduction yet explicitly allows for heterogeneity between data blocks. Region-specific and commodity-specific shocks are distinguished from genuinely common shocks, and the estimated regional and sectoral factors are easily interpreted. This approach is novel for Russia; previous studies have applied factor analysis in either sectoral (Deryugina et al. 2017) or regional (Perevyshin and Egorov 2016) dimensions, but not in both. We found little evidence of region-specific trends

in inflation rates, although prices in some regions are clearly more susceptible to idiosyncratic shocks. We also found that a large share of inflation developments were associated with changes in relative prices.

The remainder of this paper is structured as follows. Section 1 presents the data and some considerations about inflationary developments in Russia. Section 2 outlines the econometric methodology. Section 3 discusses the empirical results, and final section concludes.

## 1. LITERATURE REVIEW AND INFLATION DEVELOPMENTS IN RUSSIA

The potential origins of differences in regional inflation developments are reported in numerous theoretical studies and supported by empirical studies. For example, Altissimo et al. (2005) present a theoretical model of monetary union with two countries. In this framework, they show that asymmetric productivity shock leads to inflation differentials. As for empirical work, a set of potential determinants of inflation differentials has been examined in the empirical literature related to European countries. According to Beck et al. (2009), these determinants may be classified as follows:

- Different phases of the business cycles. Regions with high aggregate demand are likely to experience simultaneously higher price growth. In contrast, regions that experience a slowdown in economic activity might experience lower inflation.
- Asymmetric reaction to countrywide shocks. Regions might differ in sectoral specialization and openness to international trade. For example, the higher the share of imported goods is, the stronger the effect of exchange rate fluctuations on the inflation rate in a region.
- Differences in the labor market, which might also lead to differentials in wage changes. This occurs because the labor force is not perfectly mobile and the labor market is geographically segmented. Differentials in wage changes reflect differences in labor costs. As a consequence, inflation outcomes differ across regions.
- Costs of non-traded input factors, such as rent and utilities. These markets are even more segmented than the labor market. Thus, differences in input cost changes might be reflected in inflation rate differentials.
- Nominal wage and cost rigidities. As regions asymmetrically react to countrywide shocks, the adjustment process may take a different amount of time, thus giving rise to inflation differentials. This factor is closely associated with the degree of competition in

regions. In a highly competitive environment, firms are not able to keep prices and costs unchanged for a long period of time.

De Haan (2010) and García-Cintado et al. (2015, 2016) also use very similar classification of inflation differential sources.

Potential origins of volatility in relative sectoral prices have also been thoroughly discussed in the literature. Peach et al. (2004), Helbling et al. (2006), Özcan and Kalafatcilar (2009), ECB (2009), and Binici et al. (2012) outline the most important factors influencing cross-commodity differentials:

- Changes in productivity. Real wage increases do not affect profit margins only in sectors that enjoy productivity gains. Because of labor mobility, companies in other sectors must increase real wages in order to avoid labor outflow to sectors with already higher real wages. However, without support by productivity gains, increasing wages means a loss in profit margin. To remain profitable, companies raise their prices, which means that prices will grow faster in sectors where productivity improvements are slower. According to Cagliarini and McKibbin (2009), this factor was the major driver of relative price shocks in the USA from 2002 to 2008.
- Increased international competition. Prices tend to grow more slowly in those markets where the share of imports from countries with a low cost of production is high.

Other reasons for differentials in cross-commodity price changes may be roughly divided into two groups: supply-side factors and demand-side factors. As producers face different environments in various markets, their price setting policy may differ. Several supply-side factors can be highlighted:

- Market power. In addition to competition from imported goods, companies may suffer from different degrees of competition within the country. Producers with market power may increase prices more than producers without market power. As a result, prices may grow faster in sectors where market concentration is high.
- Exchange rate sensitivity. As noted in Özcan and Kalafatcilar (2009), markets with high dependence on imports (a high share of imported consumer goods or a high share of imported components in costs) react more strongly to exchange rate fluctuations.
- Commodity world price fluctuations. Even if the exchange rate is stable, companies producing different goods face unequal changes in costs because they use different commodities. In particular, this concerns internationally traded commodities and food prices.

- Regulation. Price setting in certain sectors may be administratively regulated. Furthermore, changes in taxation may affect producers' costs and therefore price setting.
- Price rigidities. Price persistence may vary across commodities, leading to relative price movements (Özcan and Kalafatcilar (2009), Mankiw and Reis (2003)).

Demand as well as supply is important for resulting price changes. Two groups of demand-side factors are crucial:

- Income elasticity of demand. The response to an increase in income may be different across sectors. Assuming the same income growth, the demand growth for superior goods is larger than that for necessity goods. Özcan and Kalafatcilar (2009) and ECB (2009) argue that this is one of the main factors explaining the divergence between goods and services inflation.
- Preference changes. Every season, consumers are offered new goods and services. Advertising may make them desirable for consumers, making the consumers ready to pay without hesitation. During this period, considerable price increases may occur. As noted in Parks (1978), another factor is family composition and distribution of age groups in the population.

### 1.1 Inflation developments in Russia: some considerations

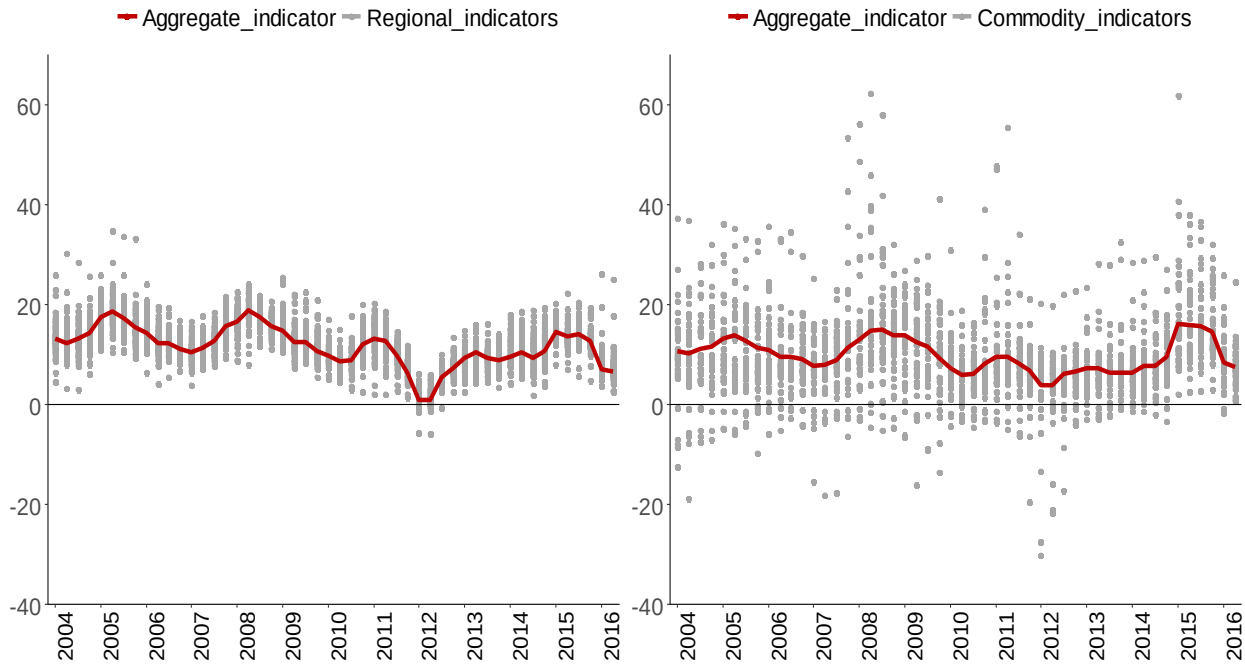
In our study, we analyze the dynamics of the components of monthly consumer price index (CPI) inflation rates of 40 product-level categories for each of the 79 regions of Russia from December 2003 to June 2016. [1] Data are drawn from EMISS[2]. Figure 1 shows growth in the price of a uniform fixed basket of consumer goods and services (on aggregate in Russia and across its regions) on the left panel as well as individual price indices of the 40 product-level categories on the right panel. Note that regional consumer price indices are estimated using region-specific consumption structures. To exclude this source of cross-regional variation, we plot the growth of price of a uniform fixed basket of consumer goods and services in Russia on the left panel (on the right panel, we plot the headline CPI measure).

