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Measuring changes in the Russian middle class between 1992 and 2008: a nonparametric distributional analysis

Zoya Nissanov · **Maria Grazia Pittau**

Abstract Since the dissolution of the USSR in 1991, Russia is generally acknowledged to be one of the most complicated countries in the world, from a sociological perspective. In particular, the evolution of the Russian middle class is an interesting but highly complex phenomenon. Most works dealing with this issue are based on summary statistics, which do not fully convey all the information on income distribution. In the present paper, we analyze the evolution of the middle class in Russia from 1992 to 2008, by applying a nonparametric tool, the "relative distribution," to Russian household incomes. The relative density function is a proper density function which compares two distributions observed in different years, in order to describe patterns of differences on the entire income scale. Despite a stable pattern of high inequality, we found that after a period of income convergence characterized by a rise of the middle class, in 1998 Russian households income started to polarize and in 2008 one can observe a very high degree of polarization and a marked decrease in the middle class. This shrinking of the middle class affected particularly incomes below the median.

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Our results can be related to the social reforms and can be partially explained by the characteristics of the Russian labor market.

Keywords Income distribution · Middle class · Relative distribution · Russia · Transition

JEL Classification C14 · D31 · P36

1 Introduction

Although "it is hard to find a set of characteristics or values that are consistently and uniquely middle class across countries and time" (Kenny 2011), newspapers and magazines routinely use titles like "China's burgeoning middle class holds the key to the future of the country" (Time magazine, 2002), "Report: Cities, Middle Class to Play Greater Role in 2014" (Voice of America, January, 2014) and "Who are the new middle classes around the world? You'd be surprised how poor some are" (The Guardian, January, 2014). Using a more scientific approach, also leading academic journals are increasingly focusing on the central role of the middle class, not only because of its potential as an engine of growth, but also for the purpose of identifying and studying the well-being or behavior of agents belonging to this group. Typical middle-class members are often characterized (Banerjee and Duflo 2008; Bank Asian Development 2010; Australian Government report 2007; Kenny 2011) as middle-aged people, who invest in their education, have a relatively small number of children, spend more on health care, pay taxes, tend to own their own house or apartment as well as one or two cars and, as a consequence, have a significant amount of debt. They are also characterized as endowed with a degree of entrepreneurial spirit, employed in specific occupations, having stable jobs and the means to avoid poverty, even when faced with unexpected difficulties such as loss of their occupation. Obviously, another characteristic is that they are positioned in the middle spectrum of the distribution of incomes, no matter how this middle range is defined.

At the same time, all these studies bear witness to the difficulties and different views that characterize any effort to identify and define a "middle class." Easterly (2001), based on a comparison of a large number of countries, defines the "middle class" as those agents positioned between the 20th and 80th percentile on the consumption distribution. Banerjee and Duflo (2008) use a range of values of per capita expenditures valued at purchasing power parity to identify agents belonging to the middle class. Other scholars identify middle class by looking at wage distribution (see among others, Beach et al. 1997) or income distribution (Ravallion 2010; Atkinson and Brandolini 2013; Vanneman and Dubey 2013). However, even when the main focus is on income levels, there is no consensus concerning the critical thresholds, which would distinguish the middle class from the poor and the rich. For this reason, one must be very prudent when attempting to assess the size of the middle class in a given country, find out whether its importance grew over time, identify its main characteristics or determine whether typical characteristics of its members have changed over time.

We have studied the evolution of the Russian middle class from 1992 to 2008, starting from the idea that it is better to examine the entire range of income distribution rather than adopting fixed boundaries, in an effort to provide answers to the following questions: What happened to the middle class after 1991? Is there anything special about the way middle-class Russians have spent their money, earned their incomes, or brought up their children since Mikhail Gorbachev left the Kremlin?

From an economic perspective, the so-called transition period that began after 1991, has been characterized by the collapse of the industry and hyperinflation in 1992 and a financial collapse in 1998. Between 1992 and 1996, the GDP in Russia fell by an aggregate 37 % (FRD 2006). At the beginning of the transition period, the income of the 10 % richest residents was 4.5 times that of the 10 % the poorest ones. By 1996, the proportion had risen to 13 and by 1999 to 14.7. In the first post-Soviet years, 70 % of the country's productive capital became privatized (Guan 2003). Between 1992 and 1996, the per capita real GDP declined by 8.5 % per year on average, unemployment rose to 11.7 % and the poverty headcount ratio reached about 30 %. At the same time, there was also a decline in life expectancy, an increase in suicide rates and a decrease in birth rates. By 2000, the situation, however, had began to improve: The per capita real GDP was rising at a rate of 8.3 % annually and unemployment, inflation and poverty rates declined (Konstantinova-Vernon 2002). However, there were enormous regional differences in growth rates in Russia: Relative incomes rose most sharply in the financial and political centers and in the regions providing hard currency export earnings (FRD 2006).

There are diverging views about what happened to the middle class during this critical period, but it is generally believed that the share of the Russian middle class decreased between 1995 and 1998 due to the financial crisis and increased between 1998 and 2000 (Birdsall et al. 2000; Hayashi 2007; Bogomolova 2011; Rosstat, various years). Maleva and Ovcharova (2009) believe that the share of the middle class remained stable during the 2000s while others (Hayashi 2007; Avramova 2008; Beliaeva 2011; Lefranc 2012) report an expansion of the midlle class due to economic growth. Most Russian researchers (see, among others, Maleva 2008; Fedorov et al. 2009; Beliaeva 2011; Ovcharova 2012) seem, however, to agree that the middle class represents more or less 20–25 % of the population. This corresponds to what could be called the "core" of middle class since it satisfies at least two of the four criteria (income, education, occupation and self-identification) often adopted by sociologists (Carnegie Moscow Center 2003; Hayashi 2007; Avramova 2008; Maleva and Ovcharova 2009; Beliaeva 2011). Moreover, the results presented by the Ministry of Economic Development of the Russian Federation are within this range (RBK 2012).

To determine what happened to the Russian middle class in this period, we need to look beyond the usual standard measures and analyze patterns of change that have occurred along the entire Russian income distribution. Methodologically, we have adopted the relative distribution approach introduced by Handcock and Morris (1998, 1999), which allows us to identify significant movements across the entire income range and to detect underlying structural breaks and to determine the effect on the size of the middle class of the economic and social reforms enacted in Russia in the 1992–2008 period. The rest of the paper is organized as follows. Section 2 describes the data and provides some descriptive statistics on income distribution in Russia

during the period 1992–2008. Section 3 briefly summarizes the relative distribution approach. Section 4 presents the main empirical results, while Sect. 5 concludes and offers suggestions for further research.

2 Data description and income distribution in Russia between 1992 and 2008

Our analysis is based on cross-sectional microdata from the Russian Longitudinal Monitoring Survey of Higher School of Economics (RLMS-HSE).[1] The RLMS-HSE is a comprehensive household survey, conducted annually since 1992, except for 1997 and 1999. It covers the period before and after the reforms, allowing for the monitoring of the effects of Russian reforms on health and on the economic welfare of households and individuals in the Russian Federation.

The survey was conducted 19 times since 1992 in two phases, each representing a separate panel. During the first phase of the project (1992–1994/round 4), the RLMS team collected four rounds of data on approximately 6,000 households. In the second phase of the project, i.e., since 1994, the team collected a new round of data covering about 4,000 households almost every year (except for 1997 and 1999). In this analysis, we use cross-sectional data from phase I for the period 1992–1993 and from phase II since 1994. Although the RLMS allows for two types of analyses, i.e., repeated cross-sectional analysis and longitudinal analysis, we have used only cross-sectional data. The reason is that, as reported on the official RLMS website at University of North Carolina, households with better economic positions and households in urban areas are more likely to drop out of the sample, impoverishing the panel component of the survey. In addition to that, the attrition rate is quite consistent: Over 32 % of the households who are present on three or less individual rounds are not in the balanced panel (Jovanovic 2001). The attrition might be nonrandom in that it is the richest and the poorest households that leave the sample (Lokshin and Ravallion 2000). The RLMS is the first nationally representative random sample for Russia and the only Russian representative microeconomic survey which includes indicators that are not available in official statistics. It contains, for example, primary data on income both for households and for individuals. In our analysis, we use household total weighted equivalent incomes—from all sources including transfers—net of taxes, expressed in June 1992 rubles deflated using the national monthly CPI deflator published by Rosstat.[2] The reason of weighted incomes is essentially due to the significant impact of geographic variations on Russian household incomes.[3] The OECD equivalence scale[4] is used to adjust household incomes for different household sizes.

Table 1 provides summary measures for household equivalent incomes in the period 1992–2008, along with their bootstrapped 95 % confidence intervals (CI) calculated

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[1] Survey conducted by Higher School of Economics and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS. RLMS-HSE sites: http://www.cpc.unc.edu/projects/rlms-hse, http://www.hse.ru/org/hse/rlms.

[2] Available at http://www.gks.ru/free_doc/new_site/prices/potr/2009/I-ipc91-08.htm.

[3] See for a discussion on this topic: http://www.cpc.unc.edu/projects/rlms-hse/project/samprep.

