The structure of herring product demand in Russia

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Abstract

Russia is experiencing deep structural changes in many areas. For the seafood industry important developments are large increases in household incomes, development of modern super- and hypermarket distribution channels, and product innovations. In the seafood category consumers are adopting new species and new product forms at a rapid rate. Herring is one of the species that is experiencing these changes. The dominant product form has traditionally been whole salted herring, typically sold at open markets. Herring sold in the traditional unprocessed form has been a protein source for poor people, consumed at home. But more processed and expensive product forms that are distributed through modern distribution channels have increased their market share during the data period.

We employ a panel data set on monthly per capita demand for different herring products in six Russian regions, from unprocessed to value added products, to test hypotheses on the structure of herring consumption. We estimate dynamic panel data demand systems, with region-specific estimates of price and income elasticities. The six regions in the data set have large differences in average per capita income. Our econometric estimates indicate significant structural regional differences in per capita consumption of different products, also after controlling for income differences. We find that whole herring is generally an inferior good, whereas fillet herring products tend to be normal goods. This suggests that if incomes continue to increase, consumption will shift further from unprocessed to value added herring products.

1. Introduction

The Russian society is experiencing deep structural changes in many areas. For the seafood industry important developments are large increases in household incomes in some regions and socioeconomic groups, development of modern distribution channels to consumers, and product innovations. Since 1999 Russia's GDP has experienced annual growth of 5 to 10%. Income growth has been uneven between regions and socioeconomic groups, and income differences are larger than what is generally the case in Western countries. Over the last ten years the distribution of food to Russian consumers has changed, with the rapid growth of so-called modern distribution channels, primarily in the form of retail chains with supermarket and hypermarket sales outlets. Distribution technologies and organization has been transferred from Western countries by both domestic and multinational retail chains. The diversity of food products has increased dramatically, and segments of the Russian population seem to adopt new food products at a rapid rate. Consumers are also including new species in their seafood consumption, and new product forms. Herring, which has long traditions in Russia, is one of the species that is experiencing these changes. We employ a panel data set on monthly regional per capita demand for different herring products, from unprocessed to value added products, to test hypotheses on the structure of herring consumption. The panel is based on a monthly survey of consumers in six different regions.

The dominant product form has traditionally been whole salted herring, typically sold at open markets. According to surveys 30-40% of households consume herring once or more a week. Herring sold in the traditional unprocessed form has been a protein source for poor people, consumed at home. But it is also processed into product forms that are more expensive. Increasingly, the processing is being done by seafood processors in stead of at home.

We estimate dynamic per capita demand systems. The six regions in our data set have large differences in average per capita income. Our econometric estimates indicate significant structural differences between per capita consumption of different products, also after controlling for income differences. We find that whole herring may be an inferior good, whereas fillet herring products are normal goods. This suggests that if income continues to increase, consumption will shift from unprocessed to value added herring products, a trend that is also observed for other seafood in Russia. It is less clear what effect further income growth will have on total demand for herring.

Herring is a raw material which is versatile in the sense that it can be marketed both as fairly unprocessed and undifferentiated in the form of whole salted herring sold in bulk and as highly processed and differentiated products in the form of herring filets that are branded, packaged and flavored with different marinades and sauces. This makes it interesting as a case study to test hypotheses on shifts in Russian food consumers' behavior.

The paper is organized as follows: Section 2 provides a short presentation of the data. In section 3 a descriptive analysis of patterns of herring consumption is provided. Section 4 presents the econometric models to be estimated. In section 5 we present the empirical results from the econometric models. Finally, section 6 provides concluding remarks.

2. Data

We have access to survey data collected by GfK/Europanel, where a representative sample of around 7000 Russian households report their consumption each month. The households are selected from all Russian regions, and the survey data is used to construct regional aggregates based on the proportion of respondents relative to the total regional population. From the survey we obtain data on total regional consumption of different herring product categories in volume (metric tonnes net product weight) and value (mill. Rubles).

The herring products are classified in two ways, by (1) packaging[1] and (2) type of processing. Here, we focus on type of processing, which have four product categories: "Fillet Herring in Portions", "Filleted Herring", “Herring in Rolls”, and "Whole Herring". Moreover, we will primarily study the two dominant categories, by volume and value, “Fillet herring in portions” and “Whole herring”.

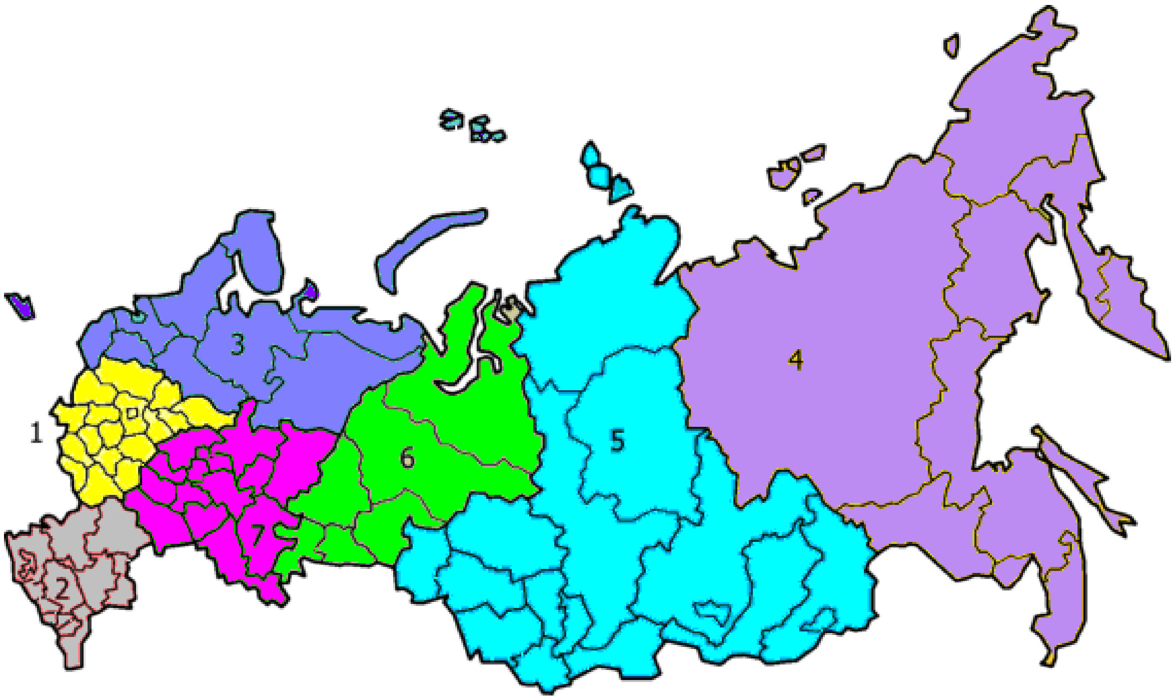

Figure 1. Russia’s regions (1. Central Federal District; 2. Southern Federal District; 3. Northwestern Federal District; 4. Far Eastern Federal District; 5. Siberian Federal District; 6. Urals Federal District; 7. Privolzhsky (Volga) Federal District)

In our data set the Far Eastern Federal District and the Siberian Federal District have been merged together as one region. Thus, we have six regions.

3. The Russian Herring Market

This section provides a discussion of the Russian market for herring, which has to be analyzed in context of the Russian economy and society.

[1] The following four product categories are distinguished by packaging: "Herring - Bulk / Not Prepacked", "Herring - Canned", "Herring - Glass Package", and "Herring – plastic package".

There are larger differences between the center, represented primarily by Moscow and St. Petersburg, and periphery in Russia than most other countries in Europe. The differences are economic, social and cultural. Changes in incomes, distribution channels and consumption patterns have been lead by the center. It will probably take time for parts of some regions to catch up with Moscow and St. Petersburg, and one should expect in a country as diverse as Russia that there will always be significant differences in consumption patterns, including food consumption.

Table 1 presents the population in Russia in 2006 by regions and by urbanization category (as defined in the survey). According to Table 1 the most populated region is the Central region, with 38 million inhabitants, and the smallest region in terms of population is the Ural region with 12 million inhabitants. Furthermore, 39 million people live in rural areas, while 26 million people live in small towns with 10-49 thousand inhabitants, and 27 million live in cities with a population over one million.