The data show that both cross-commodity and cross-regional variations in inflation are substantial, although the magnitude of the standard cross-commodity deviation of inflation rates (8%) is much higher than that of the cross-regional standard deviation (2.5%).

[1] Chechen Republic, Republic of Crimea and Sevastopol are not included due to the lack of data. The regions consisting of several autonomous okrugs (Tyumen Oblast, Arkhangelsk Oblast) are treated as single entities. Additionally, the following five time series are excluded for the same reason: "Sanatoria and Health-Improvement Services" in Kalmykia, Amur Oblast and Chucotka Autonomous Okrug, "Alcoholic Beverages" in Ingushetia and "Passenger Cars" in Chucotka Autonomous Okrug.

[2] https://fedstat.ru/indicator/31074

**Figure 1. Inflation across regions and commodities (year-over-year growth, %)**




*Sources: Rosstat.*

## 1.2 Regional prices in Russia after price liberalization: a convergence/divergence?

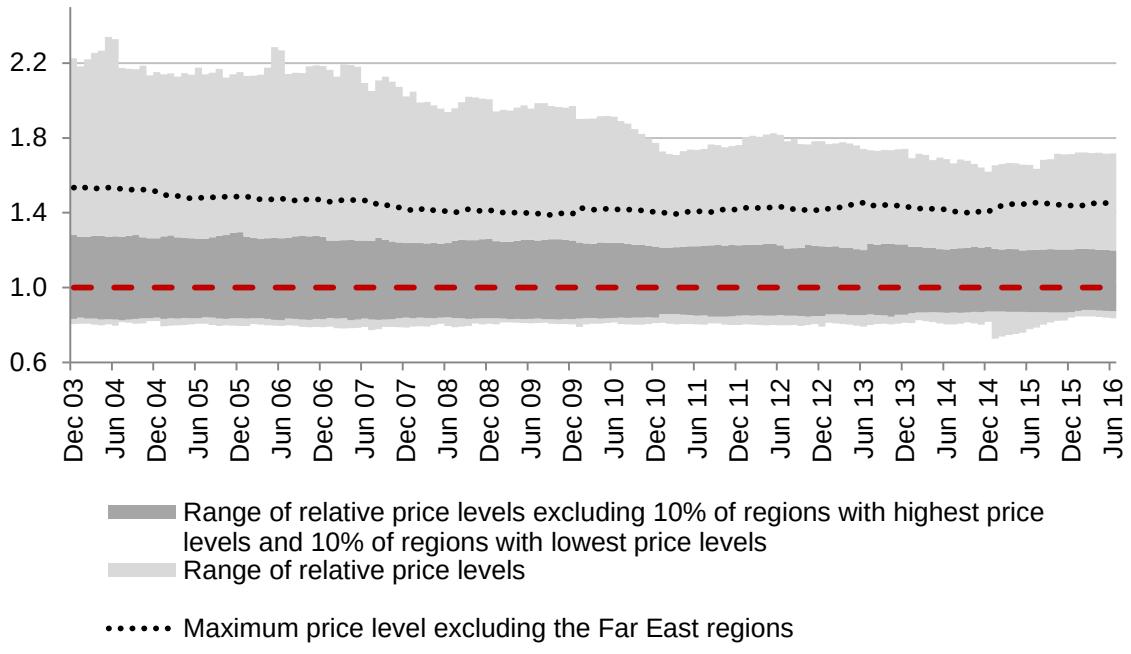
Another important factor that can affect inflation rates across regions is price level convergence. In the case of price convergence to an equilibrium level, inflation rates in regions with an initially high price level might be lower than those in regions with an initially low price level. Rogers (2001), Honohan and Lane (2003), Arnold and Verhoef (2004), and Andersson et al. (2009) conclude that inflation rates are negatively associated with previous price levels. Hofmann and Remsperger (2005) do not find this relationship, but they argue that this might be one of the reasons for inflation differentials.

As price levels depend on the distances between regions (see, for instance, Engel and Rogers (1994), Beck and Weber (2001), Baba (2007)) infrastructure improvement may lead to decreases in price dispersion among regions. Moreover, in the case of convergence/divergence of economic development across regions, price levels also converge/diverge. For example, Kurlyandskaya and Golovanova (2006) emphasize regional political decentralization during the 1990s. This was followed by an increase in economic development variation across regions, as Benini and Czyzewski (2007) show. As a result, inequality in economic development across Russian regions was extremely high in 2009 (Kaneva and Untura 2017; Iwasaki and Suganuma 2015). Malkina (2015) argues that during

the 2000s, the opposite process of convergence of economic development across regions occurred. Following the processes in economic development, price levels also diverged in the 1990s, as Gluschenko (2001) shows, but this divergence stopped in the 2000s. This process is widely studied using tests for the rule of one price (see, for instance, Gluschenko (2011, 2016, 2017), Perevyshin (2017)). Unequivocal evidence for divergence or convergence processes after 2000 was not found.

Figure 2 shows the evolution of regional price levels (in terms of the price of a uniform consumer goods basket). In general, cross-regional price level variation has been decreasing over the last 15 years. This reduction is mainly driven by lower inflation rates in regions with the highest price levels. However, if we consider a somewhat smaller sample of regions, excluding several regions with the lowest and highest price levels, the convergence process becomes less evident. Exclusion of the nine Far East regions also results in only slight decreases in price dispersion over time. The decreased variation in regional price levels can be explained only by the dynamics of the small number of regions with the highest prices (this also holds true for alternative subsamples: food products, non-food products and services). However, there is no unequivocal evidence for convergence of prices. This conclusion is in line with the findings reported by Gluschenko (2016, 2017).

**Figure 2. Distribution of price levels (as ratios to the median) across regions**




*Sources: Rosstat, authors calculations.*

## 2. MODEL

We use a dynamic hierarchical factor model approach, following Moench et al. (2013), and employ the specification with region-specific and product-specific blocks.

$$Z_{nrt} = \lambda_H H_{rt} + e_{Znrt} \quad (1)$$

$$E_{Znpt} = \lambda_G G_{pt} + e_{Enpt} \quad (2)$$

$$\begin{bmatrix} H_{rt} \\ G_{pt} \end{bmatrix} = \begin{bmatrix} \lambda_{FH} \\ \lambda_{FG} \end{bmatrix} F_t + \begin{bmatrix} e_{Hrt} \\ e_{Gpt} \end{bmatrix} \quad (3)$$

where:

$Z_{nrt}$ is the initial data (i.e., *N* individual CPI subcomponents across regions and commodities, $n = 1 \dots N$),[3] arranged by region blocks $r = 1 \dots BR$ for each time series observation $t = 1 \dots T$. Note that we apply our analysis to the individual unweighted CPI subcomponents and thus avoid the problem of spurious variation due to different regional CPI weighting schemes[4].

$H_{rt}$ is region-specific factors of regional blocks $r = 1 \dots BR$.

$G_{pt}$ is product-specific factors of product blocks $p = 1 \dots BP$.

$E_{Znpt}$ is the idiosyncratic components $e_{Znrt}$ of (1) rearranged by product block.

$F_t$ is common factors.

$e_{Enpt}$, $e_{Hrt}$, and $e_{Gpt}$ are idiosyncratic components of (2) and (3).

$\lambda_H$, $\lambda_G$, $\lambda_{FH}$, and $\lambda_{FG}$ are factor loadings.