[4] This scale assigns a value of 1 to the head of the household, a value of 0.7 to each additional adult and a value of 0.5 to each child (until age 17).

Table 1 Summary measures of Russian household equivalent disposable net income: 1992–2008. Mean and median incomes are expressed in 1992 rubles. Bootstrapped confidence intervals in parenthesis

Year	Mean	95 % CI	Median	95 % CI	Gini Index	95 % CI
1992	2,894	[2,810, 2,977]	2,036	[1,995, 2,077]	0.415	[0.403, 0.429]
1993	4,139	[3,966, 4,311]	2,843	[2,776, 2,910]	0.446	[0.429, 0.471]
1994	3,687	[3,511, 3,864]	2,419	[2,357, 2,481]	0.481	[0.461, 0.502]
1995	2,737	[2,589, 2,886]	1,811	[1,761, 1,861]	0.492	[0.470, 0.515]
1996	2,571	[2,441, 2,702]	1,696	[1,642, 1,751]	0.540	[0.522, 0.559]
1998	1,771	[1,685, 1,858]	1,210	[1,175, 1,246]	0.492	[0.473, 0.513]
2000	2,244	[2,124, 2,364]	1,458	[1,408, 1,508]	0.468	[0.447, 0.495]
2001	3,388	[3,246, 3,531]	2,319	[2,261, 2,378]	0.445	[0.428, 0.463]
2002	3,051	[2,916, 3,186]	2,186	[2,112, 2,260]	0.435	[0.416, 0.456]
2003	3,313	[3,195, 3,430]	2,364	[2,287, 2,441]	0.426	[0.413, 0.442]
2004	3,726	[3,557, 3,895]	2,660	[2,579, 2,740]	0.423	[0.404, 0.446]
2005	4,246	[4,064, 4,428]	3,111	[3,011, 3,210]	0.409	[0.391, 0.431]
2006	4,905	[4,653, 5,158]	3,456	[3,361, 3,551]	0.432	[0.408, 0.461]
2007	5,087	[4,925, 5,249]	3,811	[3,694, 3,927]	0.399	[0.386, 0.412]
2008	6,010	[5,723, 6,296]	4,455	[4,340, 4,570]	0.404	[0.382, 0.432]

using bootstrap bias-corrected (1,000 resample) method (Efron 1979; Efron and Tibshirani 1986; Mooney and Duval 1993).

Columns 4 and 5 of Table 1 show inequality as measured by the Gini index. Bootstrapped 95 % confidence intervals (CI) for each point estimates are reported in parentheses.

Besides the overall growth of the disposable mean and median incomes, the most notable feature is the fluctuating behavior of their trend pattern. Mean income rose from 2894 in 1992 to 4139 rubles in 1993 and median income from 2036 in 1992 to 2843 rubles in 1993. Afterward, mean and median income declined significantly until 1998 when they reached their lowest values. Only after 2000, did they start to increase constantly, showing a similar dynamic pattern. All these figures are consistent with the evolution of Russian's economic and social reforms (Jovanovic 2001; FRD 2006; Gorodnichenko et al. 2010), but they do not show in detail the increase in income in different parts of the distribution. In particular, is there any evidence of growing polarization? What is happening in the middle part of income distribution? Are the upper and lower tails changing similarly? In order to provide answers to the above, we have closely examined the entire income shape rather summary measures. By exploring the whole distribution, we will be able to detect significant movements across the income scale which particularly affect middle-class income. For example, the same degree of inequality can imply a radically different pattern of distributional change, depending on whether the inequality is more pronounced in the bottom or top percentiles (Morris et al. 1994; Voitchovsky 2005; Massari et al. 2009; Ravaillon 2010; Clementi and Schettino 2013).
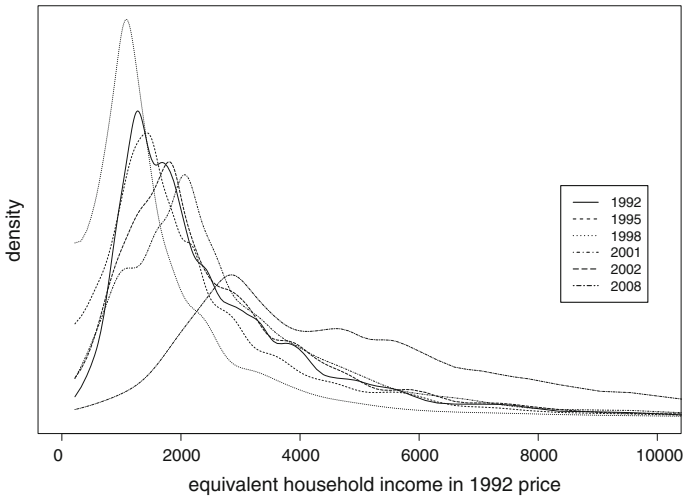
Fig. 1 Comparison between income distributions in the period 1992–2008. Authors' calculation on weighted household income data from RLMS. Kernel density estimates are obtained using adaptive bandwidth

Inequality in Russia stays rather high throughout the whole period showing a substantially unchanged pattern, apart from a moderate increase between 1992 and 1996 with a peak in 1996. Afterward, inequality slightly decreases, reaching the minimum value in 2007. These results are in line with the measurements of the Russian statistical agency (Rosstat) and with other recent studies based on microdata (see, among others, Milanovic and Jovanovic 1999; Flemming and Micklewright 2000; Jovanovic 2001; Lokshin and Yemtsov 2004; Denisova 2010).

No clear dynamic pattern emerges, rather the value fluctuates within certain intervals. It would be seen that inequality stays rather high throughout the period, with no clear tendency to either increase or decrease. Overall, based on the results reported in Table 1, Russian income distribution features display only few significant changes, besides the growth of real mean and median incomes. However, despite evidence of a rather stable inequality pattern, important shifts as well as short-term changes are evident from Fig. 1, which shows kernel density estimates of Russian income distribution for 1992, 1995, 1998, 2001, 2002 and 2008.

Figure 1 shows similar shapes between 1992 and 1995, but the two observable modes in 1992 converged to one mode in 1995. Between 1995 and 1998, the distribution moved leftward, i.e., the median income decreased. Between 1998 and 2001, the distribution moved rightward increasing the mass of high incomes, but in 2002, the median income decreased, the two observable modes converged to one and the frequency of low incomes increased. Between 2002 and 2008, the distribution diverged and moved rightward and more than one mode appeared.

Further insight is provided by the relative density function that directly compares two densities and indicates whether the upper and the lower tails of the distribution are growing at the same rate. This nonparametric tool, initially introduced by Handcock

and Morris (1998, 1999), is useful to assess whether the middle class has shrunk or not (Massari et al. 2009; Borraz et al. 2011; Clementi and Schettino 2013).

3 The relative distribution approach

The concept of relative distribution refers to a nonparametric statistical method originally proposed by Morris et al. (1994)[5], Bernhardt et al. (1995) and Handcock and Morris (1998 and 1999). This approach allows one to compare distributions by expressing values of the "comparison group" as positions in the distribution of the "reference group." The resulting single relative distribution shows how one distribution relates to the other.

This approach has several advantages compared with traditional kernel estimation methodology in investigating the evolution of the middle class (Clementi and Schettino 2013). One advantage is that it can be applied to distributions without restrictions on their ranges. It can be applied to compare two distributions, either longitudinally or, as in our case, cross-sectionally. It can identify shifts that have occurred in income distribution over time. A more detailed picture of distributional changes can be obtained by decomposing the relative density into location and shape components. Location shifts are changes due to proportional variations in all incomes that affect the entire distribution but leave the shape unaltered. Shape modifications instead alter the mass of the distribution and are, by definition, independent from location shifts. By isolating these two effects, it is possible to detect inter-distributional inequality too often hidden by location changes.

In the following, we briefly sketch the basic concepts of the methodology. For a more systematic overview, see Handcock and Morris (1998, 1999) and Hao and Naiman (2010, ch. 5). Let Y_0 and Y be the random income variables in the reference group and comparison group, respectively, F_0 and F their cumulative distribution functions (CDF) and f_0 and f their densities. Cwik and Mielniczuk (1989) define the "grade transformation" from Y to Y_0 as the random variable $R = F_0(Y)$. The CDF of R can be expressed as $G(r) = F(F_0^{-1}(r)), 0 \leq r \leq 1$ where r is the proportion of income value y in the reference group and F_0^{-1} the quantile function of F_0. Then, the relative distribution $g(r)$ is defined as the ratio of the densities of the two groups evaluated at the r-th quantile of the reference population:

$$g(r) = \frac{f(F_0^{-1}(r))}{f_0(F_0^{-1}(r)} = \frac{f(y_r)}{f_0(y_r)} \ \ 0 \leq r \leq 1, \ \ y_r \geq 0 \tag{1}$$

The resulting relative density $g(r)$ is a probability density function (PDF) of R. The relative distribution is scale-invariant, that is, its results are independent of the scale of the distributions (e.g., incomes versus log-incomes). From an intuitive point of view, the relative data r are the proportions of households in correspondence to the quantile

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[5] Actually, the aspects of the relative Probability Density Function and Cumulative Distribution Function as a basis for a comparative analysis were examined earlier by, for example, Parzen (1977, 1992), Cwik and Mielniczuk (1989, 1993).

y_r of the reference population that are realizations of a random variable R defined in [0, 1]. The rescaling imposed by the quantile function ensures that the density ratio is a proper PDF. If there are no differences between the two distributions, then $g(r)$ is uniform in the interval [0, 1] and the CDF of the relative distribution is a 45° line.

