University of Warsaw
Faculty of Economic Sciences

Working Papers
No. 9/2019 (294)

WEALTH INEQUALITY IN CENTRAL AND EASTERN EUROPE: EVIDENCE FROM JOINED HOUSEHOLD SURVEY AND RICH LISTS' DATA

Michal Brzezinski
Katarzyna Sałach
Marcin Wroński

Warsaw 2019

WORKING PAPERS 9/2019 (294)

UNIVERSITY OF WARSAW
FACULTY OF ECONOMIC SCIENCES
WORKING PAPERS

Wealth inequality in Central and Eastern Europe: evidence from joined household survey and rich lists' data

Michal Brzezinski[a]*, Katarzyna Sałach[a], Marcin Wroński[b]

[a] *University of Warsaw, Faculty of Economic Sciences*
[b] *Warsaw School of Economics*
* *Corresponding author*: *mbrzezinski@wne.uw.edu.pl*

Abstract: We study how the problem of the 'missing rich', the underrepresentation of the wealthiest in household surveys, affects wealth inequality estimates for the post-socialist countries of Central and Eastern Europe (CEE). The survey data from the second wave of the Household Finance and Consumption Survey (HFCS) are joined with the data from the national rich lists for Estonia, Hungary, Latvia, Poland and Slovakia. Pareto distribution is fitted to the joined survey and rich lists' data to impute the missing observations for the largest wealth values. We provide the first estimates of the top-corrected wealth inequality for the CEE region in 2013/2014. Despite a short period of wealth accumulation during the post-1989 market economy period, our adjustment procedure reveals that wealth inequality in the Baltic countries is comparable to that of Germany (one of the most wealth unequal countries in Europe), while in Poland and Hungary it has reached levels observed in France or Spain. We discuss possible explanations of these findings with reference to the speed and range of privatization processes, extent of income inequality, and the role of inheritances and wealth taxes in the region.

Keywords: wealth inequality, missing rich, Pareto distribution, rich lists, Forbes, Household Finance and Consumption Survey, transition countries, Central and Eastern Europe

JEL codes: D31, D63, C46, P36

Acknowledgements: This study was supported by National Science Centre under contract UMO-017/25/B/HS4/01360.

1. Introduction

Although 30 years have passed since the fall of socialism in Central and Eastern Europe (CEE), we still know almost nothing about how economic transformation from command to market economies affected household wealth distribution in the region. There is an extensive literature measuring and evaluating the impact of the economic transition on income inequality (see, for example, Aristei and Perugini, 2014; Tóth, 2014; Perugini and Pomei, 2015; Bukowski and Novokmet, 2017; Novokmet et al., 2018), but the literature on inequality of wealth is scarce.[1] This unfortunate state of affairs can be attributed to the general lack of reliable data on household wealth in the CEE countries. We have therefore very little research documenting the scale of decompression of wealth distributions in the CEE after 1989, analyzing the differences in wealth inequality between the CEE countries or comparing wealth disparities between the CEE and Western Europe. Without this knowledge, our evaluation of the economic consequences of post-socialist transformation remains severely incomplete.

The availability of household wealth microdata has improved very recently, when five CEE countries (Estonia, Hungary, Latvia, Poland, and Slovakia) participated in the Household Finance and Consumption Survey (henceforth: HFCS) run by the European Central Bank (HFCN 2016; 2017). The HFCS provides comprehensive information on wealth distributions in a harmonized and cross-country comparable way. However, raw survey-based estimates of wealth inequality are significantly biased downwards due to survey non-response and under-reporting, which disproportionately concerns the richest households (Vermeulen, 2016; 2018). Empirical studies have shown that this 'missing rich' phenomenon leads to the underestimation of top 1% wealth share in such countries as Austria or Germany by as much as 8-10 percentage points (Bach et al., 2018; Vermeulen, 2018). Therefore, in order to provide reliable wealth inequality estimates some procedure of correcting for the problem of the missing rich should be applied.

In this paper, we provide first estimates of the top-corrected wealth inequality indices for the five CEE post-socialist countries. Following the methodology of Vermeulen (2016; 2018), we join household survey data from the HFCS with wealth data for the richest persons coming from national rich lists for Estonia, Hungary, Latvia, Poland and Slovakia. We fit Pareto models to the joined survey and rich lists' data to impute missing observations for the largest

[1] Novokmet et al. (2018) provide approximate results for Russia, but little is known about other post-socialist countries such as those of CEE. On the other hand, literature on wealth inequality in Western countries has recently exploded (see, among others, Piketty, 2014; Alvaredo, et al., 2018; Zucman, 2018).

wealth values. Finally, our top-correction procedure calculates inequality measures using the joined data sets with imputed observations for the missing rich persons.

We obtain three main empirical results. First, top-correcting for the missing rich in household surveys for the CEE countries significantly raises all wealth inequality measures. The top 0.1% wealth share doubles or even triples, while the top 5% wealth shares increase on average by 9.2 percentage points. The Gini coefficient is corrected by 5.4 points on average. Second, the top-corrections to wealth distributions in the CEE are in general larger than their counterparts for Western European countries. This suggests that the coverage of the rich should be improved in future waves of the HFCS for the CEE region. Third, we show that with respect to the level of wealth inequality, our CEE countries already caught up with the West. After the imputation of top wealth values, the share of top 1% in total household wealth in Poland is as high as in Spain, while in Slovakia, despite being lowest according to the raw survey data, it is as high as in France. Estonia catches up to Germany.[2] These results are rather surprising considering that the CEE countries entered the economic transition with highly compressed wealth distributions (Guriev and Rachinsky, 2008; Perugini and Pompei, 2015) and that the process of wealth accumulation under market conditions has been rather short. At the same time, the CEE countries did not experience Russian-style oligarchic privatization that led to the explosion of wealth inequality in Russia (Guriev and Rachinsky, 2008; Novokmet et al., 2018). We provide some possible explanations of our findings with reference to the speed and coordination of market reforms in different CEE countries, the development of income inequality, as well as the role of wealth taxes and inheritances.

The paper proceeds as follows. Section 2 reviews the previous research on household wealth inequality in the CEE region. Section 3 describes our data from the HFCS and national rich lists, as well as our methodology for top-correcting wealth distributions. We present and discuss our empirical results in section 4.

2. Previous research on wealth inequality in transition countries

Until very recently, wealth and wealth inequality in post-socialist countries 'remained enigmatic' (Heyns, 2005) due to lack of reliable data. Wealth inequality estimates for the CEE region were scarce and based on non-representative or very incomplete data. For example,

[2] Germany is one of the most wealth-unequal countries in Europe (cf. Figure 1 below).

Yemtsov (2008) used household survey data to study the distribution of housing wealth in Poland, Russia and Serbia around 2001-2003. He found that housing privatization contributed significantly to increased housing inequality in all three countries, but the effect was the lowest in Poland where privatized housing stock was quite evenly spread across the distribution of housing wealth. Guriev and Rachinsky (2008) argued that wealth inequality in post-socialist countries must have increased due to multiple factors such as decompressing wage inequality, different saving rates of the poor and the rich, privatization of housing, socialist enterprises (and other previously collectivized assets such as agricultural land), the growth of private entrepreneurship, and others.[3] They have also suggested that in Russia and other Post-Soviet states overall wealth inequality was probably amplified by the rise of oligarchs and specific features of privatization processes in these countries (see also Alexeev, 1999). They also observed that wealth disparities in the CEE countries grew less than in the Post-Soviet states as for the former the prospects of the EU accession served as a commitment device to introduce institutions for greater equality of opportunity. However, they were unable to quantify the extent of wealth inequality in the post-socialist countries.

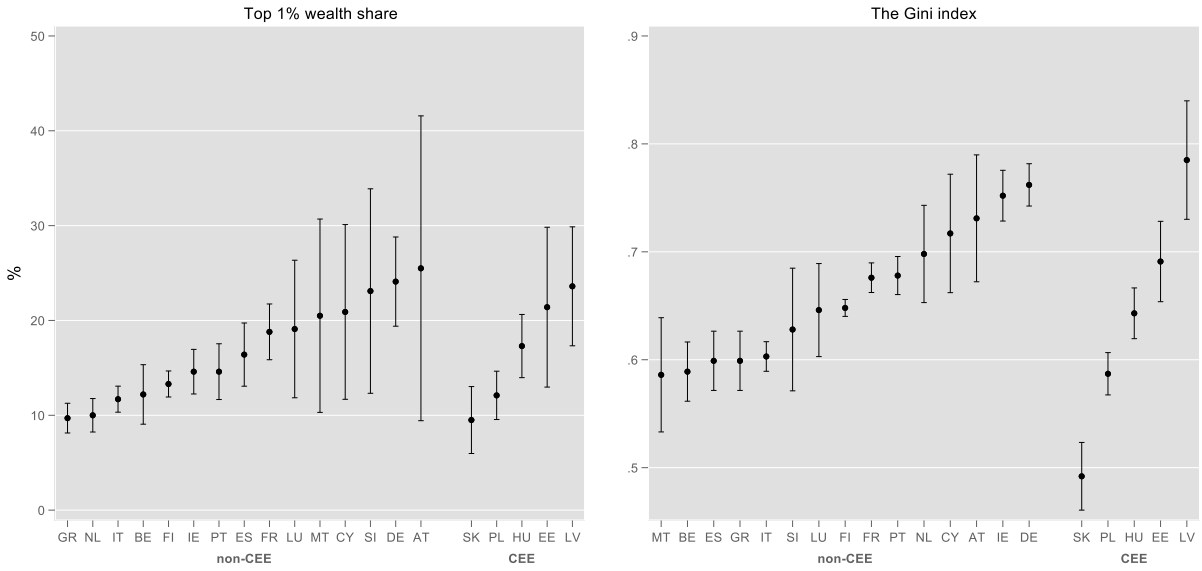
Skopek et al. (2014) used data from the Survey of Health, Ageing and Retirement in Europe (SHARE) to study wealth inequality in Czechia, Estonia, Hungary and Poland (along with many other rich European countries) over 2006-2012. The major limitation of their work is that the SHARE covers only population aged 50 and above. They found that CEE countries are distributed over the full range of levels of net wealth inequality. Estonia emerged as the most unequal country in the sample (with the Gini index of 0.67), Czechia was among the most equal with respect to wealth (with the Gini index equal to 0.49), while Hungary and Poland displayed moderate levels of wealth inequality (with the Ginis equal to 0.51 and 0.56, respectively).