We assumed that idiosyncratic components are block specific and that common factors are stationary, normally distributed autoregressive processes AR (1). The number of observations in our dataset is $T = 150$. The number of region-specific blocks is equal to the number of Russian regions considered, $BR = 79$, and the number product-specific blocks equals the number of product-level categories, $BP = 40$. Accordingly, the total number of series in the dataset $N = 3155$ (five specific series are excluded, see footnote 1). Initial parameter values were estimated by the principal component method (standard PCA). We

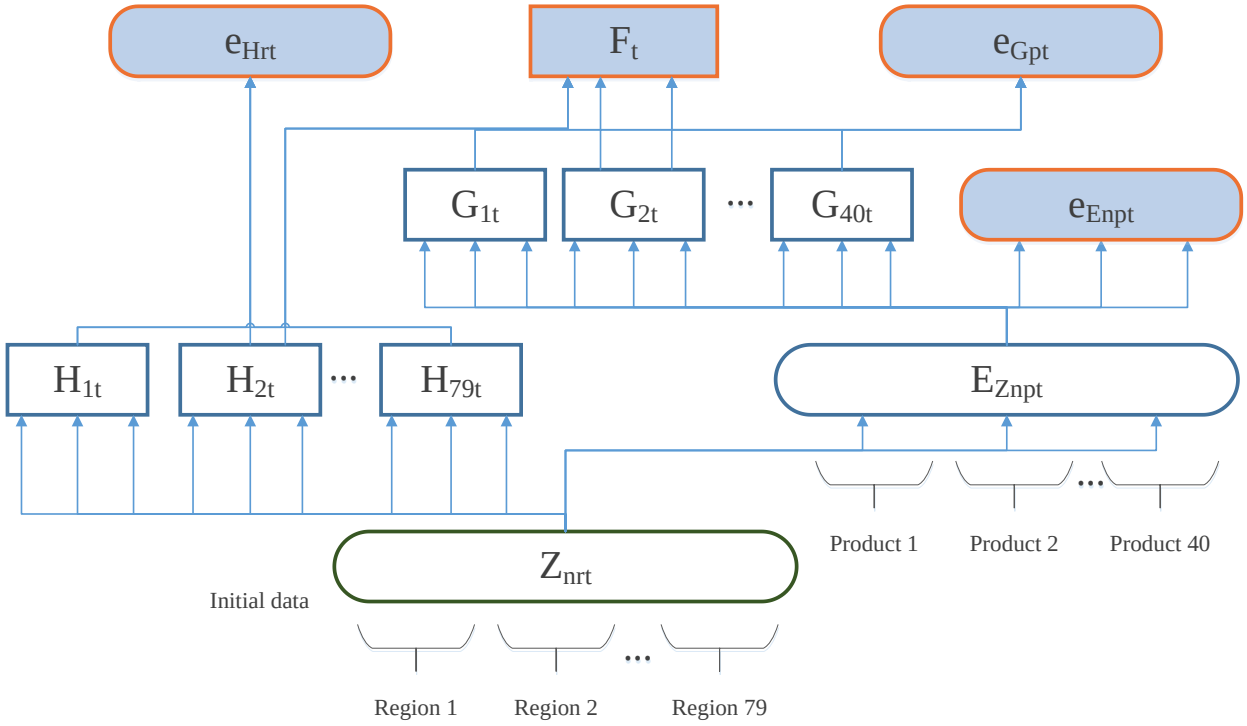
[3] All time series are in the form of standardized seasonally adjusted monthly growth rates. Seasonal adjustment was made in JDemetra+ using the TRAMO/SEATS model (RSA3 specification). The results of the panel and individual ADF tests (with lag length selected using BIC criteria) indicate that the series are stationary.

[4] Admittedly, the subcomponents of CPI that we use are still aggregates, and their calculation involves weighting (albeit at a different level and presumably with a smaller distortion effect).

then applied a Markov chain Monte Carlo (MCMC) algorithm with 20,000 iterations; after a 10,000 iteration burn in, every 200th draw was stored.

Figure 3 presents the model's layout. In (1), we arranged data in region blocks and extracted region-specific factors $H_{rt}$, reflecting the common price dynamics for each region. Next, we rearranged idiosyncratic components of (1) to product categories blocks $E_{Znpt}$. In (2), product-specific factors $G_{pt}$were extracted from these blocks. In (3), we extracted common factors $F_t$ from the pool of region-specific and commodity-specific factors. Thus, $e_{Hrt}$ and $e_{Gpt}$ represent a clear effect from regional or product price dynamics, respectively. Idiosyncratic components of (2), i.e., $e_{Enpt}$, characterize individual price features, which are not dependent on any block-level or common factors.

**Figure 3. Data blocks in the dynamic hierarchical factor model**




We employ the following number of factors: $K_F = 2$ common factors, $K_H = 82$ region-specific factors and $K_G = 54$ product-specific factors. They were identified according to the formal information criteria outlined by Bai and Ng (2002), with a penalty function $g(N_b, T) = \frac{N_b+T}{N_b T}\ln(\min(N_b, T))$, where $N_b$ is the number of series in the block $b$ and $T$ is the number of observations. We use no more than two factors from each block because of the computation

complexities that arise due to a large number of blocks. Tables 1 and 2 in the Appendix report the selected number of each block-specific factor.

As a robustness check, we estimated model parameters using an alternative order of factor extraction. We started by estimating product-specific factors $G_{pt}$. Next, we derived region-specific factors $H_{rt}$ from the set of idiosyncratic components obtained in the previous step. Finally, as in the benchmark model, common factors $F_t$ were extracted from the block-specific factors $G_{pt}$ and $H_{rt}$. The results obtained with this specification were broadly similar to the benchmark (see Figure 13 in the Appendix).

## 3. EMPIRICAL RESULTS

### 3.1. Variance decomposition

We proceed by calculating the decomposition of variance of the inflation series. Namely, we represent each $Z_{nrt}$ as

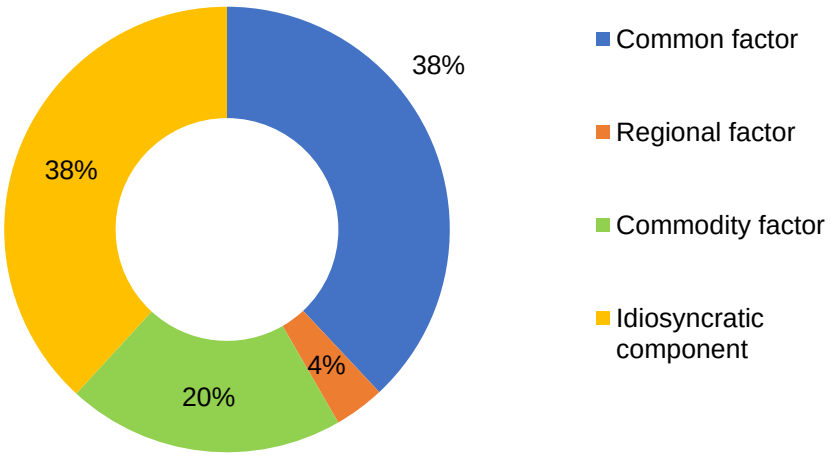
$$Z_{nrt} = \lambda_H \lambda_{FH} F_t + \lambda_G \lambda_{FG} F_t + \lambda_H e_{Hrt} + \lambda_G e_{Gpt} + e_{Enpt}$$

and decompose the variance in line with the approach by Moench et al. (2013).

This variance decomposition reflects the relevant importance of identified factors in explaining the inflation developments. The results for the average[5] measure of inflation variation across all commodities and regions are presented in Figure 4. Fluctuations of common factors account for 38% of total variance, while commodity factors explain 20%. The share of aggregate inflation developments associated with regional factors is quite small (4%), although the presence of idiosyncratic shocks is substantial (38%).

