Güner, Eren; Weichenrieder, Alfons

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Pro-rich Inflation in Europe
Implications for the Measurement of Inequality

by

Eren Gürer

(Goethe University Frankfurt)

Alfons J. Weichenrieder#

(Goethe University Frankfurt, Vienna University of Economics and Business & CESifo)

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Abstract

This paper studies the distributional consequences of a systematic variation in expenditure shares and prices. By using European Union Household Budget Surveys and Harmonized Index of Consumer Prices data, we construct household-specific price indices and reveal the existence of a pro-rich inflation in Europe. Particularly, over the period 2001-15, the consumption bundles of the poorest deciles in 25 European countries have on average become 10.5 percentage points more expensive than those of the richest decile. We find that ignoring the differential inflation across the distribution underestimates the change in the Gini (based on consumption expenditure) by up to 0.03 points. Cross-country heterogeneity in this change is large enough to affect the ranking of the countries in inequality measures.

Keywords: Inequality, Gini, EU countries, income dependent inflation

JEL classification: D31

Addresses of corresponding author

Alfons Weichenrieder
Goethe University Frankfurt
Faculty of Economics and Business Administration
60323 Frankfurt (Main)
a.weichenrieder@em.uni-frankfurt.de

Eren Gürer
Goethe University Frankfurt
Faculty of Economics and Business Administration
60323 Frankfurt (Main)
guerer@wiwi.uni-frankfurt.de

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1 Introduction

Recent decades have witnessed heterogeneous changes in consumer prices. If the variation in expenditure shares of households and price changes is systematic, price changes may contribute to economic inequality, which goes unnoticed by using a common CPI. In this paper, we construct household-specific price indices in order to capture the particular inflation experience (the effective inflation rate) of each household and highlight the role of income dependent inflation rates on inequality.

For the period 2001-2015, our results show that on average across 25 EU countries, the aggregated effective inflation rate for the lowest decile was 10.5 percent higher than for the top decile, which implies an average yearly inflation rate differential of 0.72 percentage points. We show that this "pro-rich inflation" translates into a considerable increase in inequality that is not reflected in standard measures of inequality. Particularly, ignoring the differential effective inflation rates across the distribution causes underestimation of the changes in the consumption expenditure Gini of up to 0.03 points. Cross-country heterogeneity in this effect is sizeable enough to move countries' places in the ranking of inequality.

We are not the first to highlight the possibly different effective inflation rates for different household groups. One strand of the literature explores heterogeneity in the effective inflation rates across the distribution as well as across other demographic characteristics such as age, household size, gender etc. (see, e.g., Michael (1979), Hagemann (1982), Garner et. al. (1996), Hobjin and Lagakos (2005), Murphy et. al. (2008), Oosthuizen (2013)). More relevant to our work, some scholars investigated the distributional consequences of the phenomenon of the differential effective inflation rates (see, e.g., Muellbauer (1974), Cage et. al. (2002), Crawford and Smith (2002), Garner et. al. (2003)).

Recent contributions have substantially improved our understanding regarding the evolution of inequality.[1] Yet, the possibility that the differential effective inflation rates could obscure the picture drawn by usual inequality measure has been largely neglected, particularly for the developed economies. Arndt et al. (2015) and Beck (2015) focus on some African countries with a particular emphasis on 2008 Global Food Crisis. Due to data limitations, they exploit only three categories as "Core Food", "Non-core Food" and "Non-Food" in their analysis. While Arndt et al. (2015) find that accounting for heterogeneity in the effective inflation rates yields a higher inequality in Mozambique, results by Beck (2015) indicate heterogeneous effects across countries. Focusing on South America, Goni et al. (2006) study the same issue with six expenditure categories and conclude that the inflation is anti-rich among countries of interest except for Mexico. Another recent strand of the literature concentrates on green policies and energy prices and the resulting distributional concerns. See OECD (2006) or Neuhoff et al. (2013).

To the best of our knowledge, our study is the first to analyze this phenomenon in 25 EU countries with as much as 30 expenditure categories over the post 2000 period.

It is worth noting that our analysis is mainly concerned with price variations in the upper-level expenditure categories (between-category). There is a growing body of the literature that by using supermarket scanner data investigates similar issues among specific lower-level categories (within-category), in particular for the US. See, e.g., Argente and Lee (2017), Jaravel (2017), and Faber and Fally (2017). Given the lack of comparable data for a wide set of European countries, within-category effects are beyond the scope of our paper.

The remainder of this paper is organized as follows. Section 2 formally shows the impact of a systematic variation in expenditure shares and prices. Section 3 describes the datasets used in this study

[1] In Anglo-Saxon countries, much of the gains of economic growth has benefitted disproportionally the richest of the population. The development towards more inequality is less clear in continental Europe. See, e.g., Atkinson, Piketty and Saez (2011) and Piketty and Saez (2014).

and briefly illustrates the construction of household-specific price indices. Section 4 presents the main results and Section 5 concludes.

2 Conceptual Framework

The departure point of this study is that expenditure shares usually vary across households and prices vary across items. If poorer (or richer) households spend a higher fraction of their income on particular groups of goods and prices of that groups of goods are increasing faster, then inflation affects different households differently. A uniform Consumer Price Index (CPI) cannot capture this heterogeneous impact across households. Consider the simple example of luxuries and necessities. Since the work of Ernst Engel (1857), it has become well-established that poorer (richer) households tend to spend a higher fraction of their income on necessities (luxuries). If the prices of necessities are increasing faster than the CPI, poorer households experience a larger decline in their real income.