Table 1. Population in Russia by regions and urbanization categories in 2006 (1000 inhabitants)

Volga Region	30511.2
North-West Region (incl. St.Petersburg)	13628.3
Siberia & Far East Region	26223.2
Ural Region	12244.2
Central Region (incl. Moscow)	37356.4
South Region	22790.3
Rural (<10 ths)	38648.7
Urban: 10-49 ths	26542.6
Urban: 50-499 ths	38612.2
Urban: 500-999 ths	12132.6
Urban: 1 mln+	26817.4
Russia	142753.6

Source: GfK/Europanel

The average per capita monthly income exhibits large variations between regions, as shown in Table 2. The Ural region had the highest per capita monthly income (17544 rubles), followed by the Central region (which includes Moscow) and the North-West region (which includes St. Petersburg). At the bottom is the Volga region (10101 rubles) and the South region (8880 rubles). The income in the most affluent region, Ural, is 97% higher than in the South region, and this relative difference has only been reduced marginally from 2005 to 2007. Another noteworthy feature is the rapid increase in real income. Both in 2006 and 2007 the real income increase on a national basis was around 13%.

Table 2. Real monthly income per capita in Rubles. Average January-July

Region	2005	2006	2007
Central Region (incl. Moscow)	11095	13093	14970
North-West Region (incl. St.Petersburg)	11582	12661	14702
Siberia&Far East Region	10454	11538	13150
South Region	6819	7654	8880
Ural Region	13597	15292	17544
Volga Region	7682	8596	10101

Russia National	10041	11386	12818

Source: GfK/Europanel

Russia has over the last years experienced a rapid growth in so-called modern retail distribution channels, which include supermarkets and hypermarkets owned by retail chains. This development has partly been driven by income growth. According to figure 2, the share of modern distribution channel grocery sales in per cent of total retail sales has increased from 7% in 1999 to 45% in 2006. The modern distribution channels generally have more advanced logistics than the old distribution channels. They have partly adopted information and logistical technologies from multinational retail chains, and have greater capacities in transportation and storage of chilled food. Modern distribution channels supply a greater diversity of products, including more value added products. The increasing range of products available in the shops is both an indication of shifts in Russian consumers' incomes and preferences, and the increased ability of suppliers to bring these products to the consumers. The increasing range of products in many food product categories respond to consumers' preferences for quality, variation, convenience ("easy to prepare"), and health benefits. This also seems to be the case for seafood in general, and herring in particular.

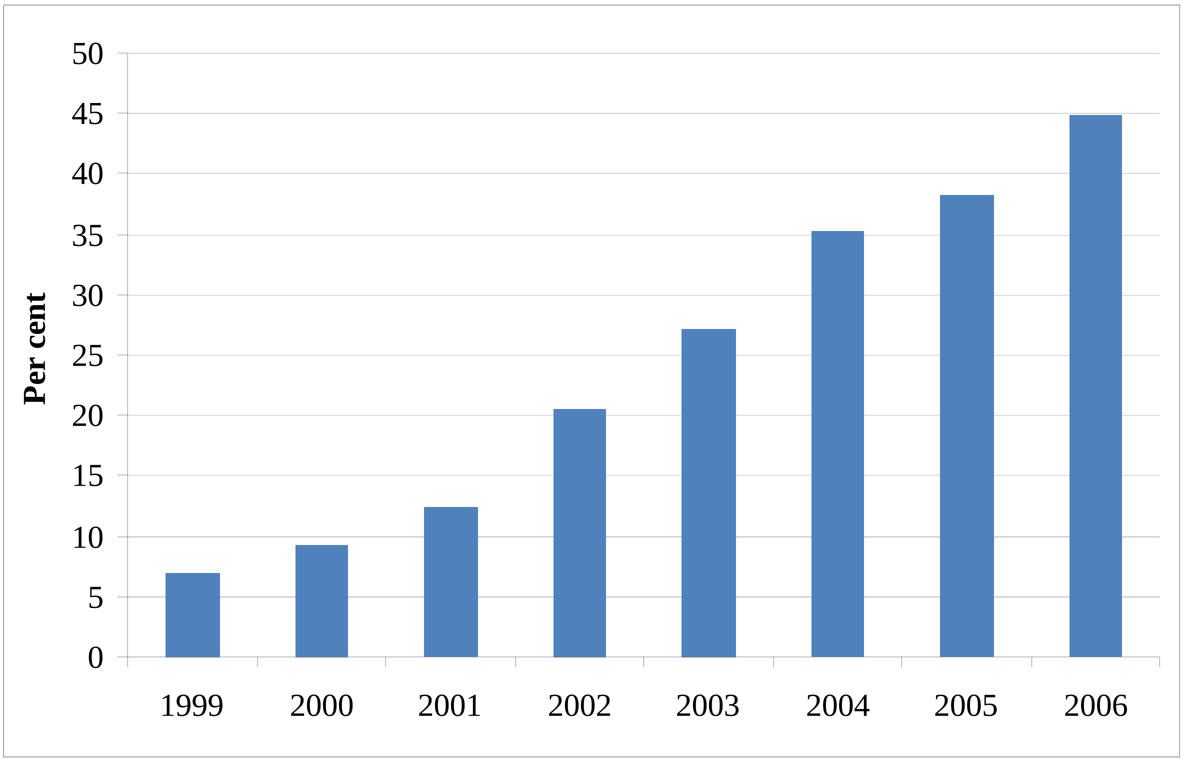

Figure 2. Modern distribution channel grocery sales in per cent of total retail sales (Source: Planet Retail)

A rather dramatic shift in herring consumption has taken place during the data period. As Table 3 shows, there was a large decline in per capita consumption of whole herring from 2006 to 2007, from 0.14 kg per month to 0.10 kg. During the same period consumption of fillet herring in portions more than doubled. In other words, there is a shift from unprocessed to more processed herring products. This probably also coincides with a shift in consumption from traditional outlets, such as open markets, to modern distribution channels in the form of super- and hypermarkets. Total herring product demand has changed less, from 0.197 kg per month in 2005 to 0.188 kg in 2007, a reduction of 5%.

Table 3. Monthly average per capita consumption of herring products January-July in whole herring equivalents (kg per kapita)[2]

Product	2005	2006	2007
Fillet Herring in Portions	0.037	0.037	0.080
Filleted Herring	0.006	0.008	0.010
Whole Herring	0.154	0.144	0.098
Herring Total	0.197	0.189	0.188

Source: GfK/Europanel

Table 4 presents monthly average per capita consumption measured in whole herring equivalents, by region and by urbanization category. The relatively poor South region had the highest per capita consumption of herring in 2005 and 2006, while the North-West region had the lowest consumption. But in 2007 the Ural region, which also has the highest income per capita, has by far the highest per capita consumption. The Nort-West region and the Volga region have the lowest consumption. There does not seem to be any clear relationship between average regional per capita income and herring consumption over time.

When we turn to second part of Table 4, we see that in 2005 rural areas and towns with less than 50 thousand inhabitants had the highest per capita consumption, while consumption was lowest in the largest cities. While demand was more or less stable until 2007 in the most urbanized areas (50.000 inhabitants and upward), rural areas experienced a significant decline. Small towns with less than 50 thousand inhabitants, experienced a large increase in per capita consumption.

Finally, Table 4 provides standard deviation of per capita consumption between regions and between urbanization categories. The increase in standard deviations from 2005 to 2007 gives indication of some divergence in per capita consumption of herring. At the least, there does not seem to be any process of convergence, neither for regions nor for urbanization categories.

Table 4. Monthly average per capita consumption of herring products January-July in whole herring equivalents by region and urbanization category (kg per kapita)

Year	2005	2006	2007
Central Region (incl. Moscow)	0.20	0.19	0.18
North-West Region (incl. St.Petersburg)	0.16	0.12	0.16
Siberia&Far East Region	0.18	0.17	0.20
South Region	0.26	0.24	0.21
Ural Region	0.18	0.18	0.27
Volga Region	0.19	0.20	0.15
Rural (<10 ths)	0.23	0.20	0.17
Urban: 10-49 ths	0.23	0.26	0.29
Urban: 50-499 ths	0.18	0.17	0.17
Urban: 500-999 ths	0.17	0.16	0.17

[2] The fourth product category, ”Herring in rolls”, is sold in very small quantities, and consequently excluded from the table.