As mentioned, the relative distribution can be decomposed into a location effect (differences between the two groups due to changes in the average/median income) and a shape effect (differences in other moments of the distribution such as spread or skewness). This decomposition, unlike the relative distribution, is not scale-invariant.

Formally, let $F_A(y)$ be the location adjusted density function, i.e., the density of the random income variable (Y_A) in the reference group having the same median as the comparison group. The CDF of Y_A is $F_A(y) = F_0(y + \rho)$ where $\rho = \mathrm{median}(Y) - \mathrm{median}(Y_0)$ and its PDF is $f_A(y)$. Then, the decomposition into location and shape effects is represented as:

$$g(r) = \frac{f(y_r)}{f_0(y_r)} = \frac{f_A(y_r)}{f_0(y_r)} \times \frac{f(y_r)}{f_A(y_r)} \qquad (2)$$

In other words, the overall relative density is equal to the density ratio for the location difference multiplied by the density ratio for the shape difference. It should be noted that the shape effect, unlike the location one, is not a proper density, i.e., it does not sum up to one.

Handcock and Morris (1998)[6] proposed to measure the contributions of shape, location and other components effects to the total difference between the two distributions using the Kullback–Leibler divergence, defined as:

$$D(F; F_0) = \int_{-\infty}^{\infty} \log \left(\frac{f(x)}{f_0(x)} \right) \mathrm{d}F(x) = \int_0^1 \log \left(g(r) \right) g(r) \mathrm{d}r \qquad (3)$$

The right hand side of (3) is the differential negative entropy of the relative density. Applying (3) to (2) leads to:

$$D(F; F_0) = D_Y(F_A; F_0) + D(F; F_A) \qquad (4)$$

where $D_Y(F_A; F_0) = \int_0^1 \log \left(g_0^A(r) \right) \mathrm{d}r$ and $g_0^A = \frac{f(y_r)}{f_A(y_r)}$ is the location-matched relative distribution. The relative sizes of these terms directly indicate the relative contributions of location and shape to the overall difference between the distributions.

Morris et al. (1994) defined also what they called the *median relative polarization index* (MRP) of Y relative to Y_0, which is based on changes in the shape of the income distribution to account for polarization and able to measure the direction and the magnitude of the change.

More formally, the index that represents the mean absolute deviation from the median of g_0^A weighted by the absolute difference between the baseline rank of y and the median, is normalized so that it varies between -1 and 1, with 0 representing no

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[6] Mielniczuk (1992) and Parzen (1994) investigated the links between the relative distribution and the Kullback–Leibler measure of divergence.

change in income distribution for the reference year. Positive values imply an increase in the tails of the distribution, that is, in the polarization, while negative values represent convergence toward the median. The MRP can be expressed as following:

$$\text{MRP}(F;\ F_0) = 4 \int_0^1 \left| r - \frac{1}{2} \right| g_0^A(r)\, \mathrm{d}r - 1 \tag{5}$$

and $\text{MRP}(F;\ F_0) = -\text{MRP}(F_0;\ F)$, that is, the index is symmetric. Moreover, the MRP index can be decomposed additively into the lower (LRP) and the upper (URP) polarization index as follows:

$$\text{LRP}(F;\ F_0) = 8 \int_0^{1/2} \left| r - \frac{1}{2} \right| g_0^A(r)\, \mathrm{d}r - 1 \tag{6}$$

$$\text{URP}(F;\ F_0) = 8 \int_{1/2}^1 \left| r - \frac{1}{2} \right| g_0^A(r)\, \mathrm{d}r - 1 \tag{7}$$

$$\text{MRP}(F;\ F_0) = \frac{1}{2}\text{LRP}\,(F;\ F_0) + \frac{1}{2}\text{URP}\,(F;\ F_0) \tag{8}$$

Intuitively, the contribution to the overall polarization can be decomposed into the contribution due to the increase in the lower tail of the distribution (decrease in household incomes over the period) and in the upper half (upper tail) of the income distribution (increase in household incomes).

Like MRP, LRP and URP range from -1 to 1 and are equal to 0 when there is no change; they are invariant to monotonic transformation and they are symmetric.

The MRP value can be interpreted as the share of the population that moved away from the median. The explanation is given in Massari et al. (2009, p. 343): "This is because of the interpretation of MRP in terms of a proportional shift of mass in the distribution from more central to less central values: $\text{MRP} = 4d\delta p$, being d the distance between the median and the tails of the distribution, measured on the unit interval, and δp a net change in the mass." Using expressions (6) and (7) to (8), it is possible to define an additive property of the relative polarization indices: $\text{MRP} = \text{URP}^* + \text{LRP}^*$ where $\text{URP}^* = 0.5 \times \text{URP}$ is the share of the population which moved from the middle of the distribution to the upper quartile and $\text{LRP}^* = 0.5 \times \text{LRP}$ is the share of the population that moved from the middle of the distribution to the lower quartile (Handcock and Janssen 2002). In the empirical analysis, we use this latter formulation.

4 What happened to the Russian middle class between 1992 and 2008? Evidence from the relative distributional approach

We show the evolution of the middle class in Russia through a full distributional comparison: First, we analyze the relative PDF for each sub-period, second we decompose the overall relative distribution into location and shape effects, and finally, we compute relative polarization measures to quantify the degree of polarization (see Table 2).

Table 2 Polarization: 1992–2008

| Year	MRP	95 % CI	LRP*	95 % CI	URP*	95 % CI
1992–1993	0.247	[0.224, 0.267]	0.171	[0.151, 0.190]	0.076	[0.056, 0.097]
1993–1994	−0.095	[−0.118, −0.071]	−0.066	[−0.089, −0.043]	−0.029	[−0.053, −0.005]
1994–1995	−0.144	[−0.169, −0.119]	−0.088	[−0.113, −0.062]	−0.056	[−0.082, −0.030]
1995–1996	0.073	[0.047, 0.100]	0.066	[0.040, 0.093]	0.007	[−0.019, 0.034]
1996–1998	−0.264	[−0.289, −0.238]	−0.168	[−0.193, −0.144]	−0.096	[−0.122, −0.070]
1998–2000	0.055	[0.029, 0.081]	0.005	[−0.021, 0.031]	0.050	[0.024, 0.076]
2000–2001	0.235	[0.210, 0.259]	0.164	[0.141, 0.187]	0.071	[0.046, 0.095]
2001–2002	−0.040	[−0.064, −0.016]	−0.036	[−0.061, −0.012]	−0.003	[−0.027, 0.021]
2002–2003	0.075	[0.051, 0.099]	0.043	[0.020, 0.067]	0.032	[0.008, 0.056]
2003–2004	0.051	[0.027, 0.075]	0.041	[0.017, 0.065]	0.010	[−0.014, 0.034]
2004–2005	0.080	[0.056, 0.104]	0.059	[0.035, 0.083]	0.020	[−0.004, 0.044]
2005–2006	0.089	[0.066, 0.112]	0.055	[0.032, 0.078]	0.034	[0.010, 0.057]
2006–2007	0.053	[0.031, 0.075]	0.038	[0.016, 0.061]	0.015	[−0.007, 0.037]
2007–2008	0.116	[0.094, 0.139]	0.092	[0.070, 0.114]	0.024	[0.002, 0.047]

Mean and median incomes are expressed in 1992 rubles. Bootstrapped confidence intervals in parenthesis

Starting with the period 1992–1993, in the following subsections, we discuss adjacent years changes and total variations considering the entire period as a whole. We present our main results and their implications. [7]

4.1 Years 1992–1993

Figure 2 shows the relative distribution of Russian households income for the period 1992–1993 along with the relative distribution and the decomposition into location and shape effects for the period 1992–1993. It is evident (Fig. 2a) that there is a clear rightward shift of the whole distribution, which implies an increase in the median income and a change of the shape, especially in the middle income range. The 1992 distribution exhibits two modes, while the distribution in 1993 seems unimodal. Also evident is a substantial decline in the mass at the lower and middle income ranges from 1992 to 1993, accompanied by a spreading out of incomes in the top half of the distribution. Further insight is provided by the relative density function, reported along with the 95 % confidence interval in Fig. 2b. The relative distribution directly compares the two densities and indicates whether the upper and the lower tails of the distribution are growing at the same rate. Their values are smaller than 1 for percentiles below the median and larger than 1 for those above the median. This means that for any percentile below (above) the median in 1992, the percentage of households in 1993 with income at the chosen percentile is smaller (larger) than the corresponding percentage of households in 1992. The largest difference between 1992 and 1993 is at the top of