The first fully representative and reliable survey on household wealth in the CEE countries appeared with the implementation of the Eurostat Household Finance and Consumption Survey (HFCS) (HFCN, 2016). The first wave of this survey conducted in 2010 provided data for Slovakia (among other euro area countries), while the second wave conducted in 2013/2014 added information for Estonia, Hungary, Latvia and Poland. Figure 1 presents estimates of wealth inequality (using the Gini index and top 1% wealth share) from the HFCS for the CEE and non-CEE countries. The numbers confirm findings of Skopek et al. (2014). Indeed, the CEE countries seem to be distributed over the full scale of survey-based wealth inequality measures

[3] See also Alexeev (1999) and Ferreira (1999) for theoretical analyses of wealth inequality in post-socialist transition.

in Europe – Slovakia is at the bottom of the ranking, Poland and Hungary belong to the middle, while the Baltic countries are placed among the most unequal countries in Europe. In this paper, we verify whether these conclusions hold if we account for the missing rich persons from the CEE region in the HFCS data.

Figure 1. Household net wealth inequality measures from the second wave of the HFCS (2013/2014)



Note: Vertical bars show 95% confidence intervals obtained using bootstrap.
Source: HFCN (2017) and own calculations.

The HFCS data have been used also in the Credit Suisse Research Institute's Global Wealth Reports (Davies et al., 2018), which produce annual wealth and wealth inequality estimates for over 200 countries for the period from 2000 to 2018. Davies et al. (2018) report that they adjust the upper tail of wealth distribution using data from the Forbes World's Billionaire List, but as noticed by Novokmet el al. (2018) the authors do not provide a list of the countries for which the adjustment, nor the methodological details of the adjustment procedure. Furthermore, the Forbes World's Billionaire List records almost no billionaires from the CEE countries, so the eventual adjustment made by Davies et al. (2018) for the transition countries is severely underestimated.

A recent study by Novokmet et al. (2018) traces the evolution of wealth inequality for Russia over 1995-2015. This is the only existing paper that attempts to provide quantitative evidence on the trend in wealth inequality in a post-socialist country over time. The results show that wealth concentration in Russia increased substantially between 1995 and 2015 with the top 1% wealth share reaching in 2015 about 43% – a level comparable to that of the US and

much higher than those of China or France. However, the authors themselves stress that their estimates should be treated very cautiously. There are no household micro data on wealth for Russia coming from wealth surveys or administrative sources. Only individual data about the wealth of the richest Russians from the Forbes World's Billionaire List and national rich lists is available. In face of these difficulties, Novokmet et al. (2018) combine Forbes data for the richest Russians with the data for the rest of population (below the 99th percentile) drawn from the normalized wealth distributions for the US, France and China. This means that Novokmet et al. (2018) assume that wealth distribution in Russia for the bottom 99% of the population has the same shape as the normalized average distribution for the US, France and China. This is a very strong assumption and we prefer not to follow this approach.

3. Data and methods

3.1. Wealth data from the HFCS and national rich lists

We use data from the second wave of the HFCS (HFCN 2016). The HFCS is a household wealth survey coordinated by the European Central Bank and conducted by national partners. The HFCS follows OECD (2013) guidelines for micro statistics on household wealth. Therefore, the survey is based on the concept of private marketable wealth. Our main variable, net household wealth, is defined as real assets plus financial assets minus households' liabilities. The European Central Bank (ECB) is responsible for the development of a survey questionnaire and common methodology, while national partners conduct the survey in each participating country. The ECB pools the data and controls the quality of country datasets. The highest possible harmonization of the survey among countries and high level of international comparability of results are crucial goals of survey organizers. Five countries from the Central Eastern Europe participated in the second wave of the survey. In each of them, the HFCS has been the first comprehensive survey on household wealth ever conducted.

Table 1 presents information on the survey design and descriptive statistics for the HFCS and other data sources we use. The HFCS sample size for the CEE countries varies between 2135 and 6205. The mean value of household wealth is highest in Poland and Estonia, while households in Latvia are the poorest among the countries we study. Maximum value of wealth in the survey sample ranges from 4 million euros in Latvia to 14 million euros in Estonia.

Household wealth surveys are plagued by the number of problems resulting in biased estimates of top wealth values. Firstly, it is hard to achieve an adequate level of representation of wealthy households in the sample. Lower response rate of wealthy households (often referred

to as differential unit non-response) is another challenge. Moreover, if underreporting of assets is positively correlated with household wealth the resulting wealth inequality will also be biased downwards. Although due to data limitations little is known about the differential underreporting, existing evidence suggests that it exists and contributes to the downward bias (Vermeulen, 2016; 2018).

Table 1. Descriptive statistics for wealth distributions in CEE taken from the HFCS and national rich lists

Sample	Data set	Number of observations	Oversampling top 10 %	Mean	Standard Deviation	Minimum	Maximum
Estonia (2013)	HFCS	2220	31 %	97	353	- 65	14 000
	Äripäev	503		20 500	30 100	5 600	298 000
Hungary (2014)	HFCS	6205	2 %	51	12	-355	4 104
	Napi.hu	100		79 600	99 400	17 300	490 000
Latvia (2014)	HFCS	1202	53 %	40	121	-170	4 065
	Kapitals	100		28 800	49 200	7 000	299 000
Poland (2014)	HFCS	3455	10 %	96	159	-31	4 606
	Forbes PL	103		235 000	424 000	50 200	2 700 000
Slovakia (2014)	HFCS	2135	5 %	66	111	-43	8 796
	Forbes SK	10		675 000	603 300	390 000	2 370 000

Note: "Effective oversampling rate" of the top 10% is equal to (S90 – 0.1)/0.1, where S90 is the share of sample households in the wealthiest 10%. Effective oversampling rate of the top 5%" equals (S95 – 0.05)/0.05, where S95 is the share of sample households in the wealthiest 5% (HFCN 2016). All monetary values are given in thousands of euro.

Source: Own calculations using data from the HFCS, Äripäev (2013) Napi.hu (2014), Kapitals (2014), Forbes Polska (2014), Forbes Slovensko (2015).

Oversampling is used by survey organizers to correct, at least partially, for the resulting bias. In the HFCS, oversampling of wealthy households was conducted in 15 of 20 participating countries. Despite the common methodology of the survey, national partners are allowed to choose the rules of oversampling to correct lower response rates of wealthier households. Estonia and Latvia oversampled wealthy households using tax registers, which resulted in higher effective oversampling rates than in the rest of CEE countries. Hungary and Poland oversampled households from wealthiest regions of their countries. Slovakia also used regional oversampling strategy, but it was based on smaller regional units than in Poland and Hungary.

Item non-response is a common phenomenon in complex surveys. To limit this problem, survey organizers use the multiple imputation approach (HFCN 2016). If the value of variable was missing, five plausible values were imputed in the HFCS data. We perform our analyses separately on each of five data sets (implicates) with imputed values and combine the results (see section 3.2). The HFCS contains also sampling weights that take into account: (i) the unit's

probability of selection; (ii) coverage issues; (iii) unit non-response; and (iv) an adjustment of weights to external data (HFCN 2016). We use sampling weights in all our estimations.

To correct for the problem of the missing rich, we pool the HFCS data with data on the country's richest persons coming from national rich lists published by national business magazines. We use *Äripäev* rich list (2013) for Estonia, *Kapitals* rich list (2015) for Latvia, *Napi.hu* rich list (2014) for Hungary and Forbes rich lists for Poland (2014) and Slovakia (2015)[4]. All the national rich lists are published annually. They are developed on the basis of publicly available data on the value of individuals' (mostly business) assets. Coverage of personal wealth, such as private real estate, financial investments other than business assets or art, is highly limited or non-existent. Due to these limitations, values on a rich list should be seen as a lower bound of net wealth of the richest people in a country.[5]

Table 1 shows that that only in Estonia the minimum value of wealth in the rich list (5.6 million euros) is lower than the maximum value of household wealth in the survey sample (14 million euros). In other countries, we observe a significant gap between the maximum wealth in the HFCS and the minimum in the rich list. This confirms that in general household survey data miss a significant portion of the richest households. Estonia is an exception here, since its rich list is extremely long – it includes 500 people in the country with population of approximately 1.3 million. On the other hand, for Slovakia the available rich list contains only 10 observations.

It should be noted that wealth in the HFCS is measured on the household level, while the rich lists are not based on a clear unit of measurement. Most of entries refer to single persons, but entries referring to households or broader family clans are also common. Some studies (see, for instance, Bach et al., 2018 for Germany) try to correct for this problem by merging rich lists entries into households. We do not follow this approach as it is often difficult to identify clearly family relations between people on a rich list. It is also doubtful if such correction leads to statistically significant results.

[4] Slovakian rich list was published in 2015, but it reports wealth values for 2014.