It is helpful to formalize the idea of the previous paragraph.[2] Let indirect (money-metric) utility of household i be given by V_t^i. Let the growth rate of a variable x_t with respect to a base period be denoted by $\hat{x}_t \equiv \frac{x_t}{x_{t_0}} - 1$. Then, the change in the indirect utility of household i may be approximated by

$$\hat{V}_t^i = \hat{W}_t^i - \sum_{g \in G} s_g^i \hat{p}_{g,t} \qquad (1)$$

In Equation (1), W_t^i represents the nominal income of household i at time t, s_g^i is her expenditure share on good g and $\hat{p}_{g,t}$ is the relative increase in price of good g with respect to the base year. Rewriting

[2] Cravino and Levchenko (2017) use the same framework in a slightly different context. Particularly, they assess the distributional consequences of 1994 Mexican devaluation.

this equation as follows illustrates the impact of a systematic change in prices and expenditure shares.

$$\hat{V}_t^i = \hat{W}_t^i - \sum_{g \in G} s_g \hat{p}_{g,t} - \sum_{g \in G} \hat{p}_{g,t} (s_g^i - s_g) \quad (2)$$

Equation (2) expresses the change in the indirect utility of household i. The first term on the right hand side is her nominal income. Given that s_g is the aggregate expenditure share of good g in the whole economy, the second term on the right hand side can be thought of as the impact of the standard CPI. If expenditure shares of each household were equal to the aggregate expenditure shares in the whole economy (s_g), subtracting the second term would be sufficient to find the change in the indirect utility of the corresponding household. However, given that s_g^i deviates from s_g, the third term may also have an impact on $\hat{V}_t^i$. This term will be non-zero if the $Cov(\hat{p}_{g,t}, s_g^i - s_g)$ is non-zero. Turning back to the point at the very beginning of this section, this covariance term indicates whether the expenditure shares and change in prices is systematic or not. If it is not, then the third term is zero. If it is different from zero, this term captures the heterogeneous effect of the price changes. For example, suppose household i is poor and there are only necessities (n) and luxuries (l). As mentioned above, she tends to spend a higher fraction of her income on necessities. This implies $s_n^i - s_n > 0$. If prices of necessities are increasing faster than luxuries ($\hat{p}_{n,t} > \hat{p}_{l,t}$), then the third term is negative, indicating an additional damage on her indirect utility.

As in Cravino and Levchenko (2017), a natural interpretation of this framework is heterogeneity in compensating variation. In essence, our analysis could provide an answer to the following question: Given the changes in prices, what should be the change in nominal income of household i such that she can afford the initial consumption bundle and her utility can be kept unchanged?

3 Data and Calculation of the Household-specific Price Index

3.1 Data

The primary data set used in this study is the European Union Household Budget Surveys (HBSs). They are conducted in all EU Member States with the aim of calculating national weights for the Consumer Price Index and Harmonised Index of Consumer Prices. These surveys are nationally representative and collect detailed expenditure information for each household. Variables are harmonized across countries in order to calculate aggregates at the EU level. Although the statistical office of the European Union, Eurostat, has been conducting and publishing main aggregates of the surveys every five years since 1988, only the 2010 wave of microeconomic data is available for researchers. The 2010 wave incorporates data for 26 countries with an effective total sample size of over 270.000.

HBSs lack information on prices. Therefore, we exploit a second data set, the Harmonised Index of Consumer Prices (HICP), provided by Eurostat. HICP contains country-year observations of a comparable measure of the changes in the prices of goods and services in the European Union with respect to a base year. Although the time series starts with 1996, a significant amount of data is missing until 2001. Therefore, this study only uses the price data between 2001 and 2015. In this context, a natural selection for the base year is 2001.

Some problems that we encounter in linking HICP to HBSs are worth mentioning here. The first problem is to construct consistent expenditure categories across countries that match available price data. HBSs contain a comprehensive coverage of expenditures on many aggregation levels, represented by number of digits in the variable codes. For example, the 2-digit category "Food and Non-alcoholic Beverages" is split into two 3-digit categories "Food" and "Non-alcoholic Beverages". The 3-digit category "Food" is further split into 4-digit categories such as "Bread and Cereals", "Meat" etc. As

mentioned above, one of the purposes of HBSs is to calculate weights for HICP. For this reason, the breakdown of consumption expenditure categories is identical in both data sets. Thus, mapping HICP data to HBSs does not require any additional procedure. However, even after 2001, HICP data is not available for all years at each every aggregation level. This makes it impossible to use the most disaggregated categories in calculation of expenditure shares. We could, however, partition the total consumption expenditure of each household to 30 expenditure categories (a combination of 2-digit and 3-digit categories) on which price data is available. Additional information on this 30 categories and their construction can be found in Appendix A (Table A.1). The second problem is that for Croatia, most of the time series of the price data is starting at 2005. Since, in this case, it is not possible to select 2001 as the base year for Croatia, we drop it from the analysis. At the end, our final data set incorporates expenditure data of 30 categories for the households in 25 countries together with prices of these categories from 2001 to 2015. The list of 25 countries can be found in the Appendix A (Table A.2).