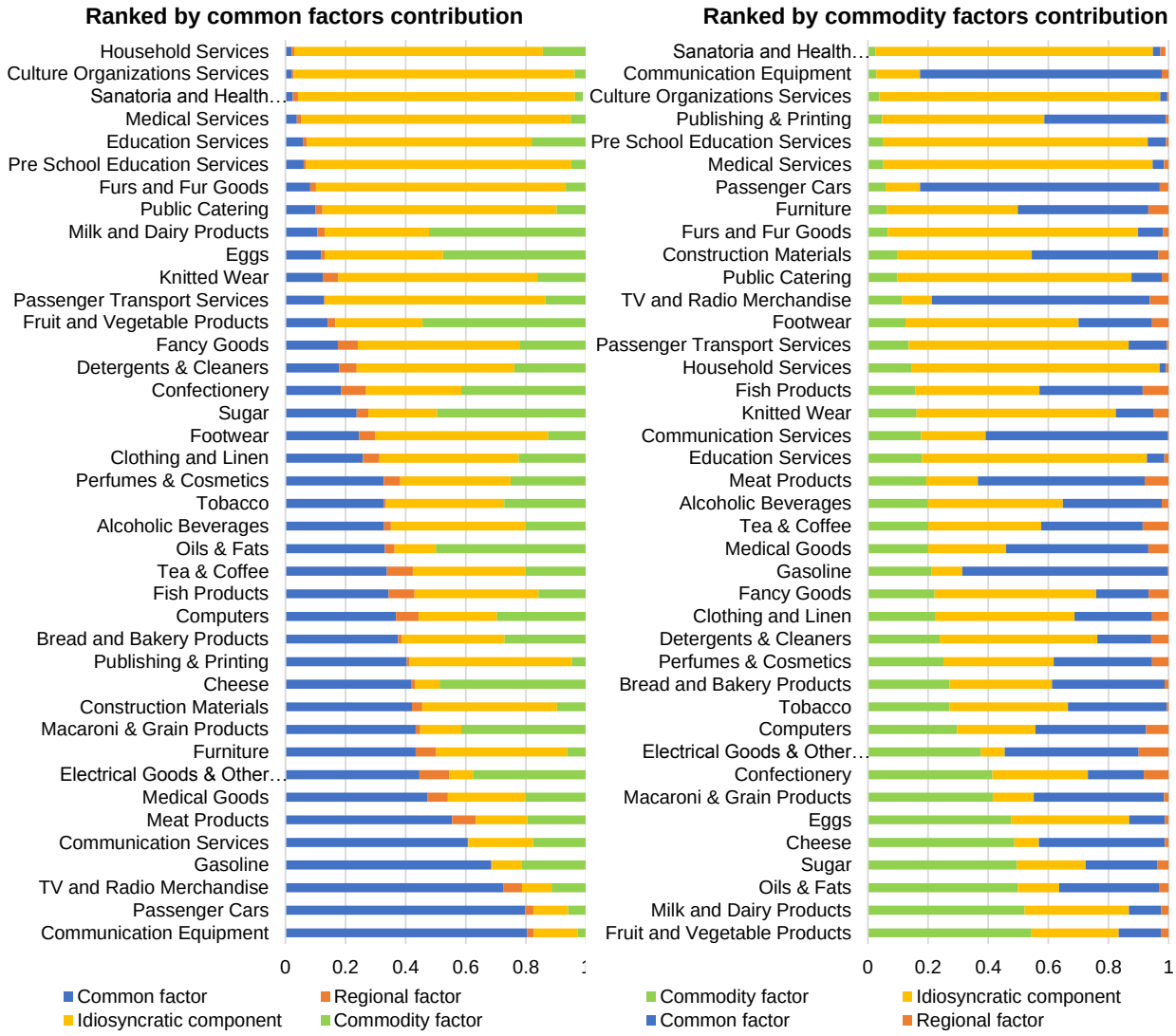
[5] The averages are constructed as follows. Sectoral averages are calculated by averaging inflation variation across regions using weights based on the gross regional product in 2015 (the use of population-based weights yields similar results). Regional averages are calculated by averaging inflation variation across sectors in accordance with the corresponding composition of consumption spending in 2015.

**Figure 4. Decomposition of overall variance of the inflation rate**



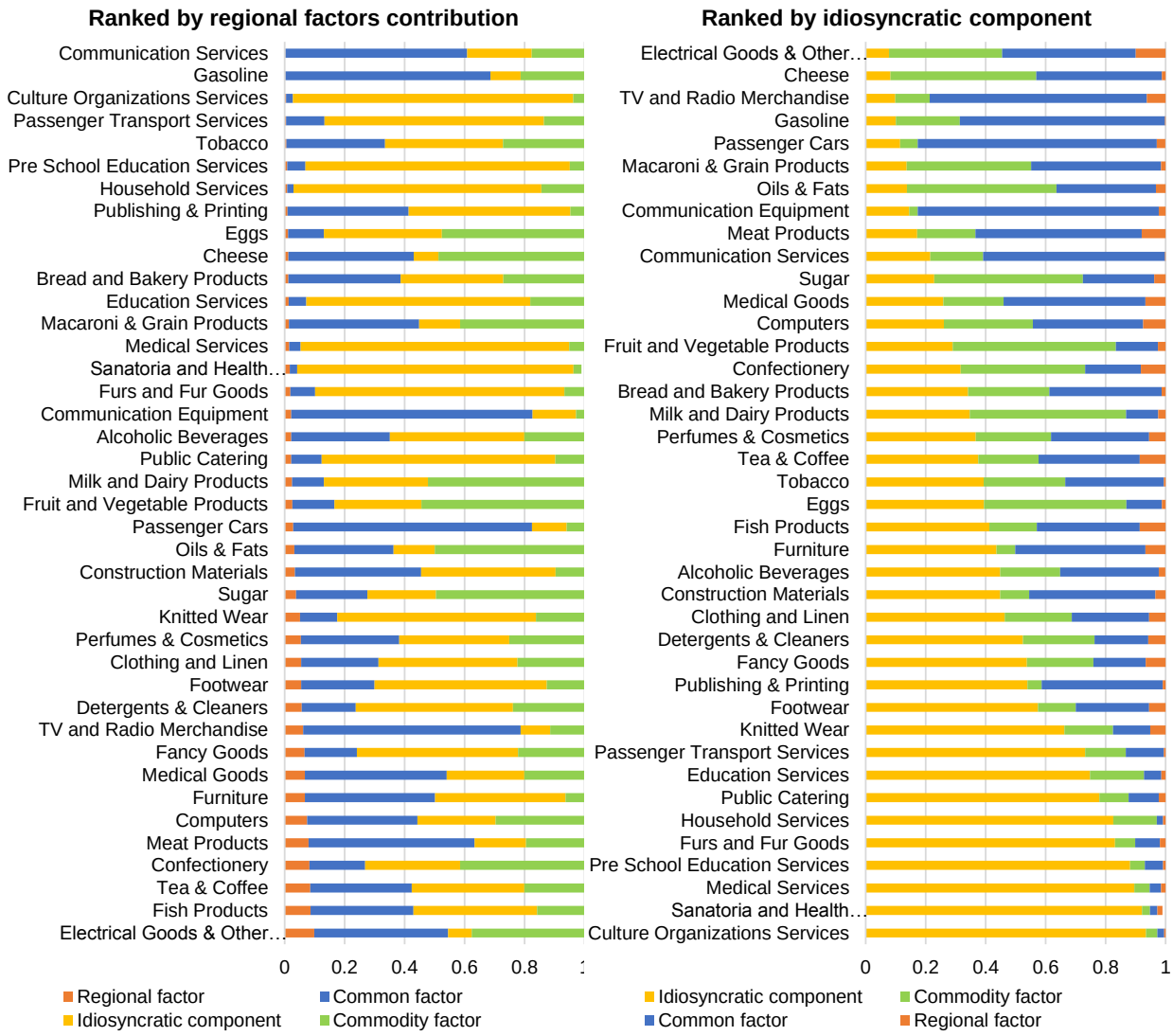

We next examined subaggregate variation of price indices. Non-food products accounted for the largest part of the variation explained by common factors (Figure 5). Conversely, commodity-specific factors were most important in food inflation developments (Figure 6). This observation may be explained by the dominance of supply-side shocks in food prices, such as those associated with weather conditions, whereas the aggregate demand shocks that are common across regions mostly determine inflation of non-food prices.