[5] Another limitation is that for many countries a significant share of household wealth is held in offshore tax havens. However, this seems to be a lesser problem for the CEE countries as compared, for example, with Russia. Alstadsæter et al. (2018) estimate that the amount of offshore household wealth for our selection of CEE countries was in 2007 equal on average to 3.1% of the GDP, while it was about 50% for Russia and 12.8% on average for all Europe.

3.2. Methods

Several recent papers provide alternative methodologies, which adjust survey wealth data for the problem of the missing wealthy respondents.[6] Vermeulen (2016; 2018) proposed to combine household wealth data from surveys and from rich lists, fit the Pareto distribution to the combined data set, and impute the largest wealth observations using the estimated Pareto distribution parameters. He has used top wealth values from the Forbes World's Billionaires List. Vermeulen (2018) provides top-corrected estimates of wealth inequality measures for the US, the UK, and nine euro area Western European countries. Bach et al. (2018) extended Vermeulen's (2018) approach by using national rich lists instead of the Forbes list. Eckerstorfer et al. (2016) do not employ rich list data but impute the largest wealth observations based on the Pareto model fitted to survey wealth data for Austria. They use formal statistical criteria to estimate the cut-off wealth above which survey data follow the Pareto distribution as well as evaluate the fit of the Pareto model using formal goodness-of-fit tests. In this paper, we integrate advantages of the existing approaches by combining survey wealth data with country-specific national rich lists and using formal statistical techniques to estimate parameters of the Pareto distribution and assess goodness-of-fit.

Large literature shows that the upper tail of wealth distribution is well-approximated by the Pareto distribution (known also as the Pareto Type I model or as 'power law' distribution) (Levy and Solomon, 1997; Davies and Shorrocks, 2000; Klass et al., 2006; Cowell & Van Kerm, 2015). The Pareto distribution is characterized by the following complementary cumulative distribution function (*ccdf*):

$$P(W > w) = \left(\frac{w_{min}}{w}\right)^{\alpha}, w > w_{min} > 0 \quad (1)$$

where w in our context denotes household net wealth values, w_{min} is the lower-bound on the Pareto distribution (or the threshold above which the distribution follows the Pareto model), and $\alpha > 0$ is the Pareto shape parameter (or Pareto tail index), which captures the heaviness of the upper tail of the distribution. The lower the α, the heavier is the upper tail of the Pareto distribution and the more unequal is the distribution.

A useful property of the Pareto distribution is that for any level of wealth, w, the average wealth higher than w, w_A, is given by $\frac{\alpha}{\alpha-1}w$, which is known as the 'van der Wijk's law' (Cowell and Van Kerm, 2015). Therefore, the ratio of w_A and w is a constant $\frac{\alpha}{\alpha-1}$ and does not depend

[6] See Dalitz (2018) for a comprehensive technical overview of the methods presented in this section.

on *w*. This property can be used to find visually an approximate value of the lower-bound threshold on the Pareto behaviour (w_{min}).

There are several suitable methods for estimating the Pareto tail index α. As noted by Vermeulen (2018), the pseudo-maximum likelihood estimator accounting for survey weights is defined as follows:

$$\alpha_{pml} = \left[\sum_{i=1}^{n} \frac{N_i}{N} \ln\left(\frac{w_i}{w_{min}}\right)\right]^{-1}, \tag{2}$$

where N_i is the survey weight for the *i*th household, $i = 1, \ldots, n$, representing the number of households that the sample observation represents, and *N* is the sum of all survey weights.

Another useful estimator for the Pareto tail index is based on the OLS regression. Equation (1) implies that for a simple random sample drawn from Pareto distribution $\{w_i, i = 1, \ldots, n\}$ and sorted from the largest to the smallest observation, $w_1 \geq w_2 \geq w_3$ ..., the *ccdf* (one minus cumulative distribution function) is approximated by:

$$\frac{i}{n} \cong \left(\frac{w_{min}}{w_i}\right)^{\alpha}, w_i \geq w_{min}. \tag{3}$$

After taking logarithms of both sides and re-arranging, Equation (3) becomes:

$$\ln(i) = C - \alpha \ln(w_i), \tag{4}$$

with $C = \ln(n) + \alpha \ln(w_{min})$.

Gabaix and Ibragimov (2011) have shown that the bias in the estimator of α obtained by the OLS regression on Equation (4) can be largely removed by replacing the rank *i* by *i* – 1/2:

$$\ln(i - 1/2) = C - \alpha \ln(w_i). \tag{5}$$

Finally, Vermeulen (2018) shows that accounting for survey weights Equation (5) becomes:

$$\ln\left((i - 1/2)\frac{\overline{N_{fi}}}{\overline{N}}\right) = C - \alpha \ln(w_i), \tag{6}$$

where $\overline{N}$ is the average survey weight for an observation, and $\overline{N_{fi}}$ is the average weight of the first *i* observations. We obtain a regression-based estimator of α, α_{reg}, by estimating Equation (6) using the OLS.

Most of the empirical studies choose the lower bound on the Pareto distribution, w_{min}, using visual inspection of the van der Wijk's law. We follow a more principled approach and

apply a procedure proposed by Clauset et al.'s (2009).[7] According to the method, for each w_i> 0 we estimate the Pareto tail index using α_{pml} or α_{reg} and compute the well-known Kolmogorov–Smirnov (KS) statistic for the sample and the fitted model.[8] We choose our main estimate of w_{min} as the w_i for which the KS statistic is the smallest. However, we also check whether our results are robust to other choices of w_{min} using visual inspection of figures depicting the van der Wijk's law.

After fitting the Pareto distribution to the HFCS survey data, we also check whether the Pareto distribution is a plausible model for the data. This test is important as it assures us that it is statistically justified to model the upper tail of our wealth data with the Pareto distribution. We follow Clauset et al. (2009) and Eckerstorfer et al. (2016) in using a semi-parametric goodness-of-fit bootstrap procedure to test whether the Pareto distribution fits well the HFCS survey data. The procedure starts with fitting the Pareto distribution to the original data set using the methods described above. We denote a KS statistic calculated for the original data set as *ks*. Next, we generate a large number of bootstrapped synthetic data sets that follow the Pareto distribution fitted to the original data set and have the same distribution as the original data set below estimated value of w_{min}. Then, Pareto models are fitted to each of the generated data sets, and the KS statistics are calculated. The fraction of data sets for which their own KS statistic is larger than *ks* is the *p*-value of the test. Following Clauset et al. (2009), we do not reject Pareto distribution if the estimated *p*-value is greater than 0.1. In our tests, we use 999 generated data sets.

We account for the missing rich households in survey data by pooling the HFCS wealth data with the observations from country-specific rich lists. We assign weights equal to one for each observation drawn from the rich lists. Pareto models are then fitted to the pooled data sets and estimates for w_{min}, α_{pml}, and α_{reg} are obtained. Using the estimates, we impute synthetic households with wealth higher than the estimated w_{min}, but lower than the lowest household net wealth value drawn from the rich lists. We assign weights to imputed households in order to match the total sum of household weights in the original HFCS data set with wealth higher than our estimate for w_{min}. The whole procedure is performed separately for each country and for each of the HFCS five implicates and all results (Pareto distribution parameters and wealth inequality measures) are averaged over the five data sets. We report our estimates for the most popular wealth inequality measures (Cowell and Van Kerm, 2015): the top 100*p*% shares of

[7] See Eckerstorfer et al. (2016) and Dalitz (2018) for an application of this type of method in context of wealth distributions.
[8] We adjust the KS statistic to account for the survey weights.

total household wealth (p = 0.10, 0.05, 0.01, 0.001), the Gini index, and the Generalized Entropy (GE) indices of inequality with inequality-aversion parameters set to one and two. GE(1) is also known as the Theil index, while GE(2) is equal to half the squared coefficient of variation.[9]

4. Empirical results

4.1. Fitting Pareto models to joined survey and rich lists' data

We start this section by presenting our estimates of w_{min} and Pareto tail indices α, together with the results of goodness of fit tests (Table 2). As noted in section 3.2, the parameter w_{min} is the lower bound on the Pareto distribution, while α describes the "fatness" of the tail: the lower the value of α, the more concentrated wealth. Our estimated w_{min} ranges from about 36,000 euro for Latvia to almost 200,000 euro for Poland. The proportion of sample with wealth higher than w_{min} varies from 12-13% for Poland and Hungary to 20-25% for Estonia and Latvia. This result is consistent with higher effective rates of oversampling of wealthy households achieved in the Baltic countries' samples. Since the HFCS samples for Estonia and Latvia have better coverage of the upper tail of wealth distribution, it is not surprising that the Pareto distribution can be fitted to a larger segment of the tail of wealth distributions.

Table 2. Estimated parameters of Pareto models and goodness of fit test results

Country	w_{min} (euro)	Proportion of sample with $w > w_{min}$ (in %)	Original HFCS data		Goodness of fit test (p-value)	HFCS data with imputed top values
			α_{pml}	α_{reg}		α_{reg}
Estonia	117 042.2	19.6	1.376	1.398	0.208	1.272
Hungary	94 666.3	13.0	1.742	1.716	0.477	1.532
Latvia	36 025.6	25.0	1.142	1.186	0.822	1.365
Poland	199 765.0	11.9	2.031	2.042	0.524	1.636
Slovakia	108 586.4	18.9	2.346	2.228	0.064	1.557

Note: HFCS sampling weights are used. α_{pml} refers to the Pseudo-ML estimate and α_{reg} to the estimate using the OLS. All values are averages across five implicates.
Source: Own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014), and Forbes Slovensko (2015).