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[7] We used the reldist function in the reldist package available in the R Archive network (R Development Core Team 2012).
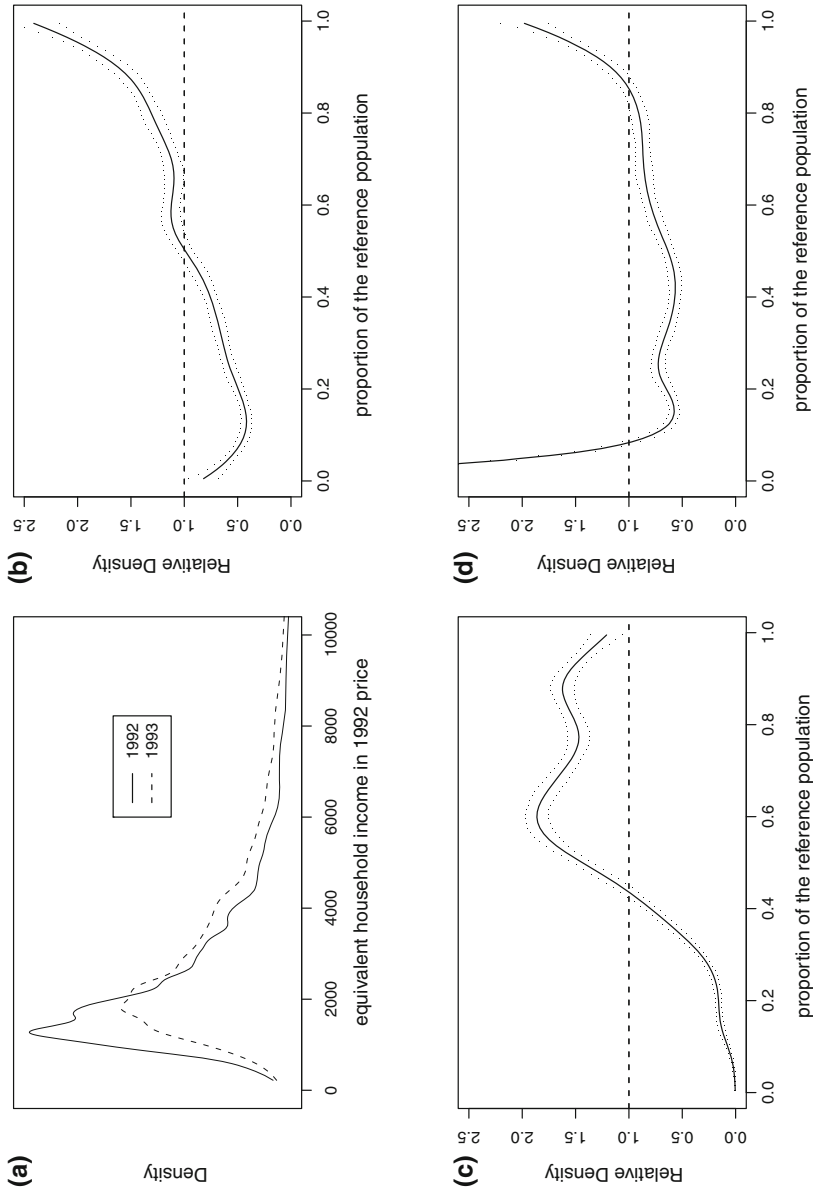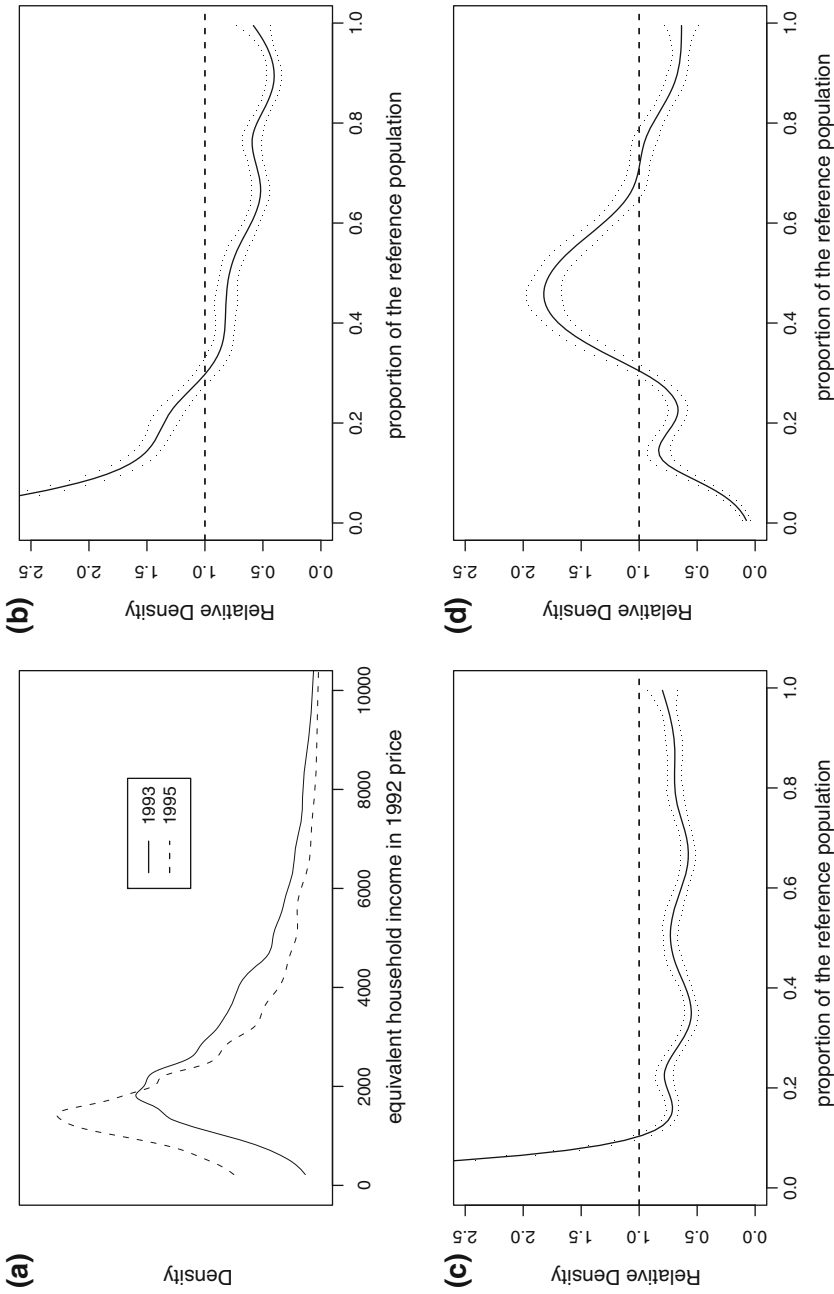
Fig. 2 Comparison and decomposition of income distribution between 1992 and 1993. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect

the distribution. The peak of the relative distribution (above 2) at the richest percentile means that Russian households in 1993 are more likely (at more than 100 %) to fall to the level of 1992 income corresponding to the richest percentile when compared with households in 1992. A more detailed picture is provided by the breakdown into location and shape effects, shown along with their confidence intervals in Fig. 2c, d, respectively. The location effect is related to the consequences of the median shift, i.e., the pattern the relative density would have exhibited if the distributional changes had occurred only because of location shifts in the density. The median shift is positive and we observe a decrease in the share of low-income deciles and an increase in the share of percentiles higher than 42, confirming the relative importance of the middle-income group. The shape effect gives insights on the overall distribution net of the median influence: We observe a decrease in the lower-middle class and an increase in the upper middle-income mass. Specifically, the isolation of the positive shift of the median translates into a decreased in households share between the 10th and 85th percentiles, namely a decline in both lower and upper middle-income groups. At the bottom of the distribution, however, the location shift follows the direction opposite to the shape effect. In terms of the shape effect, the highest value of the relative density was found for the poorest decile; in terms of the location effect, instead, the increase in the median leads to the conclusion that the poorest decile has the lowest relative density. Therefore, the losses experienced by the Russian households in 1993 are produced by both lower median gains and polarization.

These results clearly indicate that an important fraction of households experienced a growth in their income. On the other hand, the lowest part of the distribution shows significant loss in real incomes. The upper part of the distribution is characterized by significant changes and this is essentially due to the positive shift of the median. This graphical perception is confirmed by the polarization index: Its value, equal to 0.247, is the largest value of the entire period (confidence intervals and values for the polarization index are shown in Table 2).

4.2 Years 1993–1995

In contrast to previous years, 1993–1994 and 1994–1995 were periods of convergence. Figure 3 shows household income distributions and the relative distribution for the years 1993–1995. As shown in Fig. 3a, there is an important shift of the income distribution leftward. This large difference between 1993 and 1995 at the bottom of the distribution is corroborated by the highest relative density detected at the poorest decile. This value is essentially due to the location shift, i.e., the decrease in the median income (see Fig. 3c). This period is characterized by a decrease in the share of the middle class, as testified by the values of the relative distribution: They are greater than one for the three poorest deciles, indicating a prominent increase in the fraction of poorer households in 1995, and less than one for the remaining percentiles, indicating that right tail of the distribution had a heavier weight in 1993. Furthermore, from the analysis of the shape effect (3d), we can detect an increase in the share of households between the 30th the 75th percentile, i.e., an increase in the middle-income mass. Summarizing, this period resulted in the rise of the middle class with a moderate

Fig. 3 Comparison and decomposition of income distribution between 1993 and 1995. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect

reduction in upper income levels, which indicates convergence of Russian income distribution.