Urban: 1 mln+	0.15	0.14	0.15
Russia National	0.20	0.19	0.19
St.dev. regions	0.031	0.036	0.039
St.dev. urbanization categories	0.032	0.042	0.051

Source: GfK/Europanel

Next, we examine the development of consumption for the two product categories whole herring and fillet herring in portions by region and urbanization category. Tables 5 and 6 show per capita consumption of whole herring and fillet herring in portions, respectively.

The South region has the highest consumption of whole herring in all three years, according to Table 5, but there is a significant decline from 2006 to 2007. The North-West region has the lowest consumption in 2005 and 2006, but in 2007 the Ural region has by far the lowest consumption. When we study consumption patterns by urbanization category, we find that rural areas and small towns with less than 50 thousand inhabitants had the highest per capita consumption in 2005, while cities with more than one million people had the lowest consumption. For all urbanization categories demand declined from 2005 to 2007.

According to the standard deviations presented at the bottom of Table 5, which decline from 2005 to 2007 both across regions and urbanization categories, there seems to be some convergence in per capita consumption of whole herring.

Table 5. Per capita consumption of whole herring January-July (kg product weight per capita)

Year	2005	2006	2007
Central Region (incl. Moscow)	0.152	0.141	0.108
North-West Region (incl. St.Petersburg)	0.099	0.071	0.076
Siberia&Far East Region	0.139	0.140	0.102
South Region	0.223	0.201	0.126
Ural Region	0.123	0.117	0.038
Volga Region	0.155	0.152	0.092
Rural (<10 ths)	0.193	0.164	0.111
Urban: 10-49 ths	0.186	0.197	0.140
Urban: 50-499 ths	0.141	0.135	0.082
Urban: 500-999 ths	0.125	0.108	0.099
Urban: 1 mln+	0.095	0.092	0.058
Russia National	0.154	0.144	0.098
St.dev. regions	0.038	0.039	0.028
St.dev. urbanization categories	0.037	0.038	0.028

Source: GfK/Europanel

When we in Table 6 turn to fillet herring in portions, we see that the Ural region has the highest per capita consumption in all three years, and that the consumption increases by a factor of four from 2006 to 2007. The Central, North-West and Volga regions have the lowest per capita consumption in 2007.

When we examine consumption patterns by urbanization category, we find that consumption of fillet herring in portions increased in all categories from 2005 to 2007: But the increase was most dramatic in small towns with less than 50 thousand inhabitants, leading to the highest per capita consumption among the urbanization categories. Rural areas are lagging behind, and have by far the lowest per capita consumption of more processed herring.

According to the standard deviations presented at the bottom of Table 6, which increase considerably from 2005 to 2007 both across regions and urbanization categories, there is a process of divergence in per capita consumption of fillet herring in portions.

Table 6. Per capita consumption of fillet herring in portions January-July (kg product weight per capita)

Region	2005	2006	2007
Central Region (incl. Moscow)	0.022	0.020	0.032
North-West Region (incl. St.Petersburg)	0.024	0.022	0.032
Siberia&Far East Region	0.020	0.014	0.049
South Region	0.020	0.019	0.041
Ural Region	0.027	0.033	0.125
Volga Region	0.016	0.022	0.031
Rural (<10 ths)	0.018	0.019	0.029
Urban: 10-49 ths	0.022	0.024	0.075
Urban: 50-499 ths	0.019	0.017	0.043
Urban: 500-999 ths	0.019	0.024	0.035
Urban: 1 mln+	0.026	0.023	0.044
Russia National	0.021	0.021	0.045
St.dev. regions	0.003	0.006	0.033
St.dev. urbanization categories	0.003	0.003	0.016

Source: GfK/Europanel

Figure 3 presents the developments in the real price of whole herring from 2005 to 2007 (January-July average) by region. The average national price increases slightly from 71 Rubles per kg in 2005 to 74 Rubles per kg in 2006, and then drops by around 10% to 67 Rubles per kg from 2006 to 2007. We see that there are significant differences in prices between regions, with the Ural region having the highest price and Volga region the lowest price in 2005. In 2007 the South region has the highest price and the Ural the lowest price.

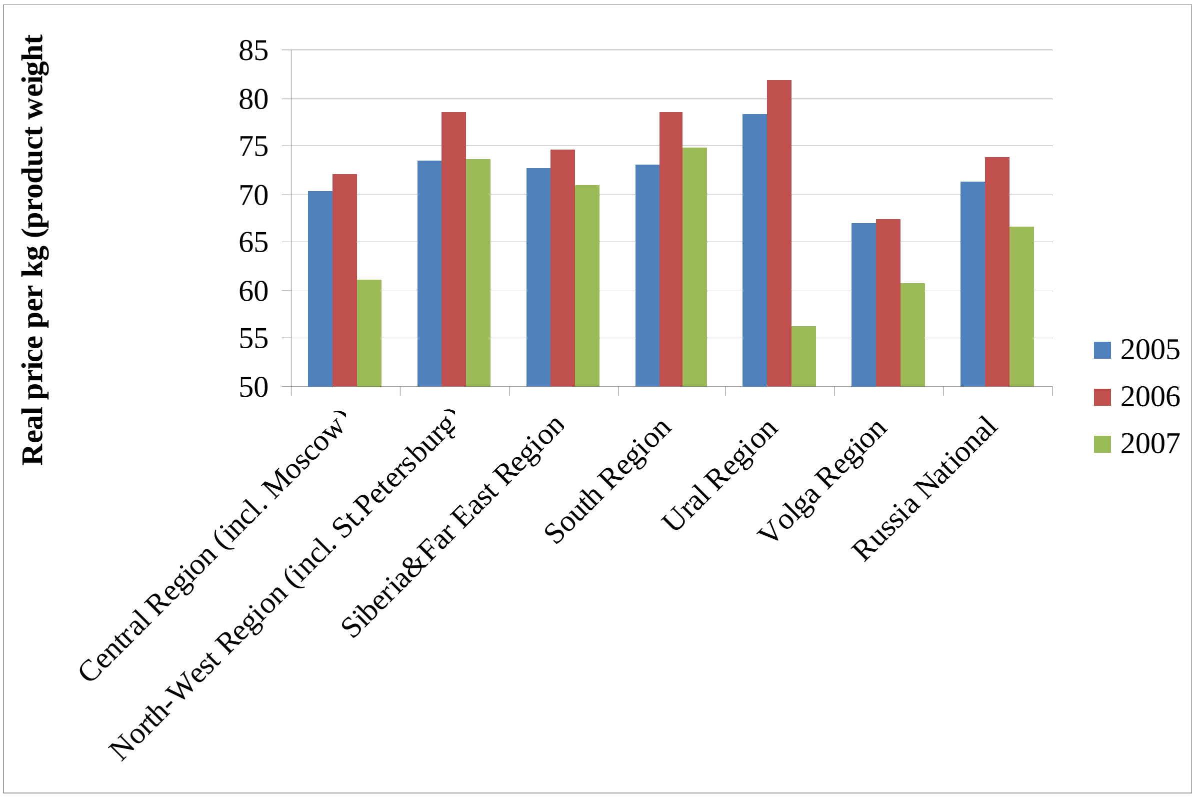

Figure 3. Real average price of whole herring January-July (Source: GfK/Europanel)

Figure 4 shows the real average price of fillet herring in portions (January-July average) from 2005 to 2007. Again we observe significant price differences between regions in each year. On average, the real price declines from 129 Rubles per kg in 2005, via 122 Rubles/kg in 2006, to 105 Rubles/kg in 2007. In 2005 the Ural region is the price leader, while Siberia&Far East region and the South region have the lowest prices. In 2007, the Ural region has become the low-price region, while the North-West region has the highest price.