The comparison between α_{reg} estimated on HFCS data with imputed top values (last column in Table 2) and the α_{reg} estimated only on HFCS data (column 5) reveals that in all but one country (Latvia) correcting for the missing rich indeed significantly "fattens" the right tail.

[9] Among inequality indices that we use, the Theil index is the only one not admitting zero or negative household net wealth values. We drop such values in calculation of this measure.

Our results are much in line with Vermeulen's (2018), who calculates Pareto tail indices for nine eurozone countries as well as for the UK and the US, correcting for the missing rich using Forbes World Billionaires list. His corrected estimates vary from 1.46 for Austria to 1.88 for Finland, whereas ours vary from 1.27 for Estonia to 1.64 for Poland. The maximum reduction in the value of estimated α observed by Vermeulen amounts to 0.44 for Italy. Our maximum reduction equals 0.79 for Slovakia. However, the results for this country should be treated with caution, since Slovakian data on average passes goodness-of-fit test only at 10% significance level. For comparison purposes, we report also results for the pseudo-maximum likelihood estimator α_{pml}. Small differences between α_{pml} and α_{reg} assure us that the estimation results are close to the underlying values. This holds for Estonia, Hungary, Latvia and Poland (Table 2). The result for Slovakia should be, again, treated with some caution. Figures A2-A6 in the Appendix illustrate our Pareto models fitted to upper tails of wealth distributions in the CEE countries. We present the complementary cumulative distribution functions (Equation 3) for both imputed data and data from rich lists, as well as lines representing our estimates of α. The Figures show that the α_{pml} does a slightly better job than α_{reg} in describing the distribution of top wealth values. Moreover, Pareto-fit regression line for the HFCS data with imputed top values are significantly flatter (except for Latvia) than the ones estimated on the HFCS data only.[10] This proves that the differential unit non-response has important impact on the shape of top wealth distribution.

The values of goodness-of-fit test presented in Table 2 are averaged over the five HFCS implicates. Detailed results are available in Table A1 in the Appendix, from where we can see that only one out of five implicates for Slovakia fits well the Pareto distribution. For Estonia, three implicates pass goodness-of-fit test, for the rest of analysed countries all five implicates seem to be Pareto-distributed. Although the results for Slovakia and Estonia may seem worrying, similar findings can be found in the literature. For instance, Eckerstorfer et al. (2015) also find that two out of five implicates of Austrian HFCS data (first wave) do not fit the Pareto distribution. They conclude that the variability expressed by the single implicates is due to different (and not known) statistical models used to impute missing data. Thus, only an average across the implicates should be a justifiable criterion. In our case, for Estonia, on average, the hypothesis still holds, so we shall worry only about the results for Slovakia.

Table A1 in the Appendix presents alternative choices of w_{min} for each country, based on visual inspection of van der Wijk's law presented in Figure A1 (also in the Appendix). The

[10] In line with the results from the Table 2, obviously, this holds for all countries except Latvia.

goodness-of-fit tests' results show, however, that for all these alternative thresholds average p-values are much smaller than those in the Table 2. Thus, we stick to our primary choice of w_{min}.

4.2. Corrected measures of wealth inequality

Table 3 presents our corrected estimates of wealth inequality for the CEE countries in terms of the Gini index, two measures from the Generalized Entropy family of indices, and top wealth shares. Regardless of the measure we focus on, the increase in the level of inequality due to the imputation of the missing rich is sizable. The percentage of total household wealth held by top 0.1% of households either doubles or even triples, depending on a country. It increases from 2.9% to 17.7% in Estonia, from 5.4% to 10.8% in Hungary, from 5.6% to 16.5% in Latvia, from about 3% to 8.3% in Poland and from 3.3% to 11.1% in Slovakia. The correction for top wealth shares covering larger segment of the upper tail are obviously smaller since these measures are less sensitive to imputing the highest wealth values. Nevertheless, the correction to the top 1% wealth shares is on average 10.4 percentage points, for top 5% shares – 9.2 percentage points, while for top 10% shares – 7.5 percentage points. The size of corrections is rather substantial.

Table 3. Inequality measures for household net wealth distributions in CEE countries

	Estonia		Hungary		Latvia		Poland		Slovakia	
	HFCS	HFCS+ rich list	HFCS	HFCS+ rich list	HFCS	HFCS+ rich list	HFCS	HFCS+ rich list	HFCS	HFCS+ rich list
Top 0.1%	9.0	17.7	5.4	10.8	5.6	16.5	2.9	8.3	3.3	11.1
Top 1%	21.4	36.0	17.3	24.3	23.6	33.0	12.1	20.3	9.5	22.5
Top 5%	43.3	54.8	35.7	42.8	49.2	52.6	29.1	37.9	23	38.3
Top 10%	55.7	65.1	48.5	54.5	63.4	64	41.9	49.6	34.6	48.4
Gini	0.691	0.755	0.641	0.681	0.785	0.792	0.587	0.639	0.492	0.597
Theil	1.093	1.724	0.793	1.164	1.141	1.597	0.613	0.973	0.448	1.066
GE(2)	6.823	43.09	2.853	64.309	4.715	135.639	1.365	77.015	1.552	99.772

Note: "HFCS + rich list" denotes HFCS data with top values imputed using data from the relevant rich list.
Source: Own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014) and Forbes Slovensko (2015).

The imputation of the missing rich raises significantly also the estimates for more comprehensive inequality indices such as the Gini coefficient. The Gini increases within the range from 0.04 (Hungary) to 0.07 (Latvia). Estimates for the Generalized Entropy measures grow even more, but these measures are more sensitive than the Gini to extremely large observations.

Table 4 puts our main findings in a comparative context. We compare changes in inequality estimates for the CEE countries due to imputation of the highest wealth values with analogous changes obtained for advanced Western economies by Vermeulen (2018) and Bach

et al. (2018).[11] The numbers clearly show that the role the missing rich play in wealth inequality estimated using household survey data is not negligible, except for the US and the UK. The top wealth shares in CEE countries grow due to the imputation of highest wealth values more than in the advanced economies, apart from Germany. In case of the Gini index, the correction for each CEE country exceeds even that for Germany.

What may explain the fact that the problem of the missing rich in household surveys seems to be more pervasive in the CEE region? One possibility is that for these countries the problem of non-response and wealth underreporting among the rich is more prevalent than elsewhere. Moreover, the oversampling of the wealthy provides less efficient remedy for this problem in the CEE region. This is evident comparing the effective rate of oversampling of the wealth between the CEE and other HFCS countries. While for the CEE region the rate (for the top 10% of the wealthiest) on average equals about 20% (cf. Table 1 in this paper), it is on average as much as 170% for France, Germany and Spain (HFCN 2016). Therefore, more effort should be put in designing and implementing more effective strategies of oversampling of the wealthy for the CEE countries.

Table 4. Changes in household net wealth inequality measures due to imputing top wealth values in household survey data, various countries

Country	Change in top 1% share due to imputing top wealth values (% points)	Change in top 5% share due to imputing top wealth values (% points)	Change in Gini index due to imputing top wealth values
Estonia (2013)	+14.6	+11.5	+0.064
Hungary (2014)	+7.0	+7.0	+0.040
Latvia (2014)	+9.4	+3.4	+0.070
Poland (2014)	+8.2	+8.8	+0.053
Slovakia (2014)	+13.0	+15.3	+0.105
Germany (2014)	+9.5	+4.8	+0.027
France (2014/2015)	+3.5	+2.6	+0.011
Spain (2011/2012)	+3.8	+0.8	+0.013
US (2010)	-3 to +3	-8 to +2	NA
UK (2008/2010)	+1 to +5	+1 to +5	NA

Note: Table shows increases in inequality indicators due to imputation of rich lists data to household survey data and estimating Pareto distribution. For CEE countries, values of w_{min} as in Table 2. For Germany, France and Spain, $w_{min} = 500{,}000$ euro. For the US and the UK, the numbers correspond to a set of thresholds (in euro): $w_{min} \in \{500{,}000;\ 1 \text{ million},\ 2 \text{ million},\ 3 \text{ million},\ 5 \text{ million},\ 10 \text{ million}\}$.
Source: For Estonia, Hungary, Latvia, Poland and Slovakia: own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014) and Forbes Slovensko (2015). For Germany, France and Spain: Bach et al. (2018). For the US and the UK: Vermeulen (2018).

[11] These studies use almost the same methodology for calculating top-corrected wealth inequality measures as the present paper. The only major difference is computation of w_{min} (see section 3.2). However, as we show in Table A2 (Appendix) our wealth inequality estimates are largely robust to the choice of w_{min}.

Figures 2-3 present both the size of the top-correction due to the imputation of the missing rich as well as the corrected levels of wealth inequality for the CEE countries compared to France, Germany and Spain. The estimates for the latter countries come from Bach et al. (2018) and Vermeulen (2018) and were constructed in an analogous way as our estimates. The most striking conclusion from Figures 2-3 is that imputation of the missing rich raises wealth inequality in the CEE to the levels observed in matured, advanced market economies. For instance, both the top 1% wealth share (Figure 2) and the Gini (Figure 3) for wealth distribution in the Baltic countries reach or even exceed their counterparts for Germany, which is the most wealth unequal country in Europe when the top-correction is accounted for (Bach et al., 2018; Vermeulen, 2018). While for Poland and Hungary, the top-corrected wealth inequality indices are significantly lower than for the Baltic countries (Estonia and Latvia), they are comparable to those for France and Spain. These are astonishing results, since there is a widely held view that the CEE countries are more equal in terms of wealth distribution than the rest of Europe as the majority of their inhabitants could start accumulating wealth only relatively recently after the fall of socialism. Our results clearly show that the analysed CEE countries already caught up with the West with respect to wealth inequality.[12]

How can we account for the surprisingly high levels of top-corrected wealth inequality in the CEE? Obviously, wealth inequality under socialism must have been relatively equally distributed as most of the assets were state-owned. We can think of several mechanisms that could be responsible for significant decompression of wealth distribution in the CEE region during the transformation to market economy.