**Figure 5. Variance decomposition of inflation across commodities**




The role of regional factors was generally quite low (Figure 6), while the influence of the random factor (idiosyncratic shocks) was found to play a crucial role for a number of non-tradable sectors (mostly services with regulated prices).

**Figure 6. Variance decomposition of inflation across commodities**




Regional aggregates generally showed a low contribution to inflation variation (Figure 7); however, there was substantial heterogeneity across regions in terms of the importance of idiosyncratic shocks. The idiosyncratic component contributed most in territories in the Far East and North Caucasus areas (Figure 8), with exceptions such as Belgorod and Murmansk Oblast.

**Figure 7. Variance decomposition of inflation across regions ranked by the sum of regional and idiosyncratic components**

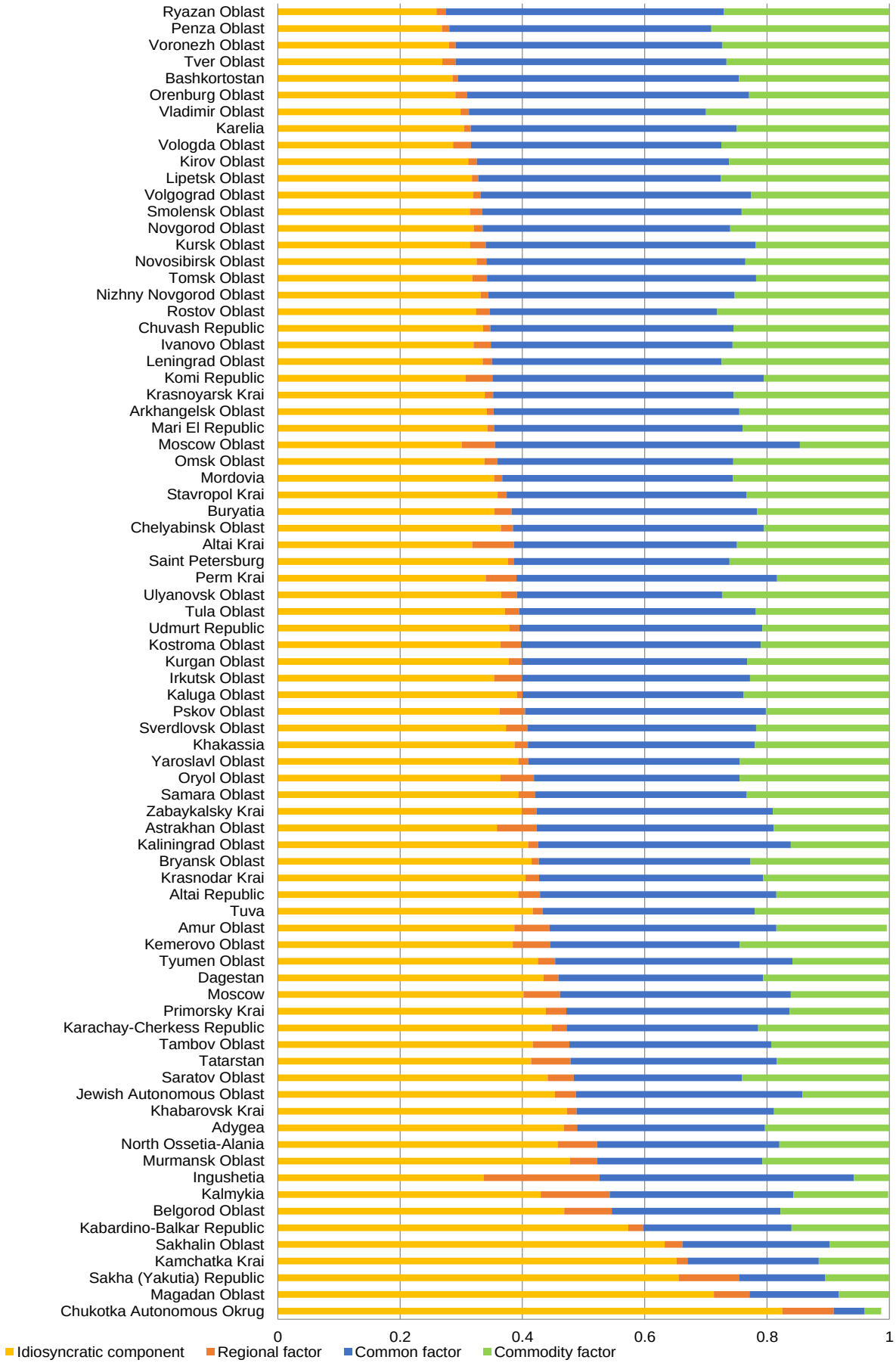
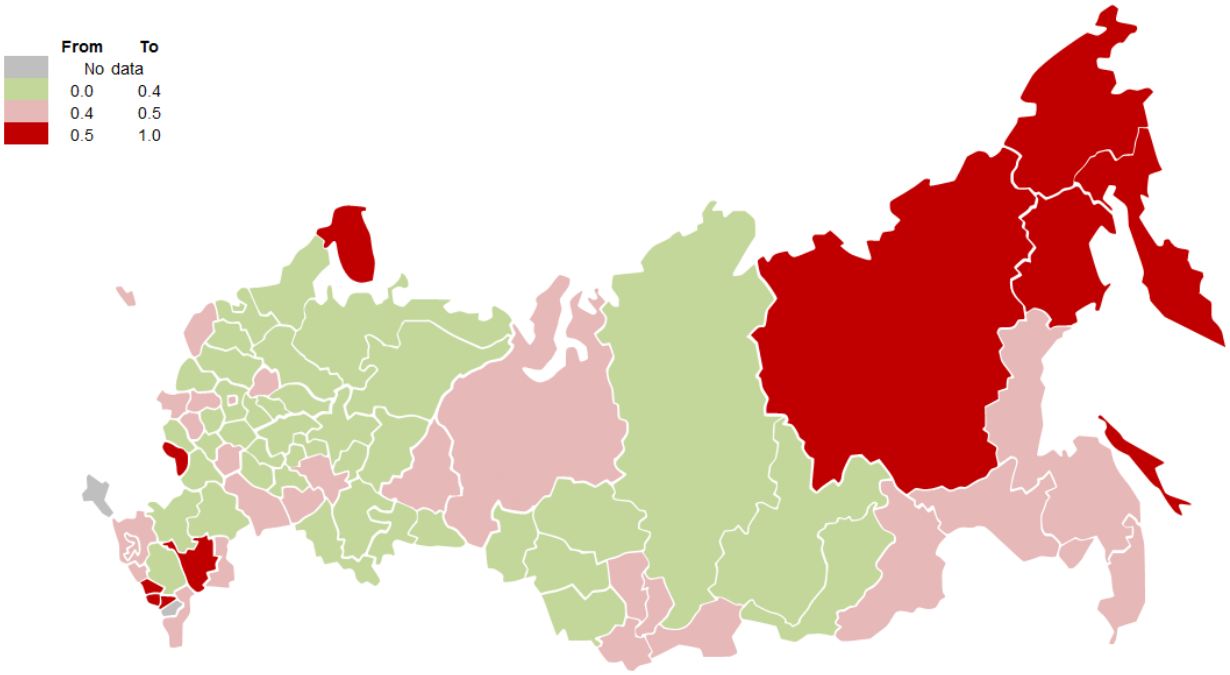


**Figure 8. Variance decomposition of inflation across regions (share of variance explained by regional and idiosyncratic components)**




## 3.2. Factor loading comparison

As noted by Reis and Watson (2010), only equiproportional price changes may be regarded as common dynamics that are genuinely isolated from relative price changes. Following this, we examined the factor loadings[6] that reflect the impact of changes in the common factor on inflation series. We found that there is notable heterogeneity in common factor loadings across commodities and regions. Importantly, there seems to be some regularity in the sectoral distribution of factor loadings, i.e., the impacts of common factors on the prices of certain goods differ consistently across all regions (Figures 9 and 10), while the cross-regional distribution of loadings (Figures 11 and 12 in the Appendix) seems more random.