4.3 Years 1995–1996

In the following years (1995–1996), about 7 % of the population moves from the median to the lower quartile (see Table 2), indicating a moderate degree of polarization. Figure 4 shows the two income densities, the relative distribution and the decomposition into location and shape effects for this sub-period. The big difference between 1995 and 1998 is at the bottom of the distribution, where the lowest decile exhibits the highest relative density. This value is due to both location and shape effects (see Fig. 4c, d). For the middle class, the location effect does not show significant changes for percentiles higher than 25, while the shape effect indicates a decrease in the lower middle-income groups, between the 10th and the 40th percentile. Therefore, we still have a relatively important fraction of households in the upper middle class but a moderate decline of the lower-middle class.

4.4 Years 1996–1998

The relative density (Fig. 5b) shows an increase in the share for percentiles in the range 0.1–0.4 along with a decrease for the percentiles higher than 0.4, i.e., an increase in the lower middle and a decrease in the higher middle-income mass. Therefore, according to the relative density, a fraction of households in the lower income levels increased, while a fraction of rich households declined. This is essentially due to changes in the middle part of the distributions (see Fig. 5d).

4.5 Years 1998–2001

The two following periods (1998–2000 and 2000–2001) are characterized by polarization. Figure 6 shows the two kernel densities and the relative distribution for this period. Household income distribution shifts rightward in 2001 and is less concentrated than in 1998 (see Fig. 6a). In addition to that, the location effect graph (see Fig. 6c) shows an evident increase in the share of households in the higher percentiles, due to changes in the median.

The values of the relative distribution (see Fig. 6b) are less than 1 (more density in 1998) for percentiles below 65 and larger than 1 (more density in 2001) for higher percentiles, clearly indicating a decrease between 1998 and 2001 of Russian households with real income in the lower-middle range of the distribution. Net of median shifts, the decrease in the middle class is further revealed by the shape effect (see Fig. 6 d) that reveals an average decline of the mass between approximately the 10th and the 80th, more pronounced in lower percentiles. This visual impression is further corroborated by the relative polarization index. Its estimated value between 2000 and 2001, equal to 0.235 (see Table 2), is one of the largest values in the whole period. The rise of polarization in those years is accompanied by a slight decrease in inequality of
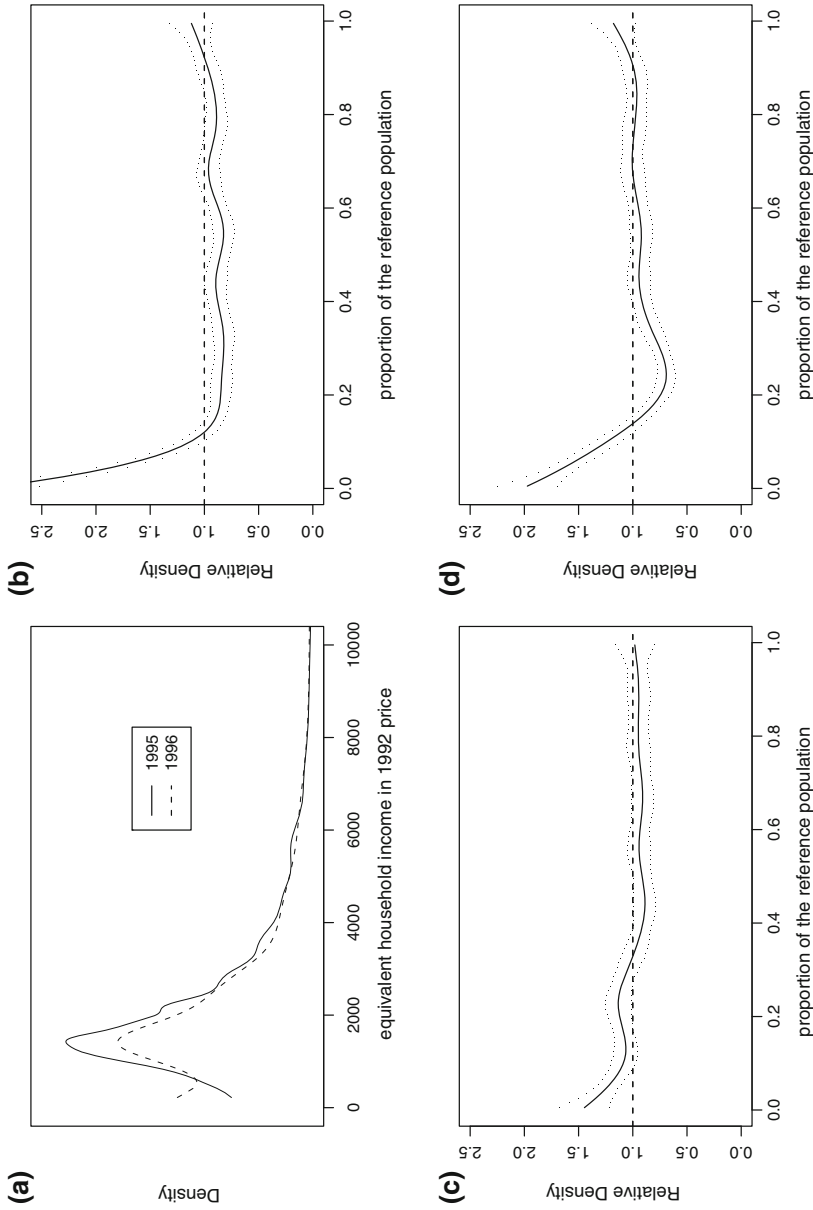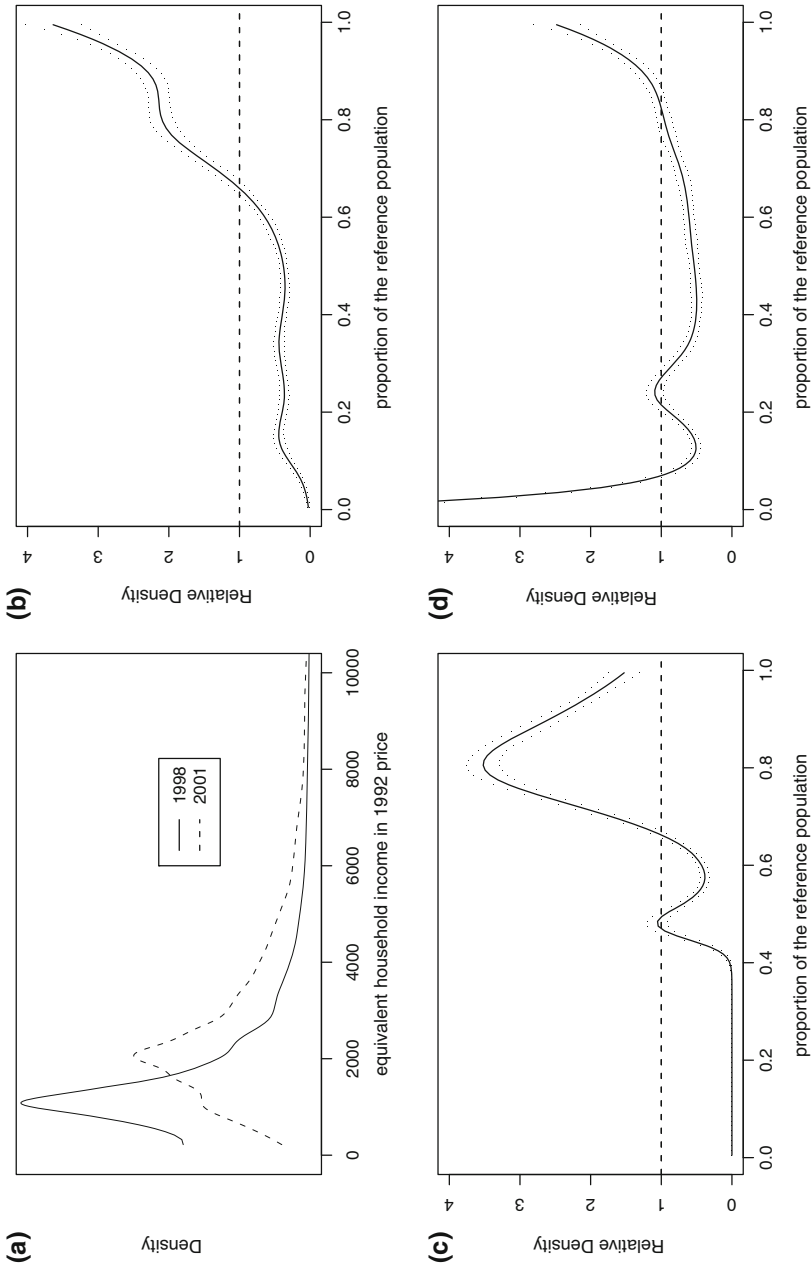
Fig. 4 Comparison and decomposition of income distribution between 1995 and 1996. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95% confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect
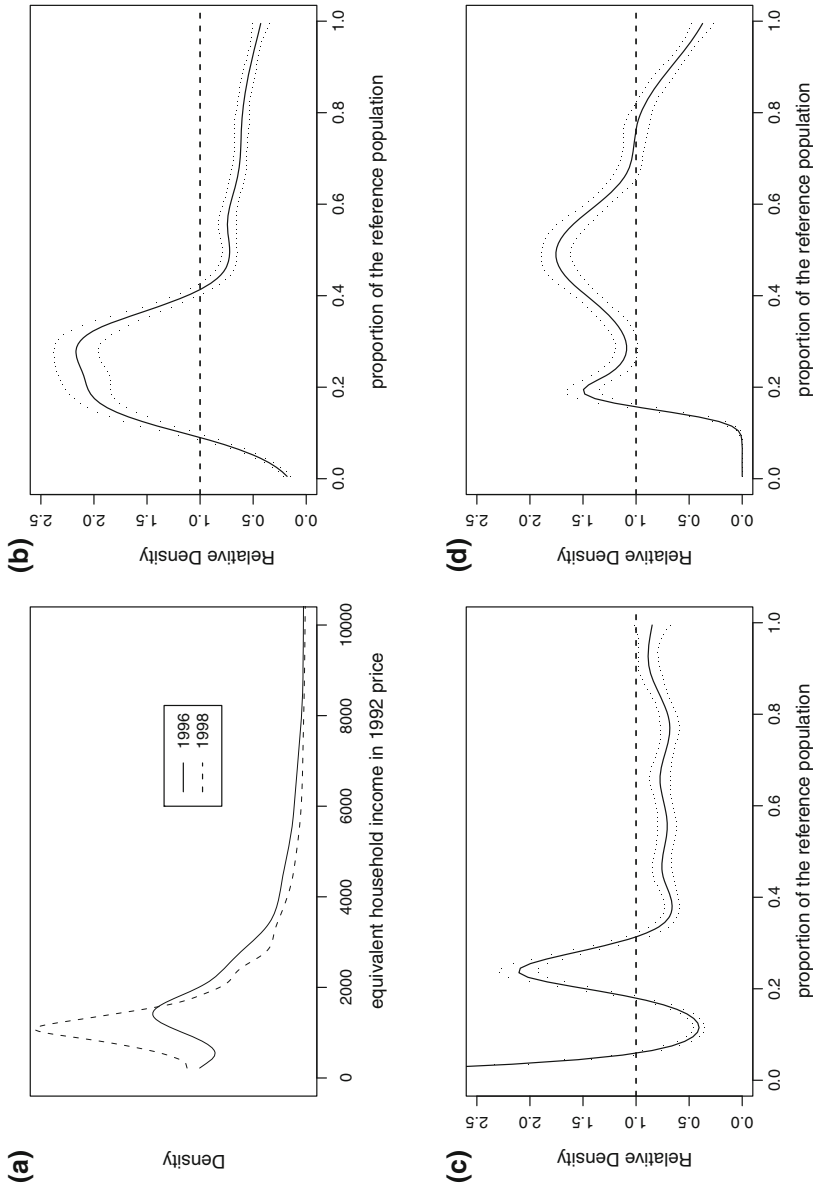
Fig. 5 Comparison and decomposition of income distribution between 1996 and 1998. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect