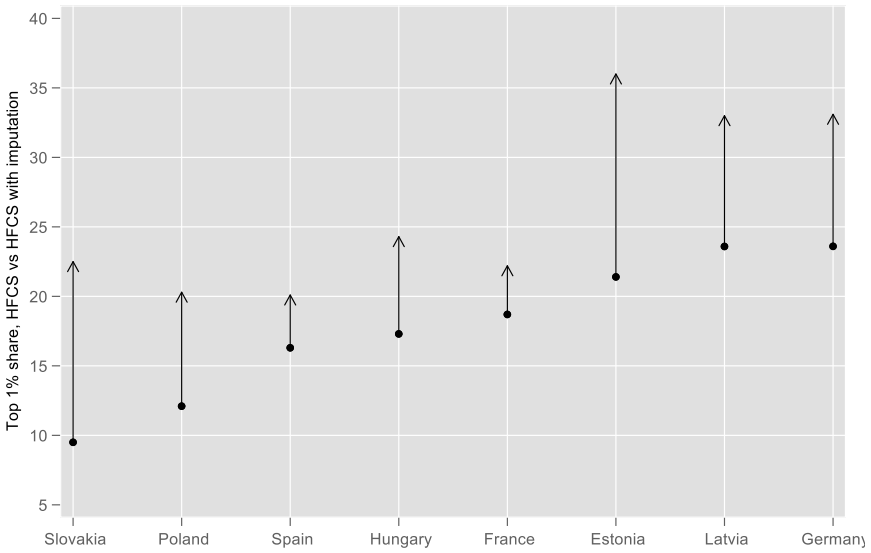
First, all post-socialist countries since early 1990s went through a process of privatization of business assets, agricultural land and housing. The speed of this process and details of its implementation differed significantly between countries in the region, but in general all forms of privatization are expected theoretically to increase wealth inequality (Ferreira 1999). Within the CEE countries, privatisation and other potentially inequality-enhancing market reforms were implemented most quickly and radically in the Baltic countries.[13] By the end of

[12] At the same time, wealth inequality in the CEE countries seem to be significantly lower than in Russia, where according to the approximate estimates of Novokmet et al. (2018) the top 1% wealth share in 2015 reached 43% - the level comparable to that of the US and much higher than observed, for example, in Germany (cf. Figure 2).

[13] However, even in the Baltic countries privatization and other market reforms were implemented in less radical and inequality-increasing way than in Russia. Novokmet et al. (2018) discuss in detail factors that may explain higher levels of wealth inequality in Russia as compared to other post-socialist countries. Beside the "shock therapy" approach to transformation, voucher privatization and rise of oligarchs, they list such factors as higher capital flight and rise of offshore wealth in Russia, smaller share of country's capital stock owned by foreign wealth holders in Russia than in other post-socialist countries, and better institutional framework (i.e. rule of law, stronger protection of property rights) in the CEE region.

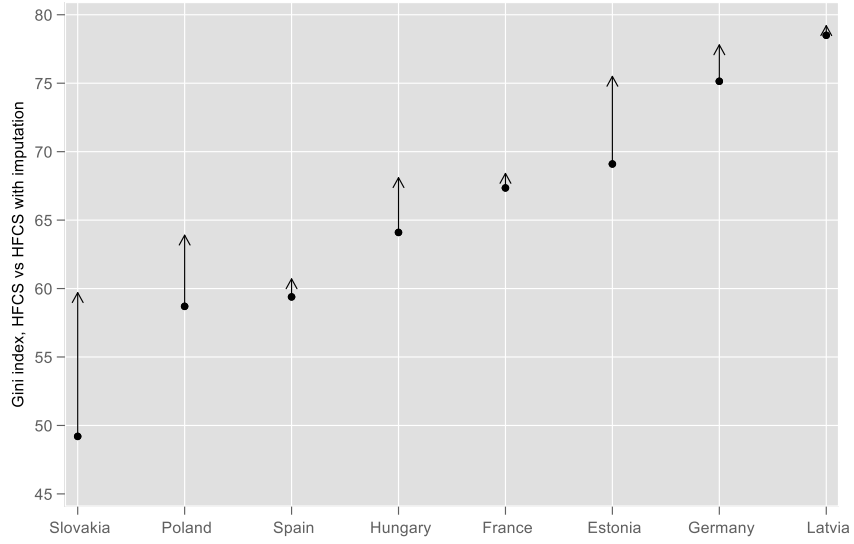
1994, about 85% of state assets were privatized in Estonia and 50% in Latvia (Masso et al., 2014).

Figure 2. Increase in the top 1% share of household net wealth distribution due to imputation of the missing rich: CEE countries versus France, Germany and Spain



Note: countries sorted by the value of the unadjusted top 1% share.
Source: For Estonia, Hungary, Latvia, Poland and Slovakia: own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014) and Forbes Slovensko (2015). For Germany, France and Spain: Bach et al. (2018). For the US and the UK: Vermeulen (2018).

Figure 3. Increase in the Gini index of household net wealth distribution due to imputation of the missing rich: CEE countries versus France, Germany and Spain



Note: countries sorted by the value of the unadjusted Gini index.
Source: For Estonia, Hungary, Latvia, Poland and Slovakia: own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014) and Forbes Slovensko (2015). For Germany, France and Spain: Bach et al. (2018). For the US and the UK: Vermeulen (2018).

Coupled with fast liberalization of prices and trade and significant withdrawal of state from its redistributive functions, the market reforms in the Baltic countries created favourable environment for growing concentration of wealth and rapid rise of income inequality. On the other hand, somewhat slower pace of privatization and its coordination with reforms in competition policy and financial sector in such countries as Czechia, Hungary, Poland and Slovakia had much smaller pro-inequality impact (Aristei and Perugini, 2014).

Second, it is possible that the level of income inequality in the CEE countries is substantially higher than we thought. If income inequality is positively correlated with wealth inequality, higher levels of income inequality could translate into more concentrated wealth.[14] The existing knowledge about income inequality in the CEE region is based mostly on estimates using household survey data. Those estimates show that during the transition to market economy the Gini coefficient of income inequality grew suddenly and substantially for the Baltic countries (by more than 10 percentage points), while somewhat less significantly for countries such as Hungary, Poland and Slovakia (Tóth, 2014). However, survey-based income inequality estimates suffer from the same problem of underreporting of top values as survey-based wealth inequality ones. The growing literature that attempts to correct for this problem shows unambiguously that income inequality in the CEE countries is much higher than official survey-based figures suggest. For example, Navickė and Lazutka (2018) reconcile income data from household surveys and macroeconomic statistics for the Baltic countries and arrive at a conclusion that the corrected Gini for income inequality in Estonia and Latvia in 2013 is on average equal to 0.397, which ranks them as the most income unequal countries in Europe. Using information from personal car registers, Siliverstovs et al. (2014) found that the Gini for income inequality in Latvia is as high as 0.480. For Poland, Bukowski and Novokmet (2017) combined survey and tax data to show that income inequality in Poland is much higher than known officially, and that the concentration of income at the top of the distribution results mainly from the high inequality of business income. This in turn implies that wealth (or at least wealth coming from business assets) in Poland is also highly concentrated.

Third, wealth taxes are either very small in size or non-existent in the CEE countries (Iara, 2015). The scope for redistributive correction of market wealth distribution is therefore

[14] Income inequality could affect positively wealth inequality when high-income earners use their incomes to accumulate wealth. On the other hand, if wealth is more unequally distributed than income, income from capital contributes to increasing income inequality.

very limited. On the other hand, wealth taxes in practice do not lead to any significant redistribution even in countries (such as Belgium, France or Spain) where they generate relatively high tax revenues (Kuypers et al., 2018).

Finally, the last mechanism that may explain our finding of rather high wealth inequality levels in the CEE countries is related to inheritances. Recent empirical research shows convincingly that although theoretically the impact of inheritance on wealth inequality is ambiguous, in practice they tend to reduce wealth inequality as measured by the Gini coefficient or top wealth shares (Boserup et al., 2016; Elinder et al., 2018). Although richer heirs inherit on average larger amounts, inheritances for less wealthy heirs contribute more proportionally to their pre-inheritance wealth leading to lower relative wealth inequality.[15] Since the accumulation of wealth in the CEE countries has started only about one generation ago, the equalizing effect of inheritances has not materialized yet. We may, however, expect that in near future inheritances will start to have their inequality-reducing impact also in the CEE region.

5. Conclusions

Although there is a growing literature on wealth inequality in advanced economies, still little is known about the CEE countries in this respect. In particular, the research which uses household survey data and corrects it with national rich lists in order to take into account the missing rich phenomenon, although increasingly popular, has not considered this region so far. We fill this gap in the literature by providing first top-corrected household wealth inequality estimates for Estonia, Hungary, Latvia, Poland and Slovakia in 2013/2014. Using the HFSC data and national rich lists, we impute missing rich household in each country's wealth distribution based on the fitted Pareto distribution and calculate top-corrected Gini indices and top wealth shares.