These results appear to confirm substantial heterogeneity in price setting across sectors in Russia. This finding is far from unprecedented. Variability of relative prices is a relevant issue for many economies. One well-known example is the volatility of food prices in emerging markets, although it may be applicable to advanced economies as well. According to Boivin et al. (2009), Mackowiak et al. (2009) and Reis and Watson (2010), the sectoral component of inflation is very volatile and explains most of the movements in sectoral prices in the US. We also found substantial variability of relative prices in Russia.

[6] Note that in our model, the impact of changes in the common factor on the inflation series in the cross-section is constituted by the combination of all factor loadings $\lambda_H$ , $\lambda_G$ , $\lambda_{FH}$ , $\lambda_{FG}$

**Figure 9. First common factor loadings sorted by commodities (change in inflation rate in response to a one-unit change in the common factor, p.p.)**

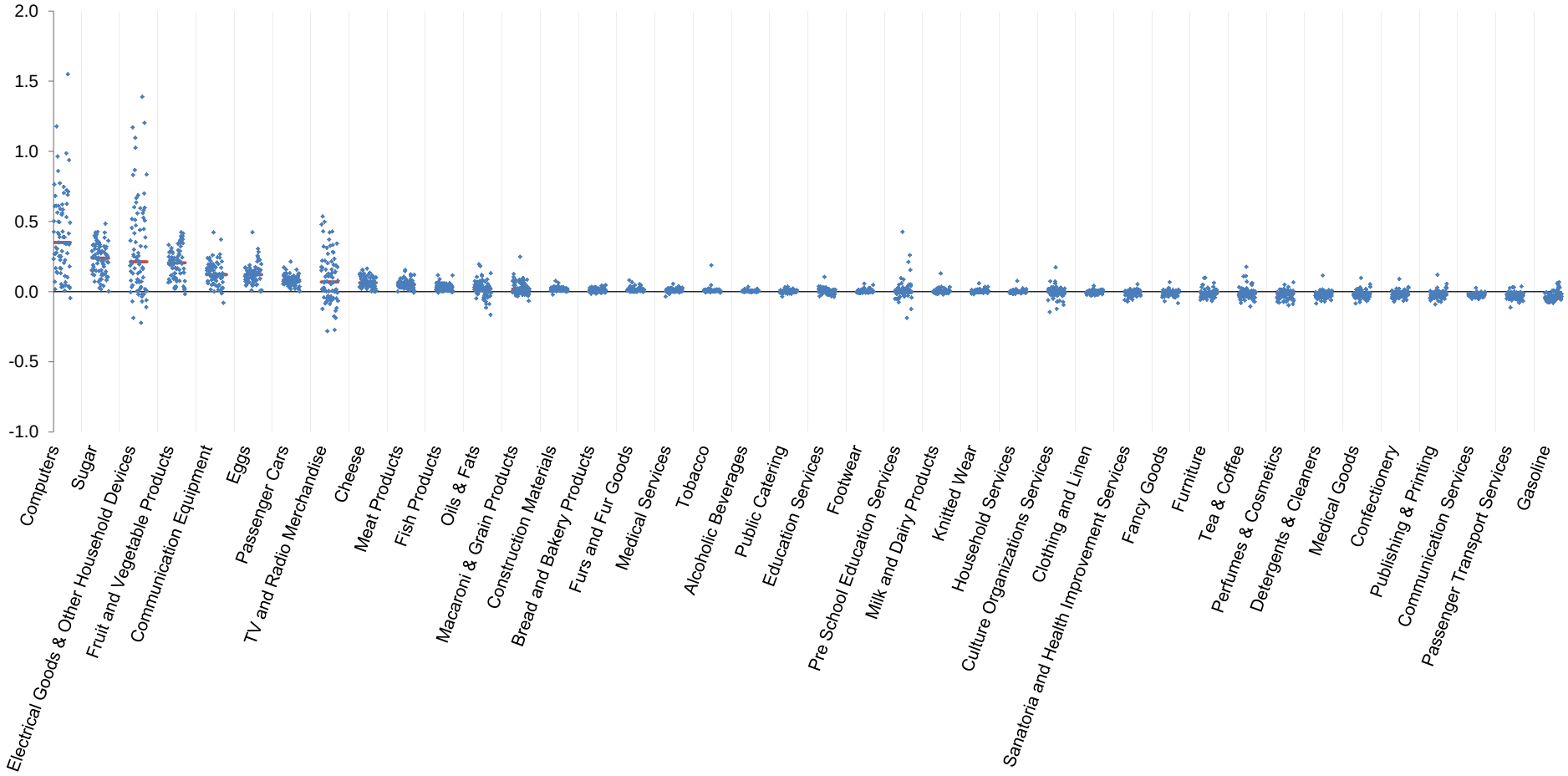
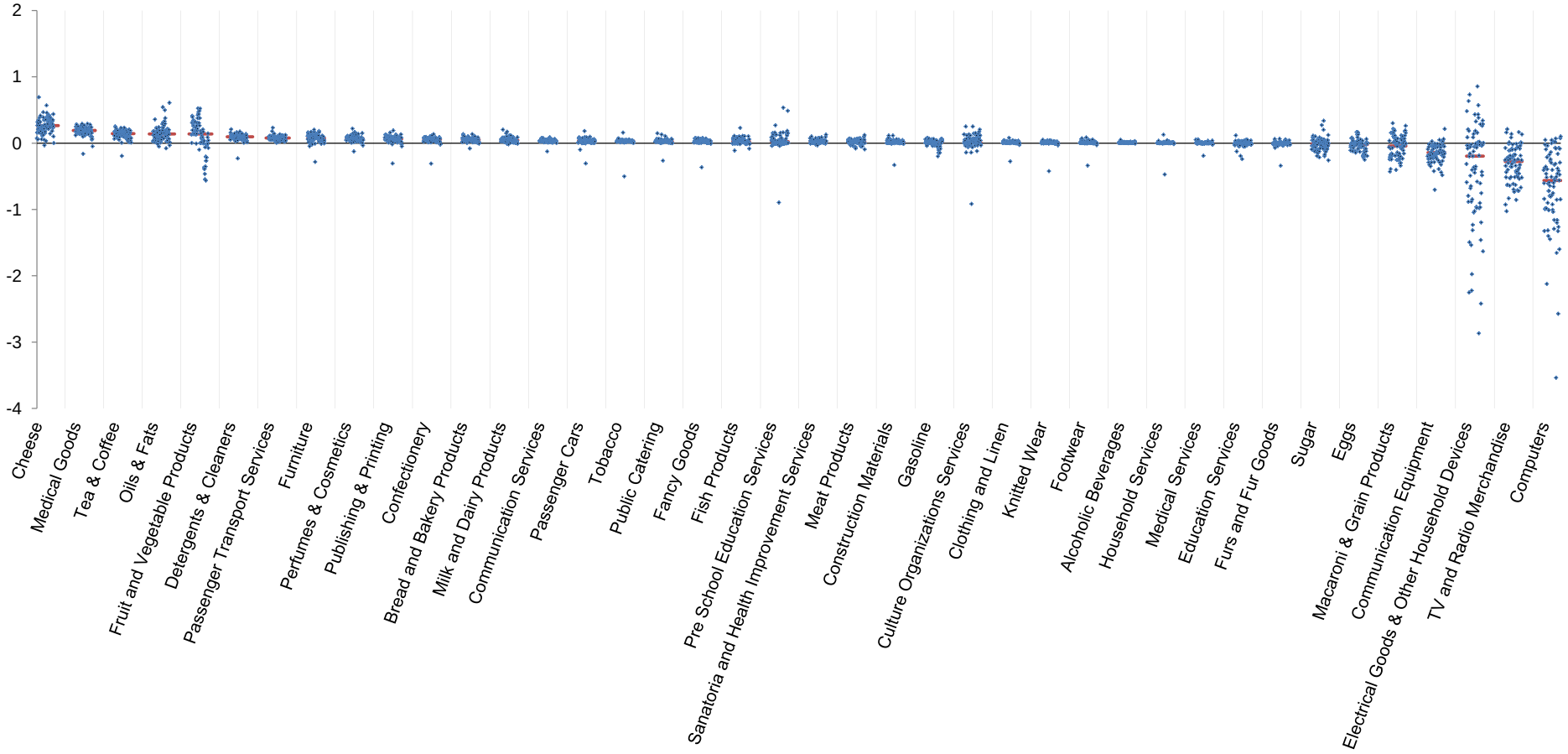