3.2 The Calculation of Household-Specific Price Indices

Equipped with prices and expenditure shares, we can turn to the empirical methodology behind computing the household-specific price indices. In essence, the price index of household i at time t can be denoted by

$$q_t^i = \sum_{g=1}^{30} s_g^i \frac{p_{g,t}}{p_{g,t_0}} \tag{3}$$

where s_g^i is expenditure share on good g, $p_{g,t}$ is price of good g at time t and p_{g,t_0} is price of the same good at the base year (which is 2001 in our case). For each household in our sample, we calculate the expenditure share of every expenditure category. Taking 2001 prices as 1, we compute the price of each category in each year.

Subsequently, multiplying expenditure shares with the prices of the corresponding categories and summing them over 30 categories for each household yield the household specific price-indices.

In Equation (3), note that expenditure shares of households (s_g^i) do not have a time indice. We recognize that observing expenditure shares of each household in each year would be ideal for the purposes of the study. However, as it is mentioned in the data section, we only have access to 2010 wave of HBSs. Limitations that are brought about because of this restriction are discussed below. For now, it is sufficient to touch on some points in the literature of price indices and shed some light on theoretical insights used related to this point.

Two most commonly employed price indices in the calculation of inflation are Laspeyres and Paasche indices. Equations (4) and (5) provide their formula.

$$\text{Laspeyres Price Index: } q_t^i = \sum_{g \in G} s_{g,t_0}^i \frac{p_{g,t}}{p_{g,t_0}} \tag{4}$$

$$\text{Paasche Price Index: } \quad q_t^i = \sum_{g \in G} s_{g,t}^i \frac{p_{g,t}}{p_{g,t_0}} \tag{5}$$

The simple difference is that the Laspeyres Price Index takes the expenditure shares from the base period (t_0) as opposed to Paasche Price Index which takes expenditure shares from the last period. This is the very reason of Paasche Price Index being evaluated as the lower bound of cost-of-living index whereas Laspeyres Price Index being evaluated as the upper bound of cost-of-living index. Economic theory suggests that agents minimize expenditure given their level of utility. If this is the case, it is reasonable to expect that they substitute away the goods with higher prices such that they can maintain the same level of utility. Using a Paasche Price Index is useful in the sense of capturing the substitution effect and providing the minimum cost-of-living at a given point in time with respect to a base year. Therefore, it has been employed as the main empirical strategy in similar studies (see eg.; Arndt et al. (2015), Beck (2015), Goni et al. (2006)).

Returning to this study, it should be kept in mind that our analysis covers the time period 2001-15 with expenditure share observations

of 2010. The period 2001-10 is in line with the theory explained in the previous paragraph. However, between 2010 and 2015, in a sense, we switch to the Laspeyres Price Index. Given our main finding of pro-rich inflation, this does not devastate our results. If the rich are more able to substitute away the goods in response to a price increase, their inflation exposure over 2010-15 is overestimated. This is because we do not capture the substitution effect over this period which is possibly favoring the rich. Then, if anything, our results regarding pro-rich inflation give the lower bound. In this framework, our assumption regarding substitution ability of the rich and the poor is crucial. In Appendix B, we provide a simple model with Stone-Geary preferences. Our model supports the assumption that the ability of the rich in substituting away from goods in response to a price increase is higher compared to the poor.

4 Results

4.1 Pro-rich Inflation in Europe

This section provides evidence on pro-rich inflation in Europe. To begin, Table 1 presents the evolution of prices. Numbers reported in the table are unweighted means of the percentage increases in prices with respect to a base year across 25 countries. Between Column 1 and Column 3, the period of interest is split into three intervals and the percentage increase in the price of the corresponding category is reported with respect to the beginning of the interval. The last column provides the overall increases in prices, taking 2001 as the base year.

Inspection of Table 1 reveals rather important clues regarding the main results. The first row of the table reports the average CPI across countries. The average price increase for all goods and services across Europe over 2001-15 is 44.68%. Categories that can naively be classified as necessities, the ones concerning food and housing, have experienced larger price increases on average. For example, price of "Water supply and misc. services" have increased