We obtain several interesting findings. First, our correction for the missing rich significantly increases the level of household wealth inequality in each country. The top 0.1% wealth share doubles or even triples, while the top 5% wealth shares increase on average by 9.2 percentage points. The Gini coefficient for wealth distribution rises due to the top-correction by 5.4 points on average. Second, we find that with respect to the level of wealth inequality, the analysed CEE countries already caught up with the Western Europe. This result is somewhat

[15] However, inheritances increase absolute inequality of wealth as measured, for instance, by the variance of the distribution (Boserup et al., 2016; Elinder et al., 2018). According to the relative notion, inequality remains unchanged under equiproportional increases in wealth. On the other hand, absolute inequality measures are unaffected by an increase of the same absolute amount to all wealth values in the distribution.

surprising considering that wealth accumulation under market conditions has a rather short history in the CEE countries. We have suggested several economic mechanisms that may explain our findings including the speed and coordination of market reforms in different CEE countries, the development of income inequality, as well as the role of wealth taxes and inheritances.

There are several limitations of our study. First, we use rich lists provided by national business magazines. As already discussed in the literature (see, for instance, Bach et al., 2018), this source of data is reliable to a limited extent. On the other hand, lacking administrative wealth data, this is the best source that can be used. Second, we analyse only selected CEE countries, since the rest of them was not covered in the HFCS. Third, we assume the Pareto distribution of the data, which is usually a reliable assumption, but fails in some cases, as is in the case of Slovakia in our study. Using more complicated distributions for the upper tail of wealth distribution such as the Generalized Pareto model (Jenkins, 2017) could be an interesting extension of our work. Fourth, in order not to repeat existing studies, we compare our results to the published ones for selected Western European countries. A disadvantage of this approach is that small differences in methodologies exist and they may make the studies slightly less comparable – although we believe they are comparable enough.

References

Alexeev, M. (1999). The effect of privatization on wealth distribution in Russia. Economics of Transition, 7(2), 449-465.

Alstadsæter, A., Johannesen, N., & Zucman, G. (2018). Who owns the wealth in tax havens? Macro evidence and implications for global inequality. Journal of Public Economics, 162, 89-100.

Äripäev (2013). Eesti 500 jõukamat inimest. Rikaste Top. Äripäev

Alvaredo, F., Chancel, L., Piketty, T., Saez, E., & Zucman, G. (2018). World inequality report 2018. WID.world.

Aristei, D., & Perugini, C. (2014). Speed and sequencing of transition reforms and income inequality: A panel data analysis. Review of Income and Wealth, 60(3), 542-570.

Bach, S., Thiemann, A., & Zucco, A. (2018). Looking for the missing rich: Tracing the top tail of the wealth distribution. DIW Discussion Paper No.1717.

Boserup, S. H., Kopczuk, W., & Kreiner, C. T. (2016). The role of bequests in shaping wealth inequality: evidence from Danish wealth records. American Economic Review, 106(5), 656-61.

Bukowski, P. & Novokmet, F. (2017). Top incomes during wars, communism and capitalism: Poland 1892–2015. WID.world Working Paper No. 2017/22.

Clauset, A., Shalizi, C. R., & Newman, M. E. (2009). Power-law distributions in empirical data. SIAM review, 51(4), 661-703.

Cowell, F. A., & Van Kerm, P. (2015). Wealth inequality: A survey. Journal of Economic Surveys, 29(4), 671-710.

Dalitz, C. (2018). Estimating wealth distribution: Top tail and inequality. arXiv preprint arXiv:1807.03592.

Davies, J. B., & Shorrocks, A. F. (2000). Chapter 11. The distribution of wealth, in Atkinson, A.B., Bourguignon, F. (ed.), Handbook of Income Distribution, Volume 1, pp. 605–675, Amsterdam: Elsevier.

Davies, J., Lluberas, R., Shorrocks, A. (2018). Global Wealth Report and Databook, Credit Suisse Research Institute.

Eckerstorfer, P., Halak, J., Kapeller, J., Schütz, B., Springholz, F., & Wildauer, R. (2016). Correcting for the missing rich: An application to wealth survey data. Review of Income and Wealth, 62(4), 605-627.

Elinder, M., Erixson, O., & Waldenström, D. (2018). Inheritance and wealth inequality: Evidence from population registers. Journal of Public Economics, 165, 17-30.

Ferreira, F. H. (1999). Economic transition and the distributions of income and wealth. Economics of Transition, 7(2), 377-410.

Forbes Polska (2014). 100 najbogatszych Polaków (Top 100 richest Poles), http://100najbogatszychpolakow.forbes.pl.

Fobres Slovensko (2015). Najbohatsi 2014, Forbes Slovensko 11/2015, Forbes

Gabaix, X., & Ibragimov, R. (2011). Rank− 1/2: a simple way to improve the OLS estimation of tail exponents. Journal of Business & Economic Statistics, 29(1), 24-39.

Grejcz, K., & Żółkiewski, Z. (2017). Household wealth in Poland: the results of a new survey of household finance. Bank i Kredyt, 48(3), 295-326.

Guriev, S. & Rachinsky, A. (2008). The Evolution of Personal Wealth in the Former Soviet Union and Central and Eastern Europe, in Davies, J. B. (ed.), Personal Wealth from a Global Perspective, Oxford: Oxford University Press.

Heyns, B. (2005). Emerging inequalities in Central and Eastern Europe. Annual Review of Sociology, 31, 163-197.

HFCN (Household Finance and Consumption Network) (2016). The Household Finance and Consumption Survey: Methodological Report for the Second Wave. Frankfurt: European Central Bank.

HFCN (Household Finance and Consumption Network) (2017). The Household Finance and Consumption Survey: Wave 2: Statistical Tables. Frankfurt: European Central Bank.

Iara A. (2015). Wealth distribution and taxation in EU Members, Working Paper N. 60-2015, European Commission Taxation Papers, European Commission.

Jenkins, S. P. (2017). Pareto models, top incomes and recent trends in UK income inequality. Economica, 84(334), 261-289.

Kapitals (2014). Latvijas miljonaru top 100. Kapitals Decembris 2014 (204). Kapitals.

Klass, O. S., Biham, O., Levy, M., Malcai, O., & Solomon, S. (2006). The Forbes 400 and the Pareto wealth distribution. Economics Letters, 90(2), 290-295.

Kuypers, S., Figari, F., & Verbist, G. (2018b). An assessment of wealth taxes in a joint income-wealth perspective. Paper prepared for the 35th IARIW General Conference, Copenhagen, Denmark, 20-25 August 2018.

Levy, M., & Solomon, S. (1997). New evidence for the power-law distribution of wealth. Physica A, 242(1-2), 90-94.

Masso, J., Espenberg, K., Masso, A., Mierina, I., & Philips, K. (2014). Between economic growth and social justice: different inequality dynamics in the Baltic States. In Nolan, B. (et al.) (eds), Changing Inequalities and Societal Impacts in Rich Countries: Thirty Countries' Experiences, Oxford, Oxford University Press, 95-125.

Navickė, J., & Lazutka, R. (2018). Distributional Implications of the Economic Development in the Baltics: Reconciling Micro and Macro Perspectives. Social Indicators Research, 138(1), 187-206.

Novokmet, F., Piketty, T., & Zucman, G. (2018). From Soviets to oligarchs: inequality and property in Russia 1905-2016. The Journal of Economic Inequality, 16(2), 189-223.

OECD (2013). OECD Guidelines for Micro Statistics on Household Wealth. OECD Publishing.

Perugini, C., & Pompei F. (eds.) (2015). Inequalities During and After Transition in Central and Eastern Europe. Houndmills, Palgrave Macmillan.

Piketty, T. (2014). Capital in the Twenty-First Century. Cambridge, Harvard University Press.

Siliverstovs, B., Kholodilin, K. A., & Dombrovsky, V. (2014). Using Personal Car Register for Measuring Economic Inequality in Countries with a Large Share of Shadow Economy: Evidence for Latvia. Review of Income and Wealth, 60(4), 948-966.

Skopek, N., Buchholz, S., & Blossfeld, H. P. (2014). National patterns of income and wealth inequality. International Journal of Comparative Sociology, 55(6), 463-488.

Tóth, I. G. (2014). Revisiting grand narratives of growing income inequalities: Lessons from 30 country studies. In Nolan, B. (et al.) (eds), Changing Inequalities and Societal Impacts in Rich Countries: Thirty Countries' Experiences, Oxford, Oxford University Press, 11-47.

Vermeulen, P. (2016). Estimating the top tail of the wealth distribution. American Economic Review, 106(5), 646-650.

Vermeulen, P. (2018). How fat is the top tail of the wealth distribution?. Review of Income and Wealth, 64(2), 357-387.

Yemtsov, R. (2008). Housing Privatization and Household Wealth in Transition, in Davies, J. B. (ed.), Personal Wealth from a Global Perspective, Oxford: Oxford University Press.

Zucman, G. (2019). Global wealth inequality. Working paper No. w25462, National Bureau of Economic Research.