**Figure 10. Second common factor loadings sorted by commodities (change in inflation rate in response to a one-unit change in the common factor, p.p.)**



## CONCLUSIONS

There are good arguments in favor of a monetary policy that takes regional inflation differentials into account. For instance, Benigno (2004) notes that it is optimal to only target overall inflation when the regions in the monetary union share the same degree of nominal rigidity. As nominal rigidities differ across regions, a feasible first-best solution consists of an inflation-targeting policy in which a higher weight is given to the inflation in the region with a higher degree of nominal rigidity. The aim of this paper is to measure to the heterogeneity of nominal rigidities across Russian regions.

For this purpose, we estimated a dynamic hierarchical factor model using inflation rates across 40 product-level categories in 79 regions of Russia. We found little evidence that region-specific factors, i.e., processes that affect the inflation rate of every product in the region, influence inflation developments. This result suggests that it is unlikely that region-specific economic developments significantly affect price setting in Russia. We interpret this result as the lack of evidence of a high degree of heterogeneity of nominal rigidities across Russian regions. Therefore, defining the monetary policy target in terms of the headline inflation rate is appropriate. Nevertheless, there are several regions in the Far East and North Caucasus where the role of the idiosyncratic component is substantial. This result may indicate incomplete integration of regional markets.

On the other hand, we found that the scope of sectoral relative price changes in Russia is substantial, indicating the presence of substantial heterogeneity of nominal rigidities across commodities. Sectoral factors are important for food inflation, while price setting for a number of services is mostly idiosyncratic. This finding is not unprecedented. The significant role of relative price shocks has been reported for both advanced and emerging market economies, and issues of relative price variability are richly represented in contemporary research. We found that similar features are pertinent to inflation developments in Russia, and accordingly, issues related to relative price variability, such as appropriate design of macroeconomic models and underlying inflation measures, are important for monetary policymakers in Russia. Namely, we believe that disaggregation by commodities may be crucial for inflation risk assessment and that breaking down headline inflation by commodity indices may be helpful. In contrast, regional disaggregation may be less relevant.

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# APPENDIX

## Table 1. Number of commodity-specific factors

| No. | Products | Number of factors $G_{pt}$ |
|---|---|---|
| 1 | Meat Products | 2 |
| 2 | Fish Products | 1 |
| 3 | Oils & Fats | 2 |
| 4 | Milk and Dairy Products | 2 |
| 5 | Cheese | 2 |
| 6 | Eggs | 2 |
| 7 | Sugar | 2 |
| 8 | Confectionery | 1 |
| 9 | Tea & Coffee | 1 |
| 10 | Bread and Bakery Products | 2 |
| 11 | Macaroni & Grain Products | 2 |
| 12 | Fruit and Vegetable Products | 2 |
| 13 | Alcoholic Beverages | 1 |
| 14 | Public Catering | 1 |
| 15 | Clothing and Linen | 1 |
| 16 | Furs and Fur Goods | 1 |
| 17 | Knitted Wear | 1 |
| 18 | Footwear | 1 |
| 19 | Detergents & Cleaners | 1 |
| 20 | Perfumes & Cosmetics | 1 |
| 21 | Fancy Goods | 1 |
| 22 | Tobacco | 1 |
| 23 | Furniture | 1 |
| 24 | Electrical Goods & Other Household Devices | 2 |
| 25 | Publishing & Printing | 1 |
| 26 | TV and Radio Merchandise | 2 |
| 27 | Computers | 1 |
| 28 | Communication Equipment | 1 |
| 29 | Construction Materials | 1 |
| 30 | Passenger Cars | 1 |
| 31 | Gasoline | 2 |
| 32 | Medical Goods | 1 |
| 33 | Household Services | 1 |
| 34 | Passenger Transport Services | 1 |
| 35 | Communication Services | 2 |
| 36 | Pre-School Education Services | 1 |
| 37 | Education Services | 2 |
| 38 | Culture Organizations Services | 1 |
| 39 | Medical Services | 1 |
| 40 | Sanatoria and Health Improvement Services | 1 |

**Table 2. Number of region-specific factors**

| Regions | Number of factors $H_{rt}$ | Regions | Number of factors $H_{rt}$ |
|---|---|---|---|
| Belgorod Oblast | 1 | Bashkortostan | 1 |
| Bryansk Oblast | 1 | Mari El Republic | 1 |
| Vladimir Oblast | 1 | Mordovia | 1 |
| Voronezh Oblast | 1 | Tatarstan | 1 |
| Ivanovo Oblast | 1 | Udmurt Republic | 1 |
| Kaluga Oblast | 1 | Chuvash Republic | 1 |
| Kostroma Oblast | 1 | Perm Krai | 1 |
| Kursk Oblast | 1 | Kirov Oblast | 1 |
| Lipetsk Oblast | 1 | Nizhny Novgorod Oblast | 1 |
| Moscow Oblast | 2 | Orenburg Oblast | 1 |
| Oryol Oblast | 1 | Penza Oblast | 1 |
| Ryazan Oblast | 1 | Samara Oblast | 1 |
| Smolensk Oblast | 1 | Saratov Oblast | 1 |
| Tambov Oblast | 1 | Ulyanovsk Oblast | 1 |
| Tver Oblast | 1 | Kurgan Oblast | 1 |
| Tula Oblast | 1 | Sverdlovsk Oblast | 1 |
| Yaroslavl Oblast | 1 | Tyumen Oblast | 1 |
| Moscow | 2 | Chelyabinsk Oblast | 1 |
| Karelia | 1 | Altai Republic | 1 |
| Komi Republic | 1 | Buryatia | 1 |
| Arkhangelsk Oblast | 1 | Tuva | 1 |
| Vologda Oblast | 1 | Khakassia | 1 |
| Kaliningrad Oblast | 1 | Altai Krai | 1 |
| Leningrad Oblast | 1 | Zabaykalsky Krai | 1 |
| Murmansk Oblast | 1 | Krasnoyarsk Krai | 1 |
| Novgorod Oblast | 1 | Irkutsk Oblast | 1 |
| Pskov Oblast | 1 | Kemerovo Oblast | 1 |
| Saint Petersburg | 1 | Novosibirsk Oblast | 1 |
| Adygea | 1 | Omsk Oblast | 1 |
| Kalmykia | 1 | Tomsk Oblast | 1 |
| Krasnodar Krai | 1 | Sakha (Yakutia) Republic | 1 |
| Astrakhan Oblast | 1 | Primorsky Krai | 1 |
| Volgograd Oblast | 1 | Khabarovsk Krai | 1 |
| Rostov Oblast | 1 | Amur Oblast | 1 |
| Dagestan | 1 | Kamchatka Krai | 1 |
| Ingushetia | 2 | Magadan Oblast | 1 |
| Kabardino-Balkar Republic | 1 | Sakhalin Oblast | 1 |
| Karachay-Cherkess Republic | 1 | Jewish Autonomous Oblast | 1 |
| North Ossetia-Alania | 1 | Chukotka Autonomous Okrug | 1 |
| Stavropol Krai | 1 | | |

**Figure 11. First common factor loadings sorted by region (change in inflation rate in response to a one-unit change in the common factor, p.p.)**