Table 1: Evolution of Prices, 2001-15

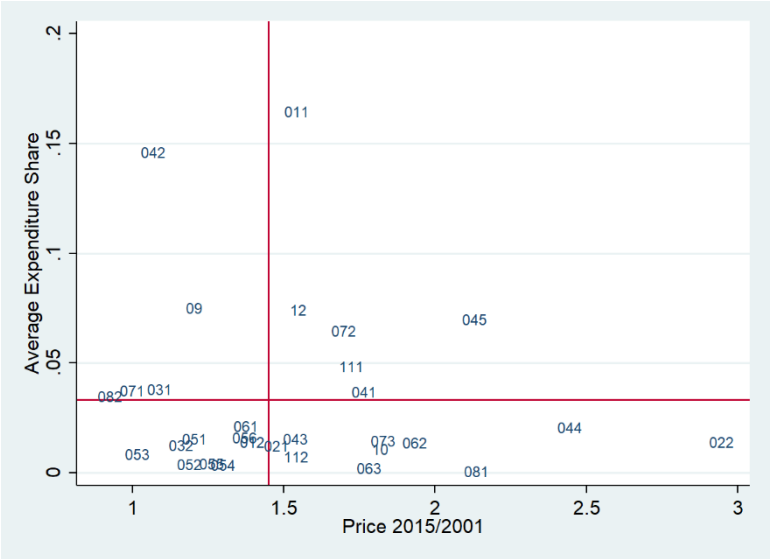
Variable Code	Expenditure Categories	P(01-05) (%)	P(05-10) (%)	P(10-15) (%)	P(01-15) (%)
00	*All consumer goods*	*14.16*	*17.38*	*7.96*	*44.68*
022	Tobacco	37.25	62.24	29.30	187.92
044	Water supply and misc. services	35.45	41.29	24.23	137.73
081	Postal services	33.02	27.80	21.65	106.79
045	Electricity, gas and other fuels	29.56	41.77	12.26	106.21
062	Out-patient services	26.09	30.81	13.06	86.48
10	Education	22.38	27.92	12.77	76.54
073	Transport services	21.47	26.39	14.67	76.05
063	Hospital services	22.44	27.31	9.91	71.33
041	Actual rentals of housing	20.22	25.95	12.10	69.74
111	Catering services	19.36	23.75	12.06	65.52
072	Operation of personal transport and equipment	23.97	23.20	6.69	62.95
12	Misc. goods and services	15.40	18.24	9.42	49.30
011	Food	10.41	20.70	10.72	47.54
112	Accommodation services	23.33	11.32	7.34	47.37
043	Maintenance and repair of the dwelling	15.02	17.80	8.58	47.11
021	Alcoholic beverages	8.13	18.34	9.98	40.74
012	Non-alcoholic beverages	5.65	13.52	10.75	32.82
061	Medical products, appliances and equipment	13.66	10.19	4.35	30.68
056	Goods and services for routine household maintenance	7.59	13.46	6.79	30.36
054	Glassware, tableware and household utensils	7.64	10.10	3.82	23.04
055	Tools and equipment for house and garden	6.84	7.96	3.51	19.40
09	Recreation and culture	7.05	5.59	1.69	14.95
051	Furniture and furnishings, carpets and other floor coverings	6.28	6.72	0.25	13.70
052	Household textiles	4.02	1.98	5.66	12.09
032	Footwear	3.01	1.89	4.16	9.32
031	Clothing	1.34	-0.70	1.44	2.07
042	Imputed rentals of housing	0.00	0.00	0.00	0.00
053	Household appliances	-0.74	-1.24	-3.86	-5.12
071	Purchase of vehicles	2.53	-6.07	-3.34	-6.91
082	Telephone and telefax services and equipment	-1.31	-5.98	-7.65	-14.31

Note: All percentage changes in prices are calculated with respect to the base year which corresponds to the first year of the period of interest. (e.g.; 2005 is the base year for the second column: P(05-10)). Price increase in imputed rentals of housing is assumed to be zero. See Data Appendix for details.

by 137.73%, "Electricity, gas and other fuels" by 106.21%, "Actual rentals of housing" by 69.74%, "Food" by 47.54%. As opposed to this, price increase in luxury-type categories, such as "Recreation and culture", "Glassware, tableware and household utensils", "Purchase of vehicles" have stayed below the common CPI.

Figure 1 plots the price increases of 30 expenditure categories (last column of Table 1) against the unweighted average of aggregate expenditure shares of the same categories across 25 countries. The red line parallel to the x-axis represents the simple mean of the common CPIs (last column of the first row of Table 1) and the red line parallel to the y-axis represents the mean of the average aggregate expenditure shares.

Figure 1: Aggregate Expenditure Shares and Prices



Notes: Explanations of the category codes can be found in the Appendix A (Table A.1). The red line parallel to the x-axis represents the mean of the common CPIs. The red line parallel to the y-axis indicates the mean of the aggregate expenditure shares of 30 categories across countries. Base year of prices is 2001.

Figure 1 is informative in two dimensions. It provides evidence on the relative price increases and the relative size of the expenditure share for each category. For example, take "Food" (011). Aggregate average expenditure share of "Food" across Europe is around 16%. Comparing this to the straight y-line, one can conclude that relative

size of "Food" share in households' budget is above average. Its price has increased slightly faster than the common CPI (red y-line). The price of Tobacco (022), on the other hand, has tripled, but its expenditure share is below average.