Appendix

Table A1. Alternative choices of w_{min} for CEE countries based on visual inspection of van der Wijk's law, and *p*-values for each HFCS implicate

	Estonia (*p*-values)					
w_{min} (euro)	Implicate 1	Implicate 2	Implicate 3	Implicate 4	Implicate 5	Average
Automatic: 117 042.2	0.298	0.562	0.103	0.048	0.028	0.208
200 000	0.001	0	0	0	0.005	0.001
300 000	0	0	0	0	0	0
500 000	0	0	0	0	0	0
	Hungary (*p*-values)					
w_{min} (euro)	Implicate 1	Implicate 2	Implicate 3	Implicate 4	Implicate 5	Average
Automatic: 94 666.3	0.573	0.406	0.491	0.490	0.426	0.477
120 000	0.001	0	0	0	0	0
150 000	0	0	0	0	0	0
200 000	0	0	0	0	0	0
	Latvia (*p*-values)					
w_{min} (euro)	Implicate 1	Implicate 2	Implicate 3	Implicate 4	Implicate 5	Average
Automatic: 36 025.6	0.995	0.811	0.797	0.629	0.876	0.822
50 000	0	0	0	0	0	0
100 000	0.024	0.005	0	0.018	0.001	0.001
200 000	0.013	0	0.208	0	0.164	0.077
	Poland (*p*-values)					
w_{min} (euro)	Implicate 1	Implicate 2	Implicate 3	Implicate 4	Implicate 5	Average
Automatic: 199 765	0.673	0.709	0.628	0.447	0.166	0.524
150 000	0	0.005	0	0	0	0.001
200 000	0.523	0.045	0.080	0.126	0	0.155
300 000	0	0.060	0.005	0.015	0.025	0.021
	Slovakia (*p*-values)					
w_{min} (euro)	Implicate 1	Implicate 2	Implicate 3	Implicate 4	Implicate 5	Average
Automatic: 108 586.4	0.055	0.005	0.178	0.046	0.036	0.064
150 000	0	0	0	0	0	0
200 000	0	0	0	0	0	0
300 000	0	0	0	0	0	0

Note: "Automatic" denotes w_{min} chosen using the procedure of Clauset et al.'s (2009), averaged over the five implicates.

Source: Own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014) and Forbes Slovensko (2015).

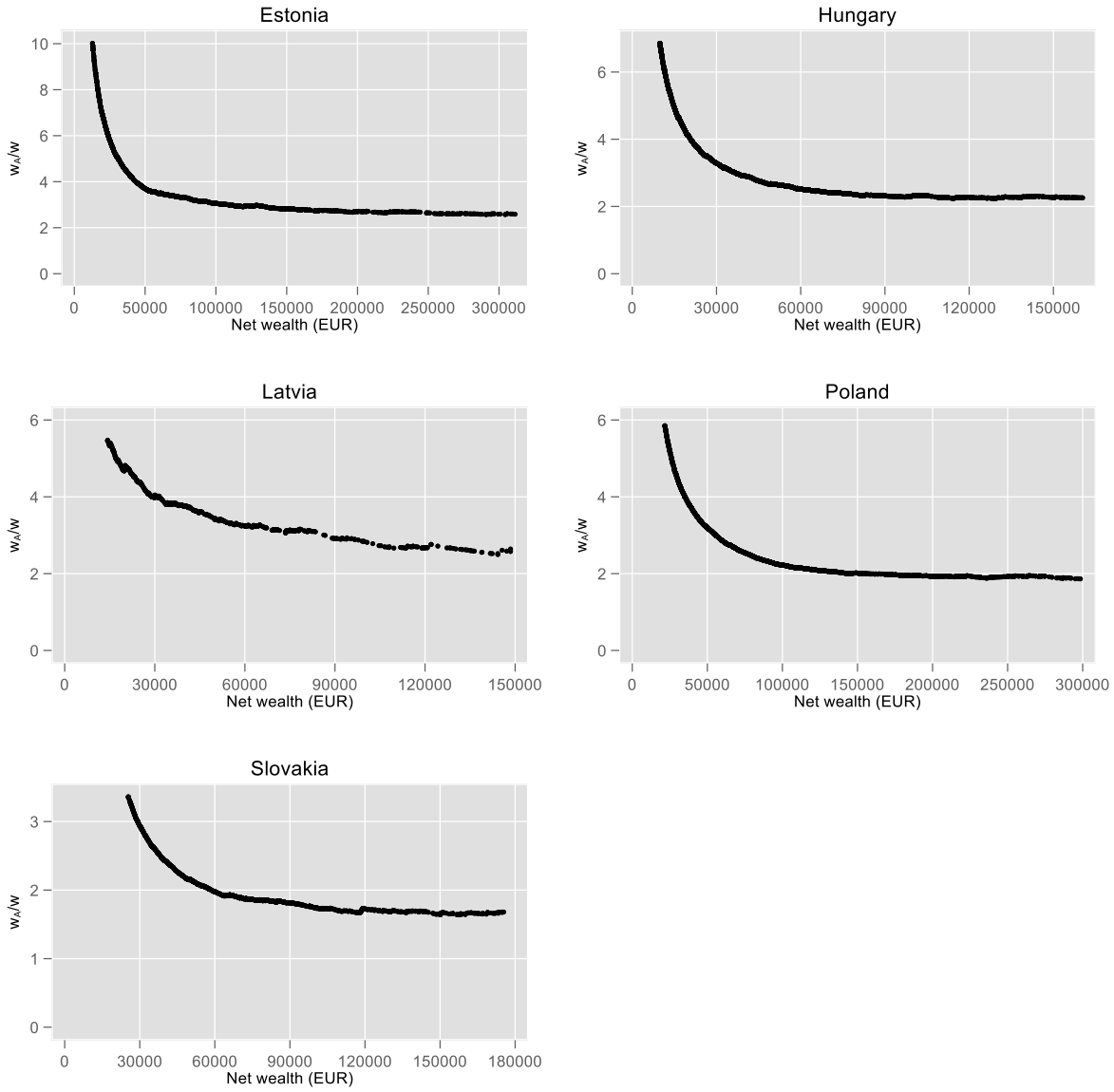
Table A2. Inequality measures for household net wealth distributions in CEE countries for alternative choices of w_{min}

Country	w_{min}	Proportion of sample with w > w_{min} (in %)	Inequality measure						
			Top 0.1% share	Top 1% share	Top 5% share	Top 10% share	Gini	Theil	GE(2)
Estonia	117042.2	19.6	17.7	36.0	54.8	65.1	0.755	1.724	43.090
	200000	9.7	17.7	36.0	54.8	65.1	0.755	1.724	43.098
	300000	5.4	18.0	36.3	54.6	64.6	0.752	1.727	44.184
	500000	3.0	17.79	36.3	55.0	65.0	0.755	1.732	43.421
Hungary	94666.3	13.0	10.8	24.3	42.7	54.5	0.681	1.163	64.337
	120000	8.4	10.9	24.4	42.7	54.3	0.680	1.164	65.124
	150000	5.6	10.9	24.3	42.2	53.7	0.677	1.156	66.621
	200000	3.3	11.1	24.1	41.2	52.9	0.672	1.143	68.735
Latvia	36025.6	25.0	16.5	33.0	52.6	64.0	0.792	1.597	135.639
	50000	17.8	15.9	32.2	52.2	64.0	0.793	1.575	127.037
	100000	8.5	15.0	31.5	52.7	65.6	0.800	1.568	112.421
	150000	5.0	14.8	31.5	53.2	66.3	0.803	1.574	108.540
	200000	3.5	14.7	31.7	53.8	66.8	0.805	1.584	105.736
Poland	199765.0	11.9	8.4	20.3	37.9	49.6	0.640	0.975	76.912
	250000	7.1	8.4	20.2	37.3	48.7	0.634	0.964	79.800
	300000	5.1	8.5	20.1	36.9	48.4	0.632	0.958	80.820
	400000	2.8	8.5	19.7	35.8	47.4	0.626	0.938	83.632
Slovakia	108586.4	18.9	11.1	22.5	38.3	48.4	0.597	1.066	99.772
	150000	7.7	12.5	24.2	39.3	48.7	0.599	1.132	104.706
	200000	3.8	13.4	24.5	37.6	47.0	0.587	1.144	116.504
	300000	1.1	13.7	21.8	33.5	43.5	0.561	1.086	136.602

Note: first value of w_{min} (in euro) for each country is based on the procedure of Clauset et al. (2009), other values based on visual inspection of figure A1.

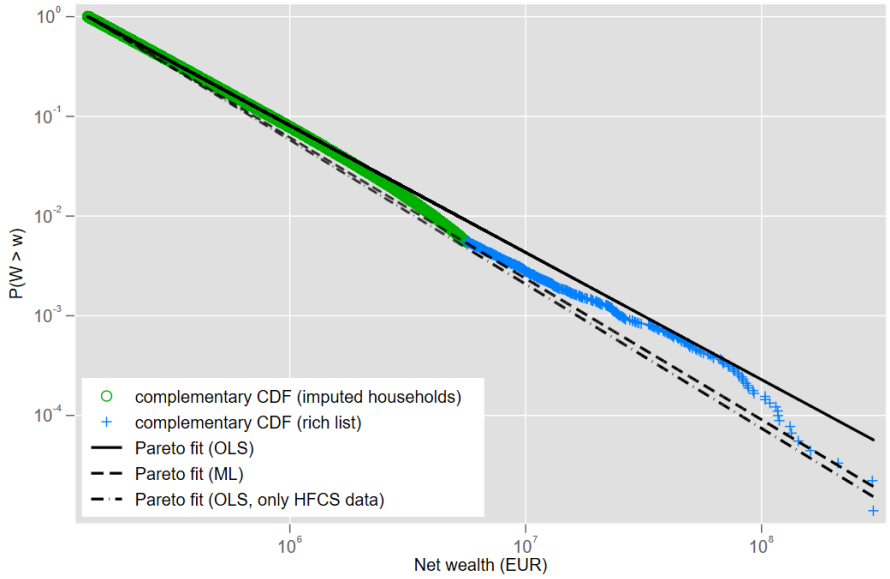
Source: Own calculations using data from the HFCS, Äripäev (2013), Napi.hu (2014), Kapitals (2014), Forbes Polska (2014) and Forbes Slovensko (2015).