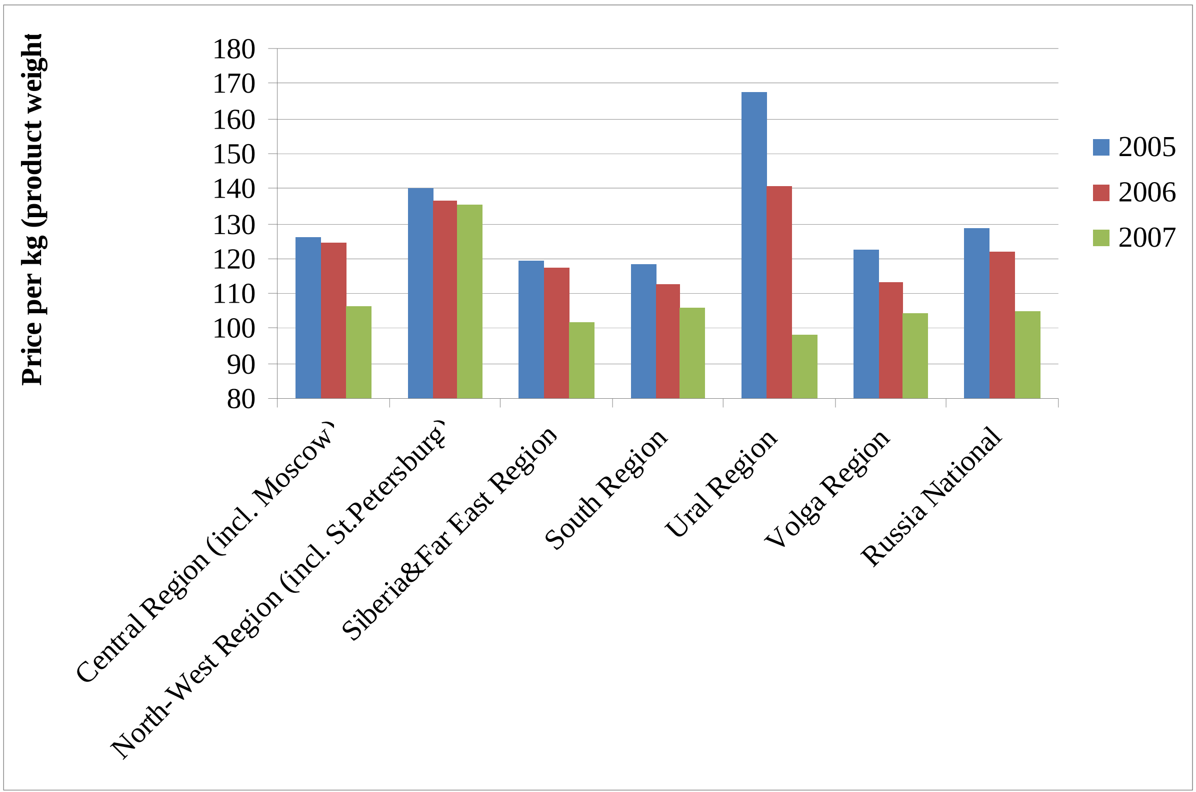

Figure 4. Real average price of fillet herring in portions January-July (Source: GfK/Europanel)

The development in per capita sales volumes of whole herring and fillet herring in portions are shown in figure 5. We see that the traditional product group, whole herring, experienced a clear downward trend from January 2005 until the summer of 2007. The consumption of fillet herring is relatively stable until the late summer of 2006, and then increases until it seems to stabilize at a level that is twice as high from the end of 2006 until the rest of the data period.

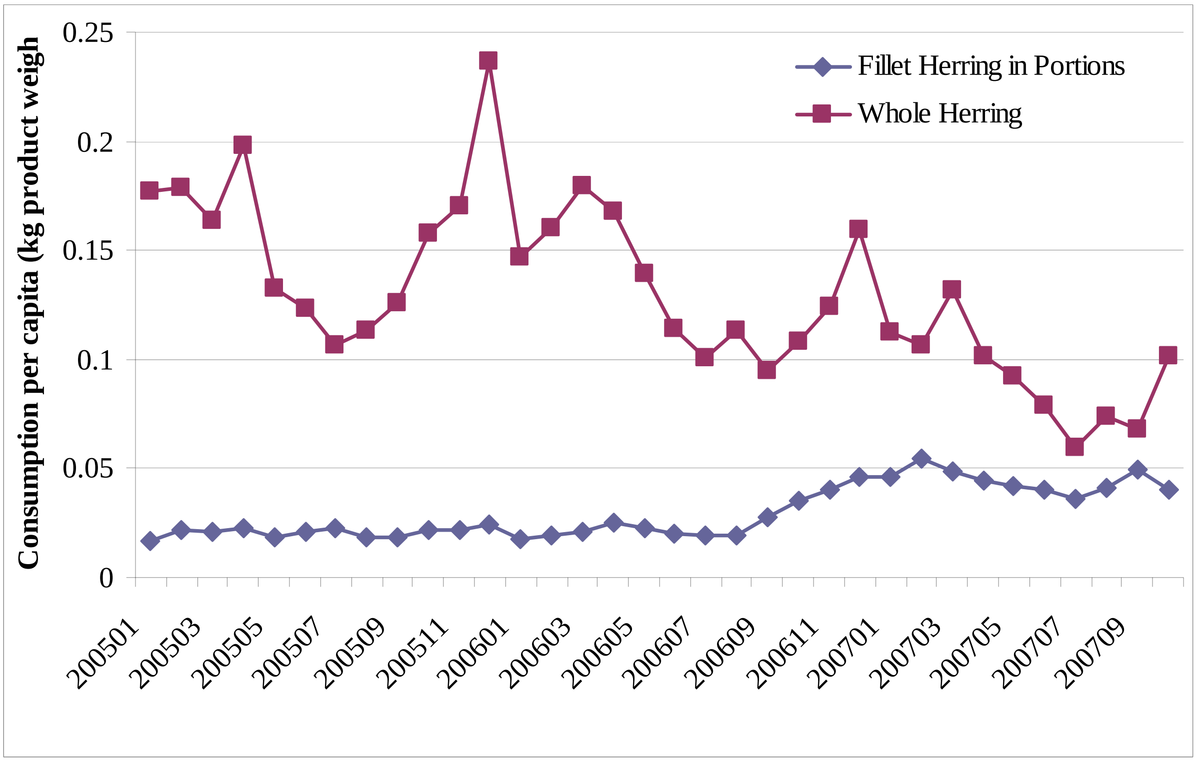

Figure 5. National average herring consumption per capita

The real price of the two most important product groups experienced a somewhat different development from January 2005 to late summer of 2007, as shown in Figure 6. The price of whole herring had an upward trend from January 2005 to late summer of 2006, while the trend has been declining since then. The time of the trend shift coincides with the time of increase in fillet product consumption shown in the previous Figure. Fillet herring has a declining price trend from January 2005 until early 2007, and then the price starts to increase.