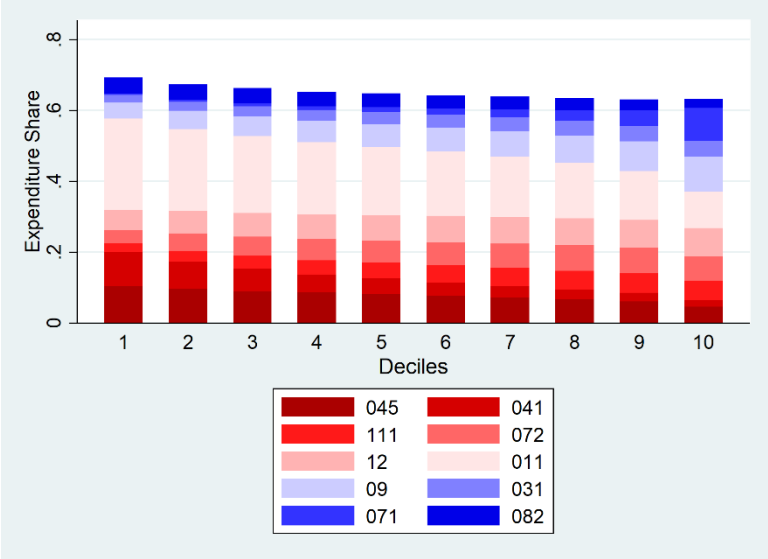
So far, we have ignored that expenditure shares vary with household income. Therefore, Figure 2 takes categories that have an above average share[3] and illustrates their expenditure shares across consumption expenditure deciles defined on the country level. As before, values are simple means of expenditure shares of deciles across 25 countries. Items depicted in red experienced a price increase above the common CPI, whereas items in blue had a price increase below the common CPI for the corresponding categories over the period 2001-15. Items are in ascending order from the top to the bottom in terms of their price increase. The ten largest expenditure categories sum up to some 65-70% of the total expenditure across deciles. Close to 60% of the poorest decile's expenditure is exposed to a price increase above the common CPI. This share for the richest decile is around 40%. Analyzing categories one by one reveals some information regarding the source of this differential. Expenditure shares of "Food" (011), "Electricity, gas and other fuels" (045) and "Actual rentals of housing" (041) are monotonically declining from lower to upper deciles and their prices have been increasing above average. Conversely, "Recreation and culture" (09) and "Purchase of vehicles" (071) constitute higher expenditure shares for richer deciles and their price increases have been below average. These five expenditure categories are potential drivers for pro-rich inflation in Europe.

Figure 3 provides a similar picture by including all expenditure categories. A simple conclusion of this figure is that around 65% of the expenditure basket of the poorest decile have been exposed to a price increase above the common CPI. The richest decile, on the other

[3] We exclude imputed rentals of housing from Figure 2. See Data Appendix for details.

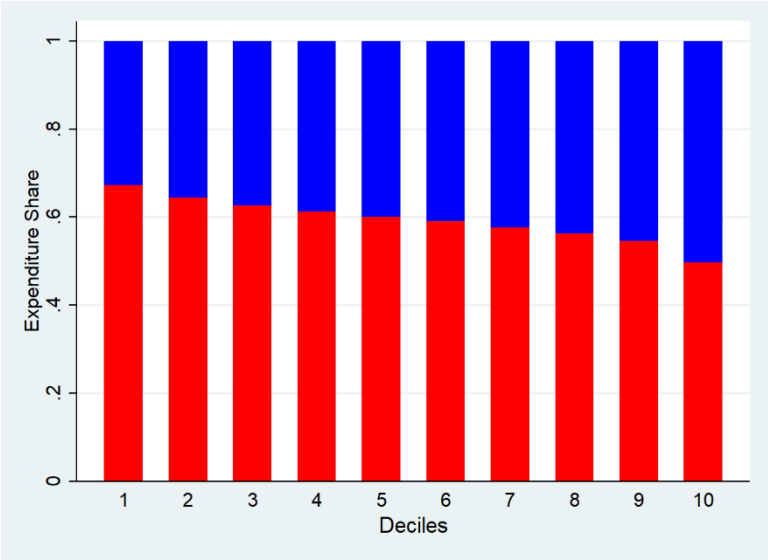
hand, has only seen around 50% of its basket's price increasing faster than average.

Figure 2: Breakdown of Expenditure Shares above/below the Common CPI by Decile



Notes: Explanations of the category codes can be found in the Appendix A (Table A.1). Items represented in red (blue) had a price increase above (below) the common CPI over the period 2001-15. Items are in ascending order from the top to the bottom in terms of their price increase.

Figure 3: Fraction of Expenditures above/below the Common CPI by Decile



Notes: Fractions represented in red (blue) had a price increase above (below) the common CPI over the period 2001-15.

Our analysis continues with the point estimates of the differences in the effective inflation rates across deciles where we construct and exploit household-specific price indices. We estimate the following simple differences-in-differences regression.

$$y_{i,t,k} = \alpha time_t + \lambda decile_{i,k} + \beta time_t * decile_{i,k} + \epsilon_{i,t,k} \quad (6)$$

This regression is used to compute the differences in the increases of the mean household-specific price indices across the xth decile (x = 1, 2, ..., 9) and the control decile (10th decile), over the span 2001-15. In this specification, $y_{i,t,k}$ denotes the mean of the household-specific price indices of households in decile i, at time t, in country k. $time_t$ is equal to 1 if year is 2015 and equal to 0 if year is 2001. $decile_i$ equals 0 for the 10th decile and equals 1 for the xth decile that is compared to the richest decile. Finally, β is the differences-in-differences estimate at the country level. A positive value indicates that the inflation rate for the xth decile was above that of the 10th decile. Table 2 presents the results. The differences between the xth decile and the highest (10th) decile, which acts as the point of comparison, are reported in the 9 columns.

Table 2: Estimates of the Differences-in-Differences Regression.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
β	0.105***	0.092***	0.087***	0.075***	0.073***	0.064***	0.055***	0.046***	0.035***
	(0.015)	(0.013)	(0.012)	(0.011)	(0.012)	(0.010)	(0.009)	(0.009)	(0.008)
Implied Yearly Difference	0.72	0.63	0.60	0.52	0.50	0.44	0.38	0.32	0.25
xth Decile	1	2	3	4	5	6	7	8	9
N	100	100	100	100	100	100	100	100	100
R^2	0.57	0.55	0.54	0.54	0.53	0.53	0.52	0.52	0.51

Note: *** denotes the significance level at 1%. Standard errors are clustered by country and reported in parentheses.