Fig. 6 Comparison and decomposition of income distribution between 1998 and 2001. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect

about 10 % (see Table 1). The largest difference between the two distributions is at the top of the density. The relative distribution shows its maximum value (above 3) at the richest percentile, i.e., the households in 2001 are more likely (at more than 200 %) to fall to the level of 1998 income corresponding to the richest percentile with respect to the households in 1998.

4.6 Years 2001–2002

Between 2001 and 2002, we observe a modest convergence toward the mass of the distribution. This shift involves the lower part of the income density that slight moves toward the median. Figure 7 shows the 2001 and 2002 income distributions along with the relative distribution and its decomposition. The overall relative distribution rises between the second and the third decile with a negligible decrease and an almost stable pattern. The rightward shift of the lower part of the density is much more evident for the location effect (Fig. 7c), which shows values higher than 1 for percentiles below around 35 and lower than 1 for the other percentiles. Its highest estimated value ($\simeq 2$) detected at the lowest percentile is essentially due to the decrease in median and mean income (see also Table 1). The shape effect confirms a moderate increase in the lower-middle class during this 2-year period. In fact, panel (d) of Fig. 7 shows an increase in the density between the second and third deciles, a decrease in the poorest and richest decile and nonsignificant changes for percentiles in the range between 0.4 and 0.9.