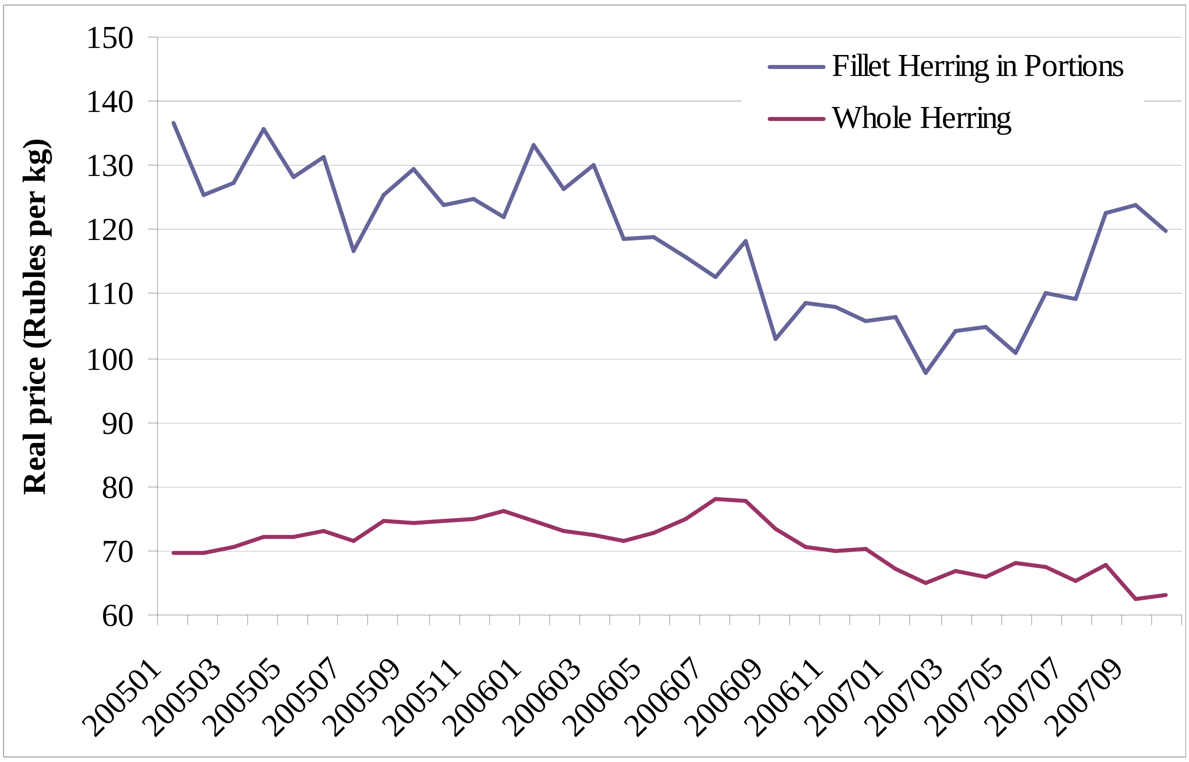

Figure 6. National average real price (Source: GfK/Europanel)

4. Econometric model specifications

This section presents the empirical model specifications. A priori, there are several considerations that should guide us in the model specification process. The econometric model should account for structural differences between regions in herring product demand responses. Moreover, it should allow for differences in short- and long-run demand responses. Since different herring products may be subject to the same exogenous shocks, as captured in the error term of the econometric demand model, it should allow for potential correlation between error terms.

Econometric demand studies use several techniques for estimating elasticities of demand from panel data. These estimators vary in their degree of parameter heterogeneity, with pooled estimators at the one extreme and individual country estimators at the other. There has been a debate on whether to use homogeneous or heterogeneous model parameters over the cross-section (Maddala, 1991; Maddala et al., 1997; Pesaran and Smith, 1995; Baltagi and Griffin, 1997; Baltagi Griffin and Xiong, 2000; Baltagi, Bresson, Griffin, and Pirotte 2003; Asche, Nilsen and Tveterås, 2008). Intermediate estimators in terms of heterogeneity include standard panel data estimators, i.e. fixed and random effects estimators, and the more novel iterative empirical Bayes estimator advocated in Maddala (1991), also called the shrinkage estimator. The latter estimator use OLS estimates as starting values and "shrink" these estimates towards a common normal distribution through an iterative estimation procedure.

When there is potential parameter heterogeneity between the countries, the fixed effects estimator is likely to impose strong restrictions on the slope parameters. In the case of a dynamic panel data model and coefficients differing between cross-sections, Pesaran and Smith (1995) argue that "pooling and aggregating give inconsistent and potentially highly misleading estimates of the coefficients, though the cross-section can provide consistent estimates of the long-run effects". The larger the degree of parameter heterogeneity, the greater the bias of the long-run effect provided by the homogeneous estimators. When the number of time observations is small, the bias of the pooled estimator is likely to be a serious problem (Pesaran and Smith, 1995). Hence, the long-run elasticities provided by the fixed effects estimator are likely to be biased if there are structural differences between cross-sections.

We estimate by Zellner's (1962) SURE a two-equation log-log demand system of per capita herring demand for herring product groups "Fillet Herring in Portions" and "Whole Herring" on a panel of Russian regions. The model is specified as:

(1)

$$\ln(\text{Demand}_{irt} / \text{Capita}_{irt}) = \sum_r \alpha_{ir} + \sum_r \alpha_{irD} \ln(\text{Demand}_{irt-1} / \text{Capita}_{irt-1}) + \sum_j \sum_r \alpha_{Pjr} \ln \text{Price}_{jrt}$$
$$+ \sum_r \alpha_{Iir} \ln(\text{Income}_{rt} / \text{Capita}_{rt}) + \sum_{m=1}^{11} \alpha_{Mim} D_{im} + u_{irt}$$

,

where subscripts *i*, *m*, *r* and *t* represent herring products (*i* = {Fillet Herring in Portions, Whole Herring}), month (*m* = 1, 2, …, 11), region (*r* = { Central Region (incl. Moscow), North-West Region (incl. St.Petersburg), Siberia & Far East Region, South Region, Ural Region, Volga Region }), and time period (*t* = 1, 2, …, 31), respectively.

The short-run elasticities of demand w.r.t. prices and income are given by

$$e_{Pir}^{SR} = \alpha_{Pir}, \qquad e_{Iir}^{SR} = \alpha_{Iir},$$

while the long run elasticities of demand are given by

$$e_{Pir}^{LR} = \alpha_{Pir} / (1 - \alpha_{irD}), \qquad e_{Iir}^{LR} = \alpha_{Iir} / (1 - \alpha_{irD}).$$

When the model is estimated by Zellner's SURE the equations are linked by the fact that their disturbances u_{irt} are allowed to be correlated across equations *i*, which seem reasonable given that some exogenous shocks probably influence the demand for both products. By taking account of the correlation of the error terms across equations we obtain estimates that are more efficient than the usual least squares statistics, and appropriate test statistics in hypothesis testing.

The model is estimated on six regions for the period January 2005 to July 2007, implying that we have 6*30 = 180 observations at our disposition. The dependent variable is per capita demand in kilos. Explanatory variables are the average regional own-price of the herring product group and the average regional price of the other herring product, average per capita monthly income, and monthly dummy variables to capture seasonal shifts. We also include lagged regional demand as an explanatory variable. This allows one to distinguish between short- and long-run demand elasticities. The short-run elasticities associated with price and income variables are given by their coefficients, while the long run elasticities are given by the price and income coefficients divided by one minus the coefficient associated with the lagged demand variable.

The model is an extension of a standard fixed effects panel data model, which only allows the intercept to vary across units. It is specified such that it allows for heterogeneity across regions in own-price, cross-price and income elasticities, since a separate parameter is estimated for each region. This allows us to test several hypotheses on regional differences in demand responses.

By including region-specific fixed effects α_{ir} (on the constant term) we allow for structural time-invariant differences in herring demand across regions, which is independent of income levels and prices.

In model (1) we are not able to distinguish between rural and urban areas, which may be a dimension that have influence on the structure of herring product demand. Rural areas are generally poorer and are perceived to be more traditional in their consumption patterns than the more urban areas. Consequently, we will also analyse if there are structural differences in herring demand between urban and rural areas. This is done by estimating the following two-equation panel data log-log demand system of per capita herring demand for herring product groups “Fillet Herring in Portions” and “Whole Herring”:

$$\text{(2)} \quad \begin{aligned} &\ln(Demand_{itu} / Capita_{itu}) = \alpha_{iu} + \alpha_{iD} \ln(Demand_{it-1,u} / Capita_{it-1,u}) + \sum_{r} \alpha_{iu} \ln Price_{itu} \\ &+ \sum_{u} \alpha_{iu} D_u t + \sum_{m=1}^{11} \alpha_{im} D_{im} + \varepsilon_{itu} \end{aligned},$$

The subscript u represents the five degrees of urbanization, which are the units we observe here, (u = "Rural (<10 ths)", "Urban: 10-49 ths", "Urban: 50-499 ths", "Urban: 500-999 ths", "Urban: 1 mln+"}). Demand equations (2) are similar in structure to equations (1). However, per capita income data are not available by urbanization category, leading us to replace income with a time trend variable that is interacted with urbanization category. Due to the missing income data we will be cautious in the evaluation of the empirical results from the estimated model.

5. Empirical results

We estimated a two-equation system of demand for whole herring and fillet herring on Russian regional panel data using Zellner’s SUR procedure, accounting for heterogeneity with region specific effects in intercept and slope parameters.

The empirical results for both econometric demand systems (1) and (2) provide support for heterogeneity in demand responses across regions for both whole herring and fillet herring in portions. A likelihood ratio test of model (1) against a restricted model with homogeneous slope parameters firmly rejected the latter with a chi-square test statistic of 79.43 (40 df, p-value = 0.0002). Furthermore, a the likelihood ratio test also rejected a restricted version of model (2) with all slope parameters homogeneus, with a chi-square test statistic of 66.72 (32 df, p-value = 0.0003).