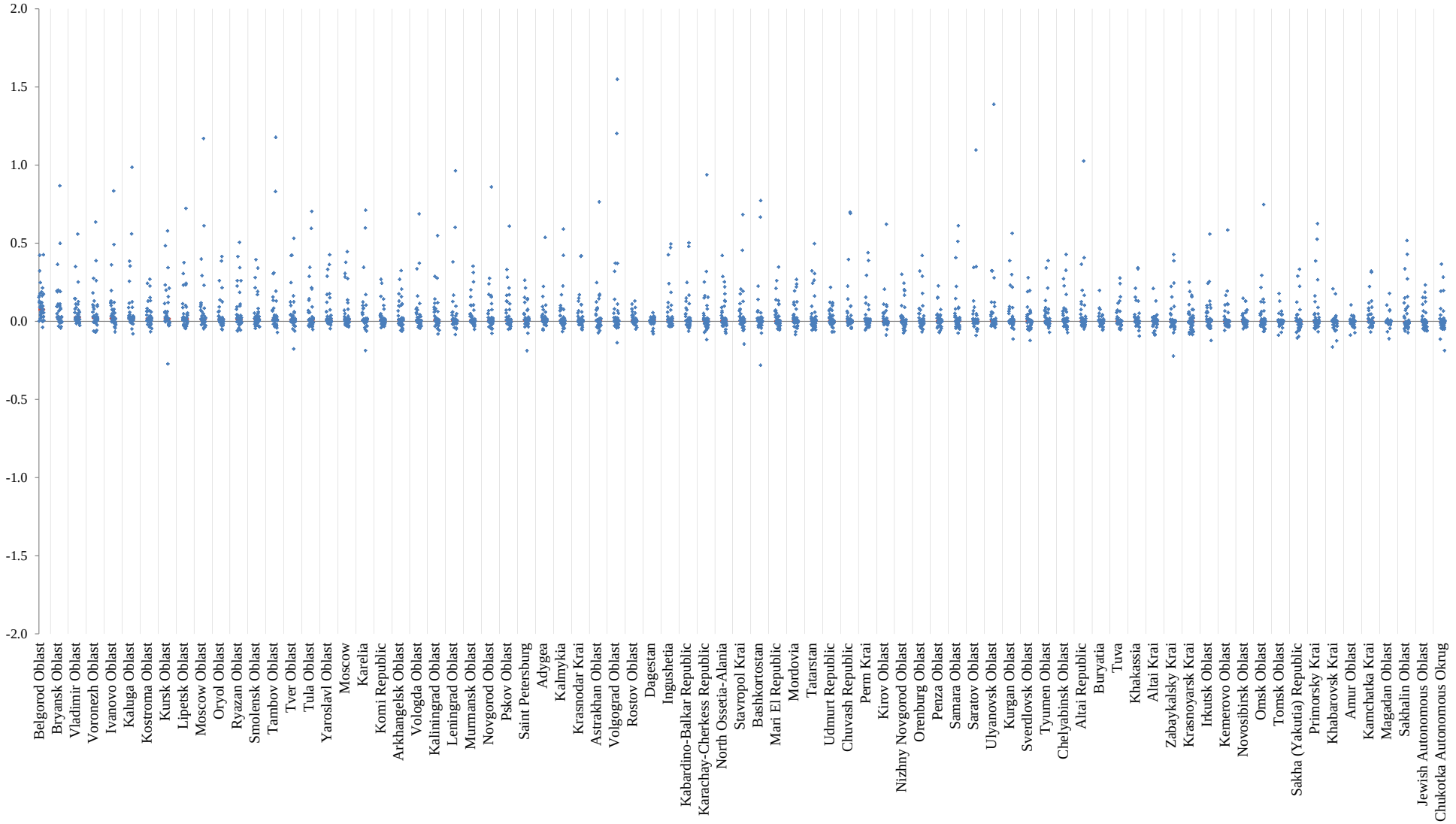

**Figure 12. Second common factor loadings sorted by region (change in inflation rate in response to a one-unit change in the common factor, p.p.)**

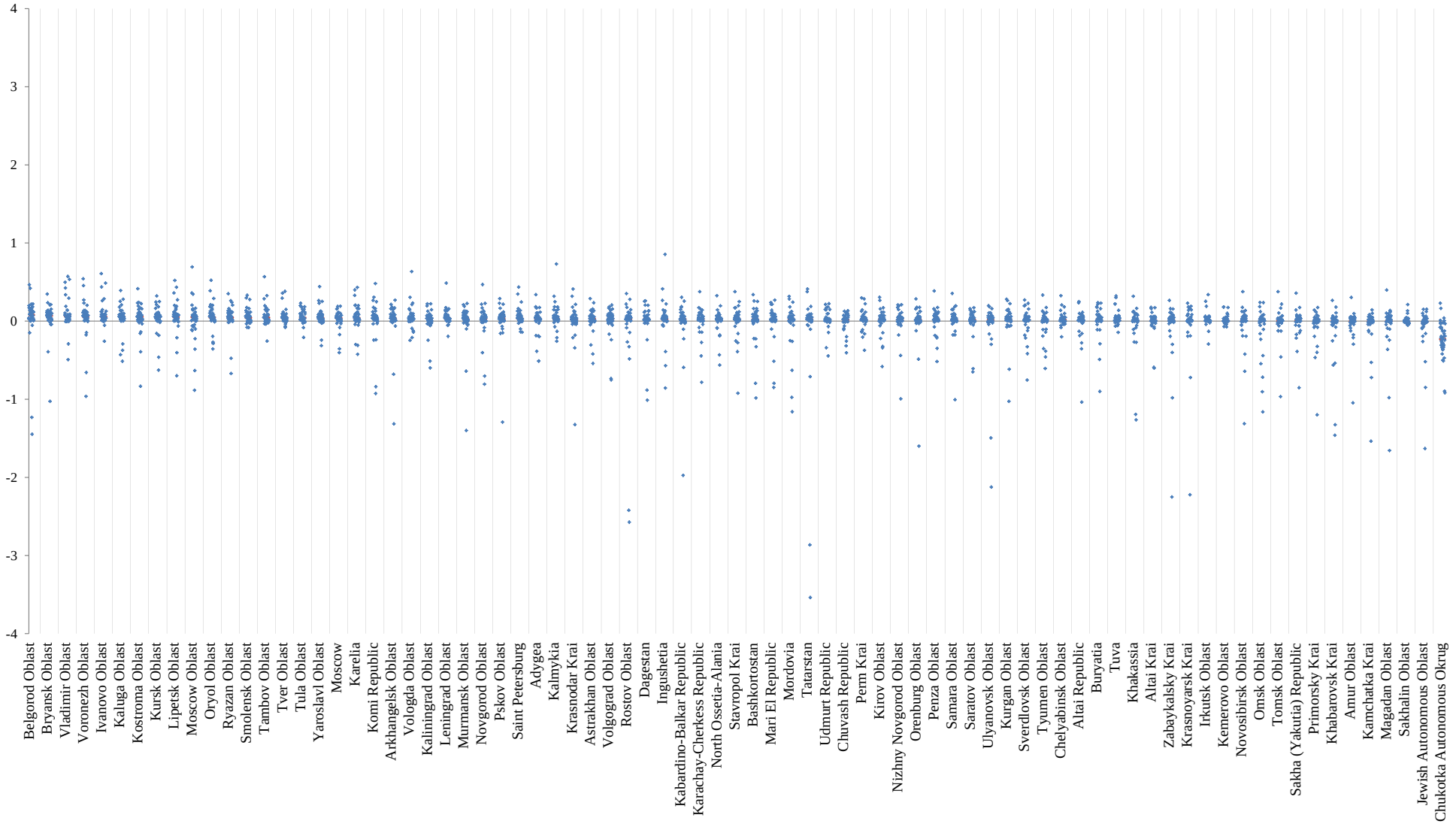

**Figure 13. Decomposition of variance of the aggregate inflation rate obtained under an alternative model's specification**