4.7 Years 2002–2008

In 2002, Russian households distribution starts to polarize. During the period 2002–2008, around 41 % of the distribution moves away from the median: 28 % to the lower quartile and 13 % to the upper one. To better understand what happened, we divided this period into two sub-periods: 2002–2005 (Fig. 8) and 2005–2008 (Fig. 9). Although the distributions in the two sub-periods are similar, we can detect some important differences. Income distribution in 2005 appears flatter than in 2002 with a fatter right tail. In other words, the overall relative distributions increase constantly and reach its maximum value in the percentiles above the median. Real median household income (in 1992 rubles) has grown significantly (around 42 %), and this translates into a steady increase in the location effect for all the percentiles above the median. The shape effects clearly shows a decrease in the mass of the distribution between the 25th and the 75th percentile accompanied by a substantial increase in the two tails. Starting from this period, we assist to a steady, relentless decline of the Russian middle class. This situation becomes clearer in the following sub-period (2005–2008). The 2008 household income distribution shifts rightward (see Figs. 1, 9a) with a particularly fat right tail. The relative density increases almost constantly and the shape effect evidences a polarization pattern. The median-adjusted relative distribution shows a marked decline of the mass between approximately the 18th and the 82nd percentile, indicating a collapse of the middle class and an increase in the bottom and top percentiles. The estimated relative polarization index equal to 0.116 from
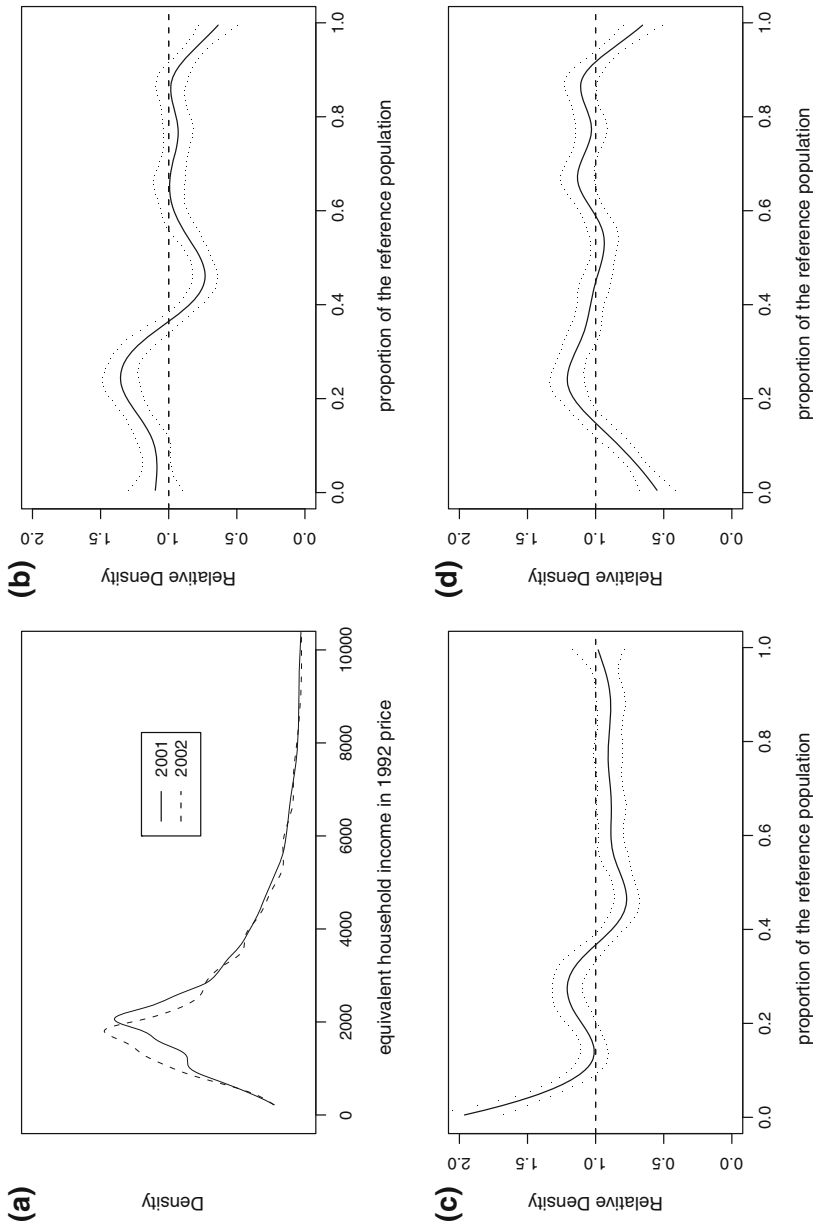
Fig. 7 Comparison and decomposition of income distribution between 2001 and 2002. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect
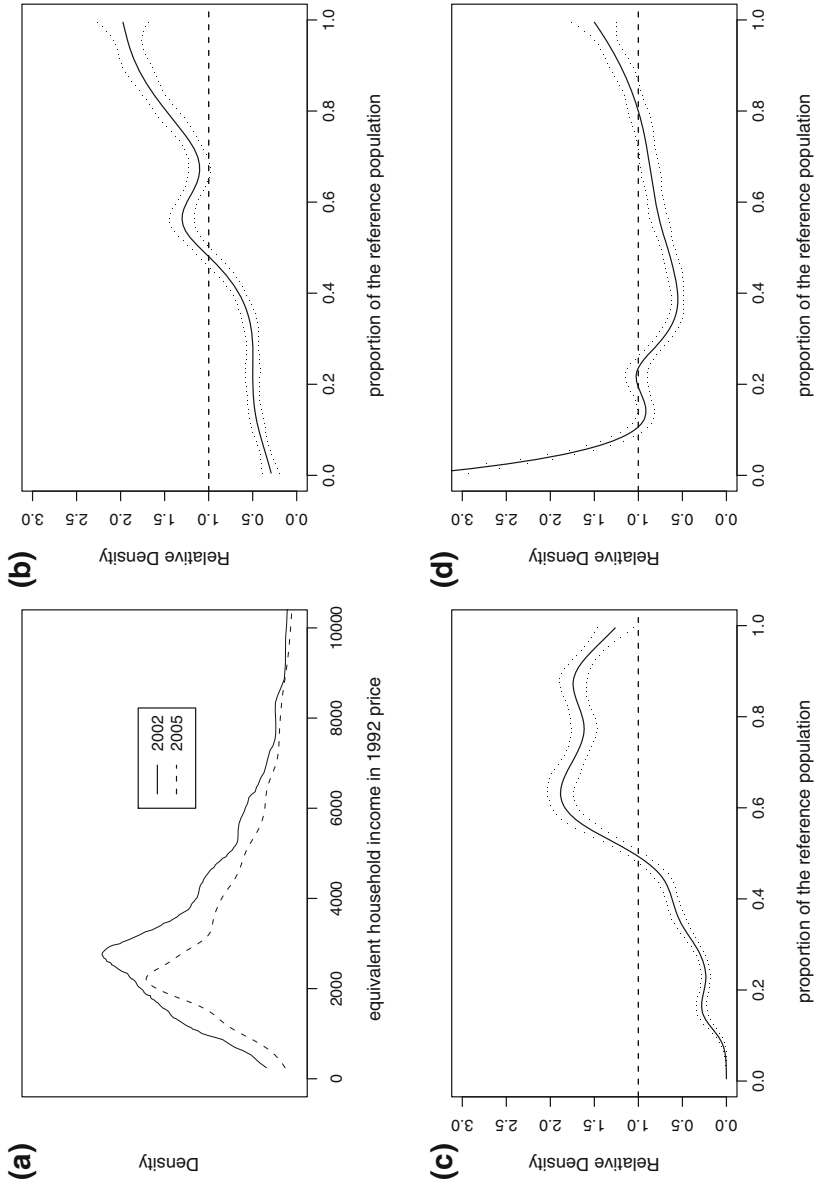
Fig. 8 Comparison and decomposition of income distribution between 2002 and 2005. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect
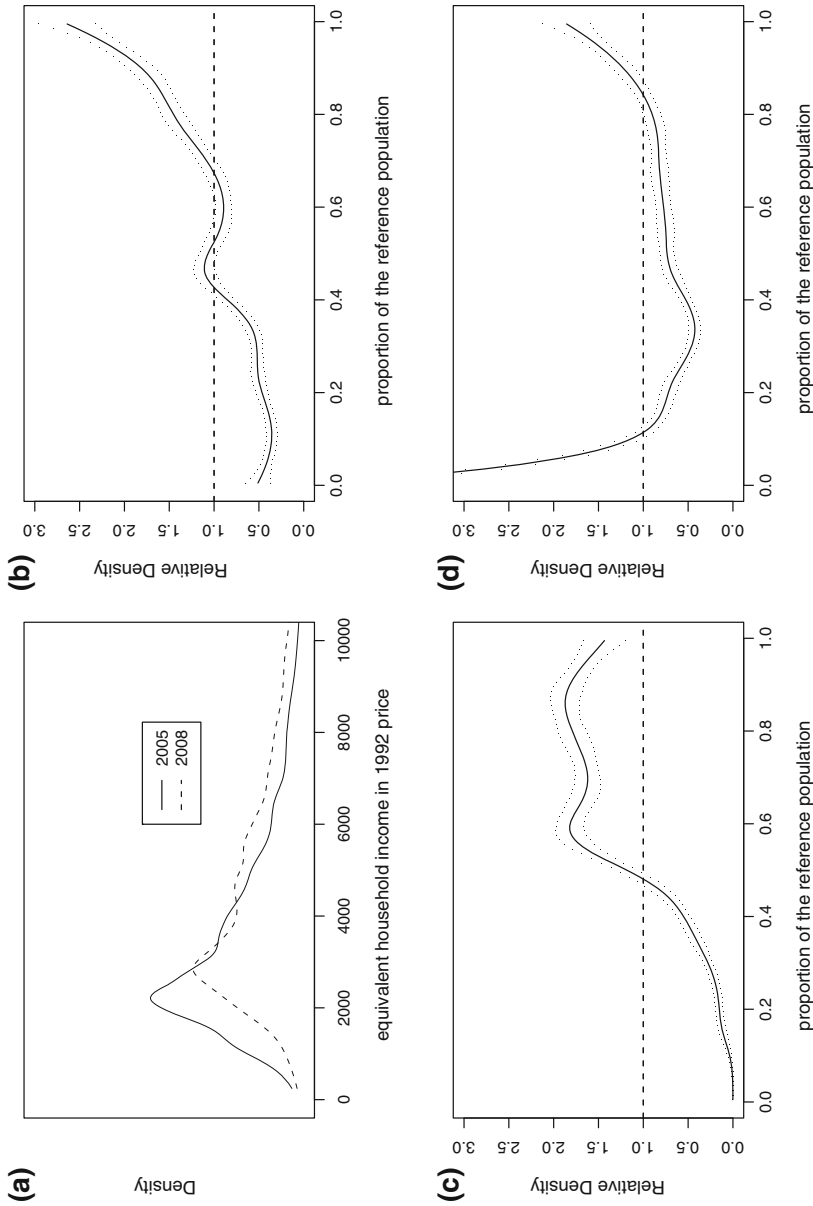
Fig. 9 Comparison and decomposition of income distribution between 2005 and 2008. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect

2007 to 2008, quantifies this graphical analysis: Around 12 % of Russian households population moved from the median to the tails of the distribution in only one year.

4.8 Years 1992–2008

To have a more general idea of the period, we also estimated the relative distribution considering the 1992–2008 interval as a whole. This perspective clearly evidences the collapse of the Russian middle class after the dissolution of the USSR in 1991. The graphs reported in Fig. 10 are particularly enlightening: The kernel densities are remarkably different. There is a significant shift of the distribution toward the right in 2008, the distribution is much less concentrated that it was in 1992 and a particularly fat upper tail is evident. During the period, the real median income increases more than 110 %; however, the relative inequality measured by Gini index does not substantially change (see Table 1). The relative distribution approach, however, enables us to detect what really happened inside the income distribution, details that summary measures were not able to capture. As shown by the relative density (Fig. 10b), there is decrease in the mass of the distribution below the sixth decile and an increase for the higher deciles: About 46 % of the distribution moved away from the median; 32 % to the lower quartile and 14 % to the upper one, indicating a clear diverging tendency. The largest difference between 1992 and 2008 is at the top of the distribution: Nearly 5 times as many households in 2008 are found in the highest percentile, based on the income level of 1992. Since the median shift is positive, the location effect reduces the share of households in bottom percentiles and increases the density in higher percentiles, confirming our previous conclusion. Net of the median influence, the shape effect clearly shows a diverging pattern, a decrease in the middle-income mass and an increase at the bottom and top of the distribution. Thus, the relative distribution method shows how income redistribution actually occurred in Russian households during the transition period: Income distribution diverged crucially, due to important changes in the shape. Although income inequality has remained almost stable in spite of economic and political turmoil in Russia, this period is characterized by a significant decrease in the middle class and a significant movement of the mass toward the tails.

4.9 Relative polarization

According to Eqs. (6), (7) and (8), we can quantify the degree of polarization already evidenced by the graphical tools.

Table 2 shows the median/lower/upper relative polarization indices (MRP/LRP*/ URP*) for 1992–2008, along with their 95 % confidence intervals. The median relative polarization indices, MRP, is positive when there is an increase in overall polarization, and negative when we observe convergence. This total outcome results from two different effects detected by LRP* and URP*: shifts from/to the median to/from lower quantiles and movements toward/from the median from/to the upper tail of the distribution.