5.1. Demand system with region as unit of observation

Tables 7a-7b present the econometric SUR estimates from demand model (1), and Tables 8a-8b present the derived short run and long run elasticity estimates. The model has no restrictions on symmetry of cross-price elasticities and homogeneity of degree zero in prices and income. A restricted model with symmetry and homogeneity imposed was rejected with a chi-square test statistic of 46.63 (18 df, p-value = 0.0002). Also a restricted model with only symmetry imposed was rejected (chi-square test statistic of 20.78, 6 df, p-value = 0.002). It should be noted, however, that the empirical results on price and income elasticities largely hold also for the restricted models, which are not presented here.

[Tables 7a-7b and 8a-8b around here]

According to Table 7a the own price elasticity of whole herring varies across regions, and is not different from zero in the majority of regions at conventional confidence levels. In the North-West region the own price elasticity is significantly negative, while in the Ural region it is significantly positive.

According to the estimated income elasticities whole herring is an inferior good (i.e. statistically significant negative value) in all regions but one – the Ural region, where the income elasticity is positive, but not significantly different from zero.

The estimated intercepts vary significantly across regions, implying that if incomes and prices had been equal across regions, per capita consumption would have been different. After having controlled for income levels etc. the demand for whole herring is highest in the North-West region that includes St.Petersburg, and lowest in the Ural region.

According to Table 7b the own price elasticity for herring fillet is significantly negative and elastic (<-1) for all regions but one – the South region, where it is not statistically different from zero.

The cross-price elasticities are not consistent in terms of sign between the whole herring demand equation (Table 7a) and the fillet herring in portions demand equation (Table 7b). According to table 7a fillet herring in portions is a substitute for whole herring in the majority of regions, while according to Table 7b the two goods tend to be complements. The model with symmetry imposed, which is not presented here, also provided a mixed picture, but where only in one region where the two products statistically significant complements.

The estimated income elasticities for fillet herring are positive in most regions, although only statistically significantly different from zero only in two regions – the South region and Siberia & Far East region. It is interesting to note that the poorest region (South) as measured by per capita income has the highest income elasticity, while the richest region (Ural) has the lowest income elasticity. The results provide some support for a positive but declining income elasticity as income increases. Hence further income growth should pull demand for more processed herring upwards, but a declining rate.

The monthly dummy variables present evidence of significant seasonal variations in demand after having controlled for prices, incomes etc. Demand for both whole and fillet herring products are highest in December, and lowest in the summer.

5.2. Demand system with urbanisation category as unit of observation:

Next, we examine the empirical results from model (2), the demand system with urbanization category as unit of observation. Tables 9a-9b present the econometric SUR parameter estimates, and Tables 10a-10b present the derived short run and long run elasticity estimates. As noted earlier, due to the missing income data we should be cautious in the evaluation of the empirical results from the estimated model. When we compare the model (2) estimates with those from model (1), the results are similar except that the own price elasticities of whole herring demand are even less well-behaved, with four of five elasticities being significantly positive.

[Tables 9a-9b and 10a-10b around here]

Model (2) included urbanization category specific time trend variables. We find that no urbanization category has a significant positive trend in demand for whole herring, while three urbanization categories have a significant negative trend.

After having controlled for other variables the demand for whole herring is smallest in towns with 50-499 thousand inhabitants, and highest in rural areas and towns with 500-999 thousand inhabitants.

The trend in demand for fillet herring is positive for all urbanization categories, but statistically significant only for two categories.

The own price demand elasticity for herring fillet in portions is significantly negative for four of five urbanization categories, and elastic (<-1) for three categories.

After having controlled for other variables the demand for fillet herring is smallest in rural areas, and highest in towns with 50-999 thousand inhabitants.

Monthly dummy variables were included to capture seasonal shifts in demand. After having controlled for prices, trends etc. demand for both whole and fillet herring is highest in December, and lowest in the summer months.

6. Summary and conclusions

We have analyzed Russian consumers' demand for herring products during a time period that was characterized by high income growth, and probably by large changes in consumption patterns. The changes are so dramatic that one could make the bold claim that the most recent Russian revolution is a consumer revolution.

During the period January 2005 – July 2007 real monthly income of Russian consumers increased rapidly in all regions. The average national increase was 46%, while the highest increase was in the central region that includes Moscow, with 55%, and the lowest increase was in the North-West Region that includes St.Petersburg. There are large differences in average income between regions, ranging from 36% above the national average in the Ural region and 30% below in the South Region.

Overall herring consumption has declined slightly during the January 2005 – July 2007 period. The decline in volume terms is 5% from Jan-Jul 2005 to Jan-Jul 2007. This reduction is driven mainly by a decline in the consumption of whole herring by 37% from Jan-Jul 2005 to Jan-Jul 2007. On the other hand, consumption of fillet herring in portions has increased by 114% in the same period.

Average prices have declined for both whole herring and fillet herring in portions from January 2005 to July 2007. But the decline is larger for fillet herring.

Our econometric estimates show that there is considerable heterogeneity in demand responses across regions.

To sum up the implications of our econometric results, income growth during the data period caused a reduction in the demand for whole herring. For fillet herring both declining prices and income growth contributed to a growth in demand. If incomes continue to grow in the future one should expect a further increase in fillet herring demand at the expense of whole herring.

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Table 7a. Econometric SUR Estimates of Whole Herring Demand Equation with Region-Specific Effects

Parameter	Estimate	St.error	t-value	P-value
$\alpha_{D,Central}$	0.259	0.124	2.080	0.037
$\alpha_{D,North\text{-}West}$	0.331	0.140	2.360	0.018
$\alpha_{D,Sib\&Far\ East}$	0.210	0.143	1.470	0.141
$\alpha_{D,South}$	0.318	0.159	2.000	0.046
$\alpha_{D,Ural}$	0.520	0.119	4.360	0.000
$\alpha_{D,Volga}$	0.179	0.124	1.450	0.148
$\alpha_{PW,Central}$	0.389	0.323	1.200	0.228
$\alpha_{PW,North\text{-}West}$	-1.132	0.597	-1.900	0.058
$\alpha_{PW,Sib\&Far\ East}$	-0.029	0.407	-0.070	0.943
$\alpha_{PW,South}$	1.155	0.757	1.530	0.127
$\alpha_{PW,Ural}$	0.676	0.338	2.000	0.046
$\alpha_{PW,Volga}$	0.353	0.691	0.510	0.609
$\alpha_{PF,Central}$	0.325	0.269	1.210	0.226
$\alpha_{PF,North\text{-}West}$	-1.185	0.659	-1.800	0.072
$\alpha_{PF,Sib\&Far\ East}$	0.455	0.253	1.800	0.072
$\alpha_{PF,South}$	0.140	0.473	0.300	0.767
$\alpha_{PF,Ural}$	1.241	0.331	3.740	0.000
$\alpha_{PF,Volga}$	-0.239	0.418	-0.570	0.568
$\alpha_{I,Central}$	-0.567	0.294	-1.930	0.053
$\alpha_{I,North\text{-}West}$	-0.814	0.413	-1.970	0.049
$\alpha_{I,Sib\&Far\ East}$	-0.797	0.344	-2.310	0.021
$\alpha_{I,South}$	-1.277	0.490	-2.600	0.009
$\alpha_{I,Ural}$	1.170	0.793	1.480	0.140
$\alpha_{I,Volga}$	-1.782	0.432	-4.130	0.000
α_{M1}	-0.509	0.064	-8.020	0.000
α_{M2}	-0.365	0.059	-6.190	0.000
α_{M3}	-0.245	0.056	-4.350	0.000
α_{M4}	-0.340	0.057	-5.970	0.000
α_{M5}	-0.510	0.056	-9.090	0.000
α_{M6}	-0.544	0.058	-9.380	0.000
α_{M7}	-0.676	0.060	-11.240	0.000
α_{M8}	-0.538	0.071	-7.560	0.000
α_{M9}	-0.524	0.065	-8.020	0.000
α_{M10}	-0.329	0.064	-5.170	0.000
α_{M11}	-0.276	0.060	-4.590	0.000
$\alpha_{Central}$	1.088	4.029	0.270	0.787
$\alpha_{North\text{-}West}$	17.154	5.954	2.880	0.004
$\alpha_{Sib\&Far\ East}$	4.204	4.289	0.980	0.327
α_{South}	4.968	5.802	0.860	0.392
α_{Ural}	-21.054	8.880	-2.370	0.018
α_{Volga}	14.562	6.060	2.400	0.016