Point estimates of the regression are consistent with the trend observed in Figure 3. The effective inflation rate is monotonically increasing as we move to poorer deciles. Between 2001 and 2015, the

expenditure basket of the poorest decile in each country became on average 10.5 percentage points more expensive compared to the richest decile. The difference is statistically significant at the 1% level. The third row of Table 2 translates the total differences into implied average yearly differences. On average, the inflation rate of the poorest decile's basket exceeded the richest decile's basket by 0.72 percentage points, while the average common CPI was 2.67%.

Next, we return to the issue pointed out at the end of Section 3.2. As explained there, expenditure minimizing behavior of agents ensure that the substitution effect is captured until 2010. Therefore, if we were to analyze effective inflation rate with prices over 2001-10 and the expenditure shares of 2010, results could be treated as the changes in the minimum-cost-of-living. However, our price data goes up to 2015. If the rich are more able to substitute away from goods in response to a price increase, as our model in Appendix B implies, not capturing the substitution effect between 2010-15 causes a stronger overestimation of the effective inflation rate for the rich and renders our point estimates as the lower bound. For example, suppose there has been a substantial increase in the prices of food over 2010-15. Given the finding of our model, the rich can substitute food with other categories more effectively (e.g.; recreation and culture, beverages etc.) and maintain the same level of utility. Since our approach cannot account for substitution over the 2010-15 period, if anything, the effective inflation rate of the rich is overestimated.

Finally, we investigate whether our results are only picking up on certain shocks in certain countries or years. We graph the evolution of the effective inflation rates of the poorest and the richest deciles in all countries across 2001-15. As in the differences-in-differences framework, we compute the effective inflation rates of deciles as the simple mean of household-specific price indexes of the corresponding decile in a country. The results are presented in Appendix C (Figure C.1). The aggregate trend found in this section holds for almost all countries. Portugal and Italy are notable exceptions. The differences in the effective inflation rates of the richest and the poorest deciles are increasing over time. Therefore, we conclude that our results is the outcome of a general recent trend in Europe.

4.2 Implications for the Measurement of Inequality: A Thought Experiment

For the final part of the analysis, we conduct a thought experiment in order to evaluate the implications of the revealed pro-rich inflation on the measurement of inequality. Suppose that, for all households in our sample, the 2010 nominal consumption expenditure was constant across the period 2001-15. Starting from this point of comparison, how would consumption inequality be affected if we account for the different evolution of prices by applying household-specific price indices? Our strategy is as follows. Let $C^C_{i,k,t}$ denote the consumption expenditure of household i in country k at time t deflated by the common CPI:

$$C^C_{i,k,t} = \frac{C^N_{i,k,2010}}{p_{k,t} m(h_i)} \tag{7}$$

where $C^N_{i,k,2010}$ is the nominal consumption expenditure of the same household, $p_{k,t}$ is the common CPI of country k at time t and $m(h_i)$ is the household equivalence scale[4]. The function $f: R^N_+ \to R_+$ maps the consumption values into an inequality index (e.g.; Gini index). Then, inequality in country k after applying the common CPI to nominal consumption expenditure values of households is given by $f(\vec{C}^C_{k,t})$, which is our baseline inequality measure. Here, $\vec{C}^C_{k,t}$ denotes the vector of country k's household incomes, $C^C_{i,k,t}$. Note that $f(\vec{C}^C_{k,t})$ is constant across the period of interest. Our thought experiment assumes $C^N_{i,k,t} = C^N_{i,k,2010}$ over 2001-15. Then, the only time varying term in the calculation of $C^C_{i,k,t}$ is $p_{k,t}$. Given that inequality measures are mean independent, our baseline inequality measure for each year is the consumption expenditure inequality at 2010.

[4] In particular, we use the modified OECD equivalence scale which assigns 1 to household head, 0.5 to each additional adult member and 0.3 to each child.

Subsequently, we calculate consumption expenditures of household i in country k at time t deflated by household-specific price index $p_{i,k,t}$ according to the following formula.