Although the results depend on the base year, these indices allow us to keep track of changes in the shapes of income distribution across the whole period 1992–2008 by
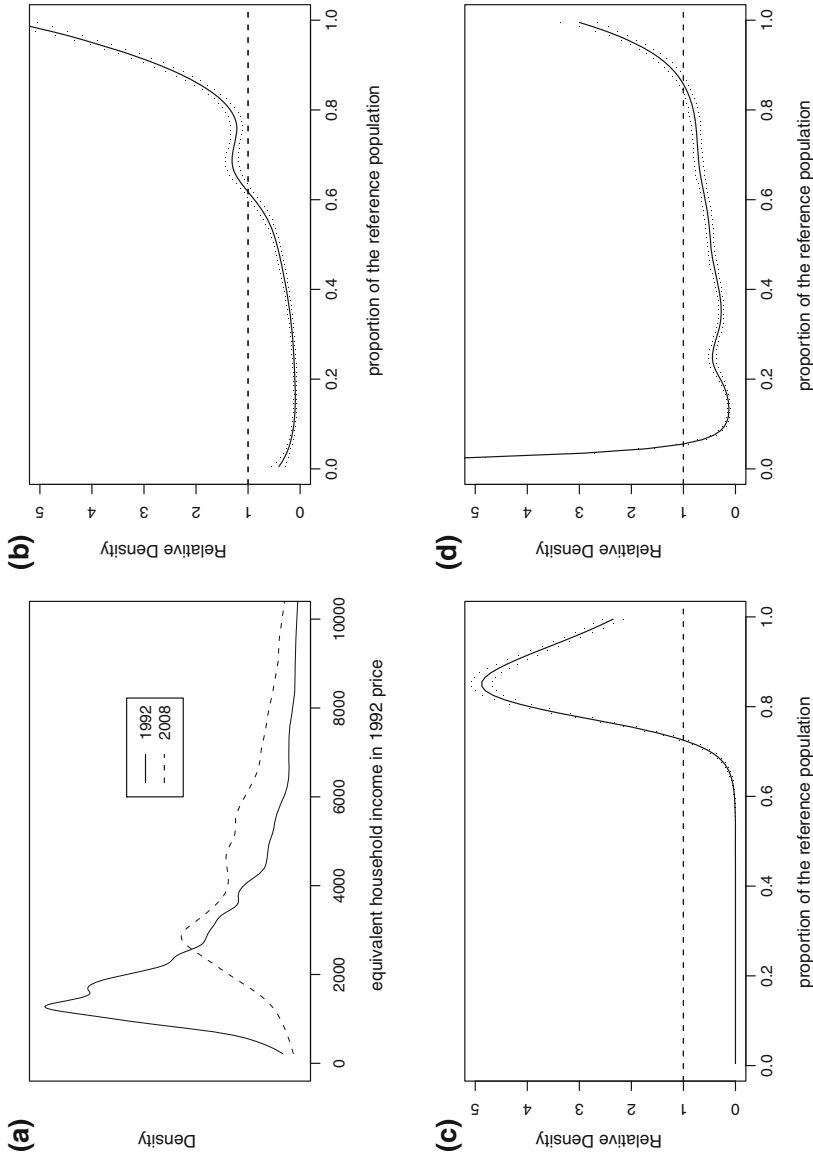
Fig. 10 Comparison and decomposition of income distribution between 1992 and 2008. Unknown densities are obtained as kernel estimates with adaptive bandwidth. Income data are size-adjusted and expressed in 1992 price. *Dotted lines* represent 95 % confidence intervals. **a** Kernel density, **b** relative distribution, **c** location effect, **d** shape effect

measuring the magnitude and the directions of the differences. In general, the absolute value of the LRP* is higher than the value of URP*, that is, the degree of polarization is essentially due to shifts from the median to the lower tail of the distribution.

The largest median relative polarization indices, MRP, are observed for the sub-periods 1992–1993 and 2000–2001, and are equal to 0.247 and 0.235, respectively. In both cases, they are significantly positive (at 5 % significance level), implying an increase in the overall polarization. In 1992–1993, around 25 % of the distribution moved from the median: This effect is the result of a 17 % population shift from the median to the lower tail and of a 8 % from the median to the upper tail of the distribution. In 2000–2001 these percentages change in 16 and 7 %, respectively. Both the indices LRP* and URP* have large positive effects indicating a clear process of divergence from the median of the distribution toward the tails. The sub-periods 1993–1994 and 1994–1995 are periods characterized by moderate convergence. Rather high convergence is detected instead in the sub-period 1996–1998: Around 26.4 % of the distribution moved toward the median; around 16.8 % from the lower quartile and 9.6 % from the upper quartile. We also estimated a modest degree of convergence in the sub-period 2001–2002. The sub-periods 1995–1996, 1998–2000, 2002–2003, 2003–2004, 2004–2005, 2005–2006 and 2006–2007 behave similarly. They are characterized by a moderate degree of polarization: The estimated values of MRP range from 5.1 % in 2003–2004 to 8.9 % in 2005–2006. In all cases, this outcome results from convergence toward the median in the lower tail and in the upper tail of the distribution. In the latest sub-period of analysis 2007–2008, the significant estimated value of MRP indicates polarization: About 12 % of the population moved from the median to the tails of the distribution; around 9 % toward the lower tail and around 2 % toward the upper tail.

Since the results are sensitive to the choice of the reference year, we estimated all the possible combinations changing baseline every year, starting from 1992 to 2007. What we have found[8] is the following pattern: The sub-period 1993–1998 is marked by high level of convergence (MRP= −0.423) and the sub-period 1998–2008 by a substantial level of polarization (MRP= 0.5907). These figures are in line with what happened in Russia: In 2006, the income of the 10 % rich is more than 13 times that of the poorest 10 %. These estimated results further confirm what we have already seen by the graphical analysis and the combination of the descriptive and inferential techniques has provided a considerable insight into the changes in Russian middle class over time.

When one considers the entire period comparing 2008 to 1992, one observes a significant degree of polarization (MRP= 0.460) further confirming that the Russian household distribution diverged.

5 Concluding remarks

Our analysis tried to assess the situation of the middle class in Russia during the process of economic transition and to distinguish between changes in income distribution due to differences in location and differences in shape. With respect to standard summary

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[8] Results are available upon request.

measures of distributional inequality, the relative distribution approach enabled us to discriminate between these aspects and understand where income growth occurred. Our analysis documents relevant changes in Russian household income, despite a stable pattern of inequality. The study of size-adjusted incomes indicates a clear shift of the distribution rightward, especially in 2008 and a median income growth greater than 100 %. Once we account for the median increase, a clear pattern of polarization emerges, due to both a downgrading of lower incomes and an upgrading of middle-high incomes. This agrees with the findings by Lefranc (2012), according to which wealthy Russian households are becoming wealthier, a pattern characterizing both the very top incomes as well as households whose income ranges above the 82nd percentile of the distribution. After a period of income convergence characterized by a rise of the middle class, in 1998 household incomes started to polarize, leading to a very significant degree of polarization in the year 2008. The conclusions based on graphical analysis are strengthened by the relative polarization indices, which clearly show a temporal pattern of increasing polarization with a peak in 2008, and a constant decrease in the middle class. In contrast to Maleva and Ovcharova (2009) but in line with Lefranc (2012), our results suggest a shrinking of the middle class in the years 2000–2008: The mass of the distribution tends to move mostly to lower quantiles of the income distribution. Therefore, our findings suggest that Russian economic growth altered the shape of income distribution and that political and economic reforms were not able to prevent a rather high degree of polarization which, in the year 2008, led to a collapse of the middle class, most exposed to the impact of the economic crisis (Delcour 2009). This failure in the rise of the middle class can be mainly explained in terms of the Russian labor market which is characterized by a prevalence of low-wage jobs and informal employment. In 2011, around 13 % of the employees of large and medium-sized enterprises earned wages below the subsistence minimum (Rosstat official data, 2011). Moreover, since the start of the economic crisis members of the middle class have been changing jobs more often than other social groups. In many cases, job changes are accompanied by wage reductions (Ovcharova 2012), explaining the movements of Russian households toward the lower tail of the distribution. Furthermore, according to the Russian Statistical Yearbook (2010), in 2009 at least 16 out of 69.3 million employees were informally employed. Weak contractual relations and extreme flexibility on salaries encouraged the proliferation of informal jobs typically combine with lower job security and lower earnings (Muravyev and Oshchepkov 2013). As pointed out by Maleva (2011), Russian households distribution reveals that the "Russian leadership's policy is still far from achieving its aim. This is not, as is often claimed, a consequence of the economic crisis and the subsequent rise in unemployment and fall in real wages, but rather of the fact that, in contradiction to its declared goal, the state in the past ten years has formed a society without a middle class." Methodologically, the relative distribution approach and MRP polarization indices offer a way to visualize and summarize these changes in Russian households income distribution. This method can be seen as an alternative to traditional simple mean- and variance-based analyses, since it allows one to identify which sections of the income distribution change.

Of course, our analysis is limited and can be extended. A step forward in the analysis would be to examine how different sources of household income might have impacted

on the observed pattern of polarization. Moreover, the decomposition of the relative distribution according to household characteristics like geographic location, gender, age and ethnicity would make it possible to detect the relative impact of different factors on the observed changes.

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