N = 180, RMSE = 0.1432, Pseudo R-squared=0.9955

Table 7b. Econometric SUR Estimates of Fillet Herring in Portions Demand Equation with Region-Specific Effects

Parameter	Estimate	St.error	t-value	P-value
$\alpha_{D,Central}$	0.002	0.177	0.010	0.992
$\alpha_{D,North\text{-}West}$	0.467	0.164	2.850	0.004
$\alpha_{D,Sib\&Far\ East}$	0.535	0.083	6.420	0.000
$\alpha_{D,South}$	0.562	0.138	4.070	0.000
$\alpha_{D,Ural}$	0.144	0.159	0.910	0.364
$\alpha_{D,Volga}$	0.326	0.159	2.050	0.040
$\alpha_{PW,Central}$	-1.059	0.334	-3.170	0.002
$\alpha_{PW,North\text{-}West}$	-1.718	0.842	-2.040	0.041
$\alpha_{PW,Sib\&Far\ East}$	-1.651	0.341	-4.850	0.000
$\alpha_{PW,South}$	-0.096	0.605	-0.160	0.874
$\alpha_{PW,Ural}$	-1.837	0.467	-3.940	0.000
$\alpha_{PW,Volga}$	-1.656	0.543	-3.050	0.002
$\alpha_{PF,Central}$	-0.951	0.530	-1.800	0.073
$\alpha_{PF,North\text{-}West}$	-1.716	0.760	-2.260	0.024
$\alpha_{PF,Sib\&Far\ East}$	0.507	0.546	0.930	0.353
$\alpha_{PF,South}$	-1.329	1.106	-1.200	0.230
$\alpha_{PF,Ural}$	-0.955	0.466	-2.050	0.040
$\alpha_{PF,Volga}$	-0.673	1.036	-0.650	0.516
$\alpha_{I,Central}$	0.288	0.355	0.810	0.418
$\alpha_{I,North\text{-}West}$	0.389	0.552	0.700	0.481
$\alpha_{I,Sib\&Far\ East}$	0.905	0.479	1.890	0.059
$\alpha_{I,South}$	1.063	0.510	2.090	0.037
$\alpha_{I,Ural}$	0.094	0.963	0.100	0.923
$\alpha_{I,Volga}$	0.406	0.462	0.880	0.379
α_{M1}	-0.149	0.078	-1.900	0.057
α_{M2}	-0.077	0.078	-0.980	0.326
α_{M3}	-0.135	0.073	-1.860	0.064
α_{M4}	-0.069	0.075	-0.930	0.353
α_{M5}	-0.233	0.073	-3.200	0.001
α_{M6}	-0.220	0.076	-2.900	0.004
α_{M7}	-0.309	0.074	-4.160	0.000
α_{M8}	-0.329	0.082	-4.020	0.000
α_{M9}	-0.190	0.083	-2.300	0.021
α_{M10}	-0.053	0.079	-0.680	0.496
α_{M11}	-0.084	0.078	-1.080	0.282
$\alpha_{Central}$	2.813	5.063	0.560	0.578
$\alpha_{North\text{-}West}$	10.365	8.281	1.250	0.211
$\alpha_{Sib\&Far\ East}$	-4.434	5.654	-0.780	0.433
α_{South}	-4.795	6.459	-0.740	0.458
α_{Ural}	9.693	11.213	0.860	0.387
α_{Volga}	4.546	7.213	0.630	0.529

N = 180, RMSE = 0.1847, Pseudo R-squared=0.9975

Table 8a. Estimated Short- and Long-Run Elasticities from Whole Herring Demand Equation with Region-Specific Effects

Elasticity	Short run			Long run		
	Estimate	t-value	P-value	Estimate	t-value	P-value
$e_{PW,Central}$	0.389	1.20	0.228	0.525	1.15	0.252
$e_{PW,North\text{-}West}$	-1.132	-1.90	0.058	-1.694	-1.67	0.095
$e_{PW,Sib\&Far\ East}$	-0.029	-0.07	0.943	-0.037	-0.07	0.943
$e_{PW,South}$	1.155	1.53	0.127	1.693	1.47	0.141
$e_{PW,Ural}$	0.676	2.00	0.046	1.408	2.22	0.026
$e_{PW,Volga}$	0.353	0.51	0.609	0.431	0.52	0.606
$e_{PF,Central}$	0.325	1.21	0.226	0.439	1.24	0.214
$e_{PF,North\text{-}West}$	-1.185	-1.80	0.072	-1.772	-1.60	0.109
$e_{PF,Sib\&Far\ East}$	0.455	1.80	0.072	0.576	1.72	0.086
$e_{PF,South}$	0.140	0.30	0.767	0.205	0.29	0.769
$e_{PF,Ural}$	1.241	3.74	0.000	2.586	3.05	0.002
$e_{PF,Volga}$	-0.239	-0.57	0.568	-0.291	-0.58	0.561
$e_{I,Central}$	-0.567	-1.93	0.053	-0.766	-2.15	0.032
$e_{I,North\text{-}West}$	-0.814	-1.97	0.049	-1.217	-2.10	0.036
$e_{I,Sib\&Far\ East}$	-0.797	-2.31	0.021	-1.009	-2.48	0.013
$e_{I,South}$	-1.277	-2.60	0.009	-1.871	-3.79	0.000
$e_{I,Ural}$	1.170	1.48	0.140	2.439	1.26	0.208
$e_{I,Volga}$	-1.782	-4.13	0.000	-2.172	-5.27	0.000

Table 8b. Estimated Short- and Long-Run Elasticities from Fillet Herring in Portions Demand Equation with Region-Specific Effects

Elasticity	Short run			Long run		
	Estimate	t-value	P-value	Estimate	t-value	P-value
$e_{PW,Central}$	-1.059	-3.17	0.002	-1.061	-2.75	0.006
$e_{PW,North\text{-}West}$	-1.718	-2.04	0.041	-3.224	-1.67	0.095
$e_{PW,Sib\&Far\ East}$	-1.651	-4.85	0.000	-3.554	-4.34	0.000
$e_{PW,South}$	-0.096	-0.16	0.874	-0.219	-0.16	0.875
$e_{PW,Ural}$	-1.837	-3.94	0.000	-2.147	-4.19	0.000
$e_{PW,Volga}$	-1.656	-3.05	0.002	-2.458	-2.89	0.004
$e_{PF,Central}$	-0.951	-1.80	0.073	-0.953	-2.16	0.031
$e_{PF,North\text{-}West}$	-1.716	-2.26	0.024	-3.221	-1.88	0.061
$e_{PF,Sib\&Far\ East}$	0.507	0.93	0.353	1.091	0.88	0.380
$e_{PF,South}$	-1.329	-1.20	0.230	-3.039	-1.36	0.174
$e_{PF,Ural}$	-0.955	-2.05	0.040	-1.116	-2.41	0.016
$e_{PF,Volga}$	-0.673	-0.65	0.516	-0.998	-0.70	0.484
$e_{I,Central}$	0.288	0.81	0.418	0.288	0.84	0.401
$e_{I,North\text{-}West}$	0.389	0.70	0.481	0.730	0.76	0.447
$e_{I,Sib\&Far\ East}$	0.905	1.89	0.059	1.948	2.15	0.032
$e_{I,South}$	1.063	2.09	0.037	2.430	2.49	0.013
$e_{I,Ural}$	0.094	0.10	0.923	0.109	0.10	0.922
$e_{I,Volga}$	0.406	0.88	0.379	0.603	0.93	0.353

Table 9a. Econometric SUR Estimates of Whole Herring Demand Equation with Urbanization Category Specific Effects