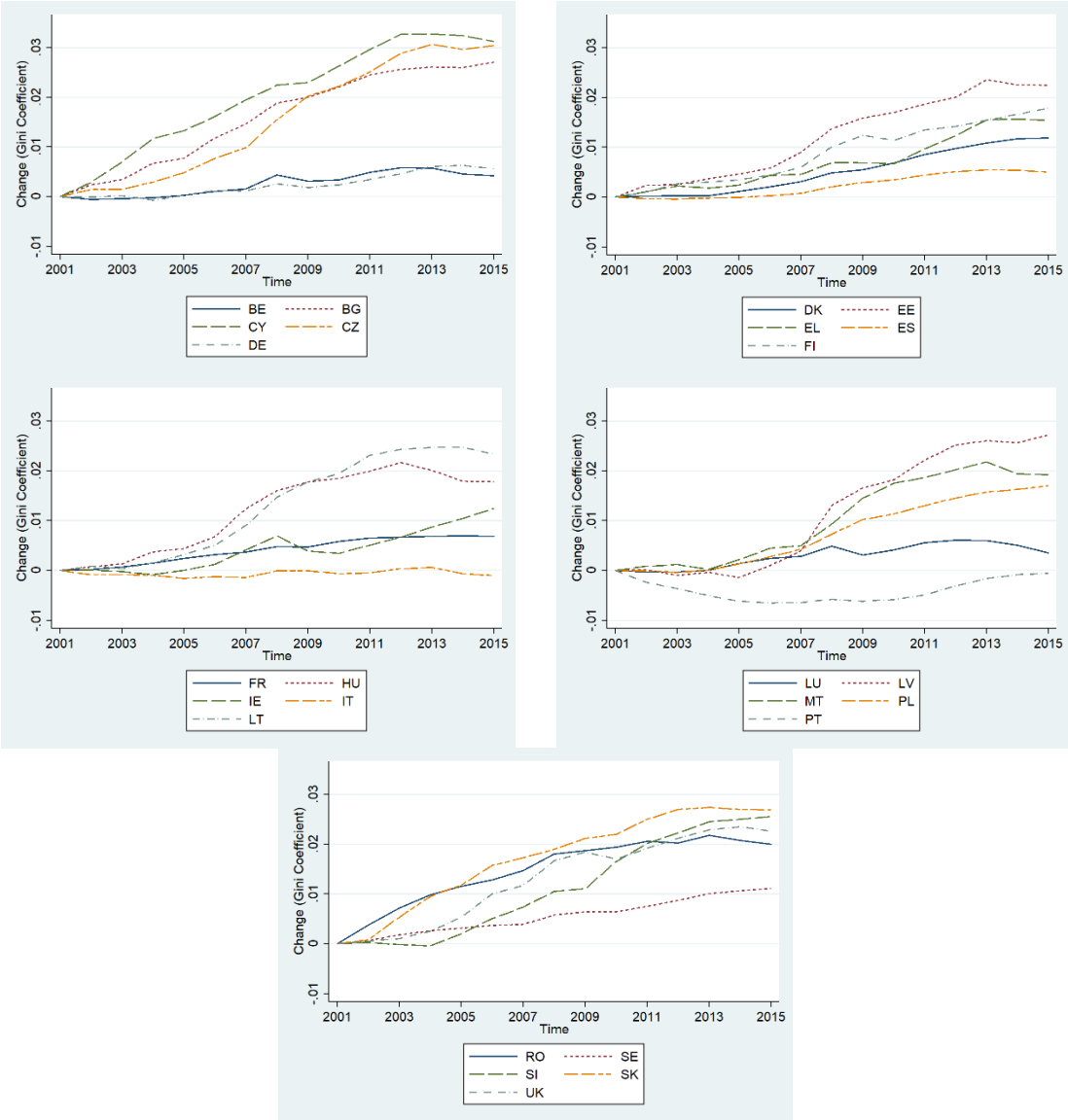
$$C_{i,k,t}^{HH} = \frac{C_{i,k,2010}^{N}}{p_{i,k,t}m(h_i)} \quad \text{where} \quad p_{i,k,t} = \sum_{j=1}^{30} s_{j,i,k} q_{j,k,t} \tag{8}$$

In Equation (8), $s_{j,i,k}$ is the expenditure share of household i in country k on expenditure category j. (Note that it does not have a time index because the thought experiment assumes that households consume the same bundle across 2001-15.) $q_{j,k,t}$ is the price of expenditure category j in country k at time t with respect to the base year (which is 2001 in our case). Inequality in country k after deflating nominal consumption values with household-specific price indexes is given by $f\left(\vec{C}_{k,t}^{HH}\right)$, where $\vec{C}_{k,t}^{HH}$ is the vector of all real household consumption levels, $C_{i,k,t}^{HH}$. Finally, the difference between two inequality measures at time t yields the change coming from ignoring the heterogeneity in the effective inflation rates.

$$Change_{k,t} = f\left(\vec{C}_{k,t}^{HH}\right) - f\left(\vec{C}_{k,t}^{C}\right) \tag{9}$$

Figure 4 presents the evolution of $Change_{k,t}$ over 2001-15. If the pro-rich inflation is a general trend in Europe and the gap in the effective inflation rates of rich and poor is increasing over time, as we found in the previous section, we should find a positive and increasing difference between $f\left(\vec{C}_{k,t}^{HH}\right)$ and baseline inequality measures $f\left(\vec{C}_{k,t}^{C}\right)$. Indeed, in all of the countries except Italy and Portugal, the Gini coefficient is higher once the household-specific price indices are accounted for. Results reveal that in most of the European countries, inequality measures that ignore the effective inflation rate differentials across the distribution yield an underestimation of the change in inequality over the period 2001-15. The magnitude of $Change_{k,t}$ is generally rising over time.