Figure A1. Ratio of mean level of wealth higher than w, w_A, and w for averaged HFCS data sets.



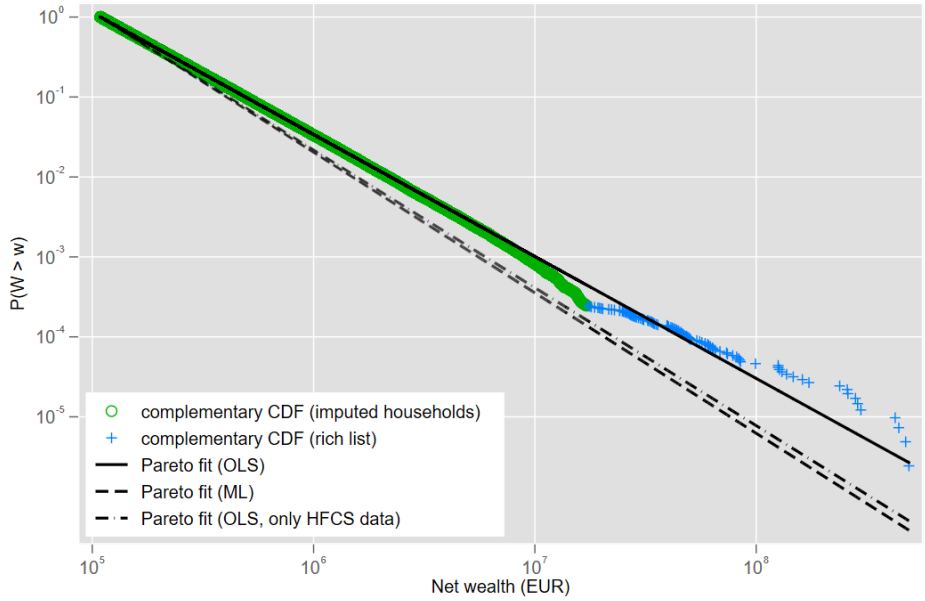
Source: HFCS (second wave), data averaged over five implicates, own calculations.

Figure A2. Adjusted tail household net wealth distribution, Estonia



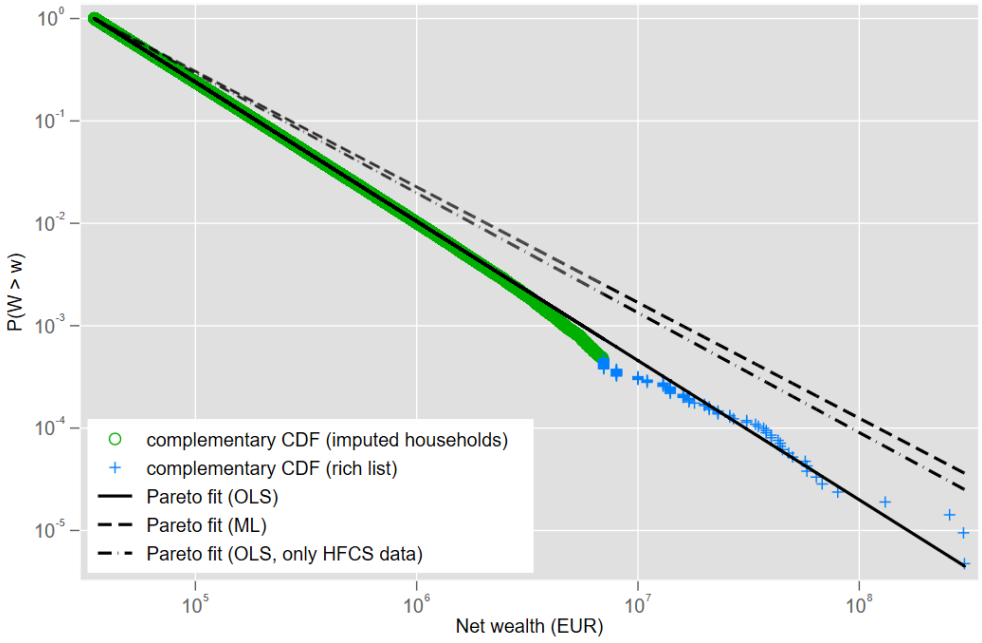
Note: $w_{min} = 117042.2$ euro. Figure for HFCS implicate; figures for other implicates are available upon request.
Source: HFCS first implicate and Äripäev (2013) data, own calculations.

Figure A3. Adjusted tail household net wealth distribution, Hungary



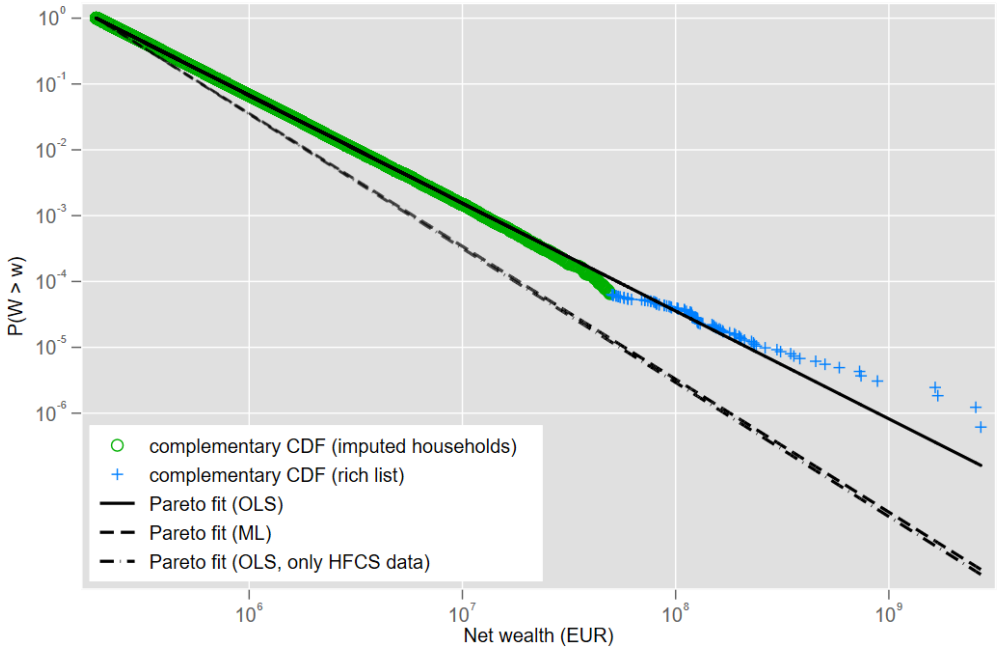
Note: $w_{min} = 94666.3$ euro. Figure for HFCS implicate; figures for other implicates are available upon request.
Source: HFCS first implicate and Napi.hu (2014) data, own calculations.

Figure A4. Adjusted tail household net wealth distribution, Latvia



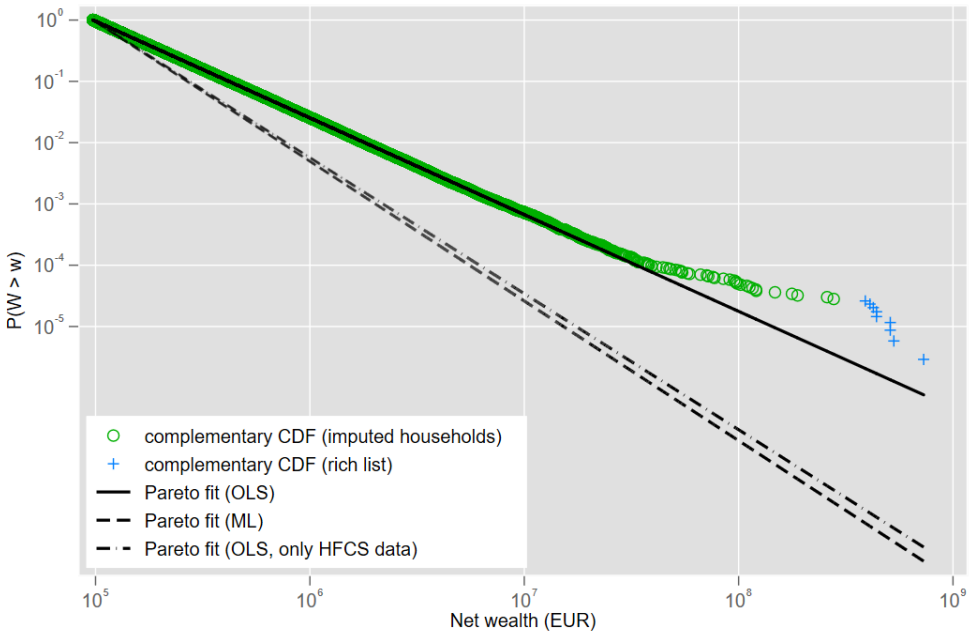
Note: $w_{min} = 36025.6$ euro. Figure for HFCS implicate; figures for other implicates are available upon request.
Source: HFCS first implicate and Kapitals (2014) data, own calculations.

Figure A5. Adjusted tail household net wealth distribution, Poland



Note: $w_{min} = 199765$ euro. Figure for HFCS implicate; figures for other implicates are available upon request.
Source: HFCS first implicate and Forbes Polska (2014) data, own calculations.

Figure A6. Adjusted tail household net wealth distribution, Slovakia



Note: $w_{min} = 108586.4$ euro. Figure for HFCS implicate; figures for other implicates are available upon request.
Source: HFCS first implicate and Forbes Slovensko (2015) data, own calculations.

University of Warsaw
Faculty of Economic Sciences
44/50 Długa St.
00-241 Warsaw
www.wne.uw.edu.pl