Parameter	Estimate	St.error	t-value	P-value
$\alpha_{D,0\text{-}10}$	0.231	0.101	2.280	0.022
$\alpha_{D,10\text{-}49}$	0.225	0.113	1.990	0.046
$\alpha_{D,50\text{-}499}$	0.181	0.106	1.710	0.086
$\alpha_{D,500\text{-}999}$	0.324	0.104	3.100	0.002
$\alpha_{D,1000+}$	0.286	0.091	3.130	0.002
$\alpha_{PW,0\text{-}10}$	0.929	0.503	1.850	0.065
$\alpha_{PW,10\text{-}49}$	0.887	0.348	2.550	0.011
$\alpha_{PW,50\text{-}499}$	1.369	0.386	3.540	0.000
$\alpha_{PW,500\text{-}999}$	0.269	0.405	0.660	0.506
$\alpha_{PW,1000+}$	1.311	0.369	3.550	0.000
$\alpha_{PF,0\text{-}10}$	-0.071	0.283	-0.250	0.803
$\alpha_{PF,10\text{-}49}$	0.617	0.231	2.670	0.008
$\alpha_{PF,50\text{-}499}$	0.430	0.252	1.710	0.088
$\alpha_{PF,500\text{-}999}$	0.375	0.268	1.400	0.162
$\alpha_{PF,1000+}$	0.017	0.256	0.070	0.946
$\alpha_{t,0\text{-}10}$	-0.016	0.004	-3.660	0.000
$\alpha_{t,10\text{-}49}$	0.003	0.004	0.830	0.404
$\alpha_{t,50\text{-}499}$	-0.013	0.004	-3.480	0.001
$\alpha_{t,500\text{-}999}$	-0.004	0.003	-1.060	0.289
$\alpha_{t,1000+}$	-0.014	0.004	-3.860	0.000
α_{M1}	-0.429	0.055	-7.740	0.000
α_{M2}	-0.254	0.048	-5.330	0.000
α_{M3}	-0.185	0.047	-3.930	0.000
α_{M4}	-0.267	0.047	-5.630	0.000
α_{M5}	-0.469	0.047	-10.060	0.000
α_{M6}	-0.571	0.048	-11.860	0.000
α_{M7}	-0.713	0.052	-13.780	0.000
α_{M8}	-0.554	0.059	-9.430	0.000
α_{M9}	-0.548	0.053	-10.430	0.000
α_{M10}	-0.283	0.052	-5.480	0.000
α_{M11}	-0.240	0.050	-4.780	0.000
$\alpha_{0\text{-}10}$	-4.433	2.457	-1.800	0.071
$\alpha_{10\text{-}49}$	-7.765	2.083	-3.730	0.000
$\alpha_{50\text{-}499}$	-9.004	2.363	-3.810	0.000
$\alpha_{500\text{-}999}$	-4.053	2.084	-1.940	0.052
α_{1000+}	-7.009	1.782	-3.930	0.000

N = 165, RMSE = 0.1101, Pseudo R-squared=0.9975

Table 9b. Econometric SUR Estimates of Fillet Herring in Portions Demand Equation with Urbanization Category Specific Effects

Parameter	Estimate	St.error	t-value	P-value
$\alpha_{D,0\text{-}10}$	-0.012	0.159	-0.080	0.939
$\alpha_{D,10\text{-}49}$	0.338	0.108	3.120	0.002
$\alpha_{D,50\text{-}499}$	0.431	0.122	3.520	0.000
$\alpha_{D,500\text{-}999}$	0.274	0.129	2.130	0.033
$\alpha_{D,1000+}$	0.266	0.185	1.440	0.151
$\alpha_{PW,0\text{-}10}$	-0.030	0.426	-0.070	0.944
$\alpha_{PW,10\text{-}49}$	-1.795	0.347	-5.180	0.000
$\alpha_{PW,50\text{-}499}$	-1.219	0.369	-3.300	0.001
$\alpha_{PW,500\text{-}999}$	-1.132	0.405	-2.800	0.005
$\alpha_{PW,1000+}$	-0.786	0.366	-2.150	0.032
$\alpha_{PF,0\text{-}10}$	-2.347	0.742	-3.160	0.002
$\alpha_{PF,10\text{-}49}$	-2.039	0.563	-3.620	0.000
$\alpha_{PF,50\text{-}499}$	-2.329	0.638	-3.650	0.000
$\alpha_{PF,500\text{-}999}$	-1.347	0.585	-2.300	0.021
$\alpha_{PF,1000+}$	-1.767	0.728	-2.430	0.015
$\alpha_{t,0\text{-}10}$	0.012	0.006	2.050	0.040
$\alpha_{t,10\text{-}49}$	0.007	0.006	1.230	0.219
$\alpha_{t,50\text{-}499}$	0.005	0.005	0.990	0.320
$\alpha_{t,500\text{-}999}$	0.009	0.005	1.880	0.060
$\alpha_{t,1000+}$	0.008	0.005	1.590	0.111
α_{M1}	-0.229	0.073	-3.140	0.002
α_{M2}	-0.178	0.070	-2.530	0.011
α_{M3}	-0.183	0.067	-2.720	0.007
α_{M4}	-0.155	0.067	-2.290	0.022
α_{M5}	-0.237	0.067	-3.510	0.000
α_{M6}	-0.208	0.066	-3.140	0.002
α_{M7}	-0.301	0.068	-4.400	0.000
α_{M8}	-0.217	0.069	-3.140	0.002
α_{M9}	-0.153	0.071	-2.150	0.031
α_{M10}	-0.148	0.069	-2.130	0.033
α_{M11}	-0.103	0.072	-1.440	0.150
$\alpha_{0\text{-}10}$	6.220	3.501	1.780	0.076
$\alpha_{10\text{-}49}$	15.069	3.191	4.720	0.000
$\alpha_{50\text{-}499}$	13.572	3.577	3.790	0.000
$\alpha_{500\text{-}999}$	8.564	3.033	2.820	0.005
α_{1000+}	9.035	3.055	2.960	0.003

N = 165, RMSE = 0.1577, Pseudo R-squared=0.9981

Table 10a. Estimated Short- and Long-Run Elasticities from Whole Herring Demand Equation with Urbanization Category Specific Effects

Elasticity	Short run			Long run		
	Estimate	t-value	P-value	Estimate	t-value	P-value
$e_{PW,0\text{-}10}$	0.929	1.850	0.065	1.209	1.80	0.071
$e_{PW,10\text{-}49}$	0.887	2.550	0.011	1.145	2.58	0.010
$e_{PW,50\text{-}499}$	1.369	3.540	0.000	1.672	3.62	0.000
$e_{PW,500\text{-}999}$	0.269	0.660	0.506	0.398	0.65	0.515
$e_{PW,1000+}$	1.311	3.550	0.000	1.836	3.78	0.000
$e_{PF,0\text{-}10}$	-0.071	-0.250	0.803	-0.092	-0.25	0.801
$e_{PF,10\text{-}49}$	0.617	2.670	0.008	0.797	2.43	0.015
$e_{PF,50\text{-}499}$	0.430	1.710	0.088	0.526	1.64	0.101
$e_{PF,500\text{-}999}$	0.375	1.400	0.162	0.555	1.35	0.176
$e_{PF,1000+}$	0.017	0.070	0.946	0.024	0.07	0.946

Table 10b. Estimated Short- and Long-Run Elasticities from Fillet Herring in Portions Demand Equation with Urbanization Category Specific Effects

Elasticity	Short run			Long run		
	Estimate	t-value	P-value	Estimate	t-value	P-value
$e_{PW,0\text{-}10}$	-0.030	-0.070	0.944	-0.030	-0.07	0.944
$e_{PW,10\text{-}49}$	-1.795	-5.180	0.000	-2.711	-4.74	0.000
$e_{PW,50\text{-}499}$	-1.219	-3.300	0.001	-2.142	-3.14	0.002
$e_{PW,500\text{-}999}$	-1.132	-2.800	0.005	-1.559	-2.93	0.003
$e_{PW,1000+}$	-0.786	-2.150	0.032	-1.070	-2.00	0.046
$e_{PF,0\text{-}10}$	-2.347	-3.160	0.002	-2.319	-3.20	0.001
$e_{PF,10\text{-}49}$	-2.039	-3.620	0.000	-3.079	-4.20	0.000
$e_{PF,50\text{-}499}$	-2.329	-3.650	0.000	-4.092	-4.26	0.000
$e_{PF,500\text{-}999}$	-1.347	-2.300	0.021	-1.854	-2.30	0.021
$e_{PF,1000+}$	-1.767	-2.430	0.015	-2.406	-3.55	0.000