Figure 4: $Change_{k,t}$ by Country



Notes: Country abbreviations can be found in Appendix A (Table A.2)

Secondly, we explore the magnitude and cross-country heterogeneity of $Change_t$. Table 4 presents baseline inequality measures $f(\vec{C}^{C}_{k,t})$ by country. Following that, we graph $Change_{k,t}$ at 2015 (last data points of Figure 4) in Figure 5. Over the period of interest, the total impact of the differential effective inflation rates on the Gini coefficient goes up to 0.03. In addition, cross-country heterogeneity in magnitudes of the errors are large enough to change

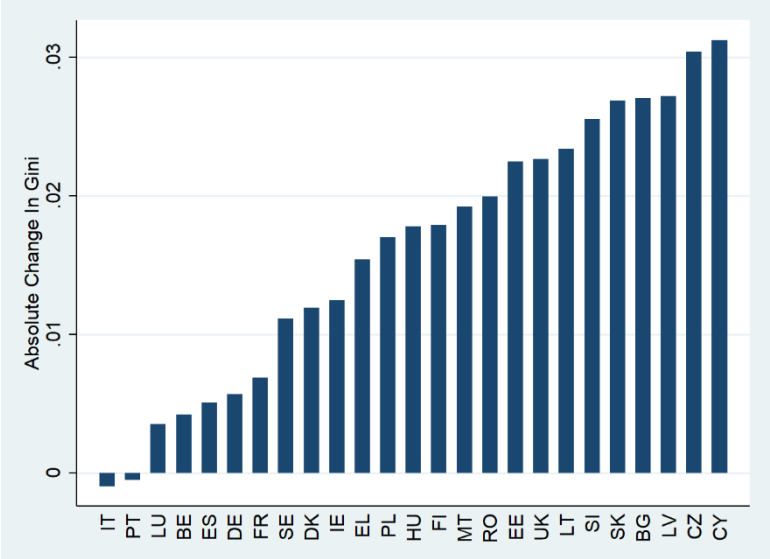
the ordering of countries. For example, although Italy is on the upper part of the baseline list, it moves to the middle after accounting for the error. Portugal, the second most unequal country, moves to fifth in the modified list.

Table 3: Baseline Gini Indices $f(\vec{C}^{C}_{k,t})$ by Country

Country	Gini Index	Adjusted Gini Index
Estonia	0.333	0.356
Portugal	0.332	0.331
Malta	0.328	0.347
Latvia	0.315	0.343
United Kingdom	0.315	0.338
Italy	0.308	0.307
Greece	0.302	0.318
Cyprus	0.294	0.325
Lithuania	0.293	0.316
Poland	0.285	0.302
Finland	0.284	0.302
Spain	0.282	0.287
France	0.281	0.288
Germany	0.279	0.285
Luxembourg	0.277	0.281
Romania	0.277	0.297
Belgium	0.260	0.265
Ireland	0.260	0.273
Bulgaria	0.259	0.286
Slovenia	0.257	0.283
Hungary	0.244	0.262
Sweden	0.240	0.251
Denmark	0.230	0.242
Slovakia	0.225	0.251
Czech Republic	0.206	0.236

Notes: The adjusted Gini Index is calculated after correcting nominal consumption expenditures of households in 2010 by the the benefit (disadvantage) that derived as household-specific price indices decreased (incrased) compared to the general CPI during the period 2001-2015. It equals the Gini index in column 2, plus the inflation effects indicated in Figure 5.

Figure 5: Absolute Change in Gini Index after Applying Household-specific Price Indices

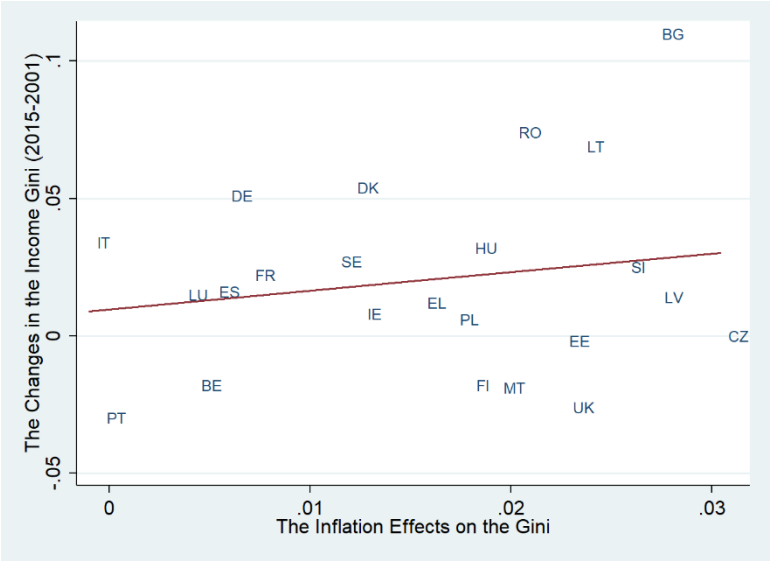


Notes: Country abbreviations can be found in Appendix A (Table A.2)

Whether pro-rich inflation indeed leads to an overall more unequal distributions depends on whether the effect of inflation on the Gini and the effect from the development of nominal consumption levels on the Gini are positively or negatively correlated. For example, it is possible that countries with a stronger pro-rich inflation had a more pro-poor development of income and consumption that compensated the inflation effect. Since the European HBS that is used in this paper contains consumption data for 2010 only, we rely on the available development of the income Gini (Eurostat, 2017) to check for a possible correlation with the amount of pro-rich inflation. Figure 6 illustrates the results. For each country in our sample, the y-axis measures the difference in the Gini between 2015 and 2001. This Gini relies on disposable income, and its change ignores household-specific inflation. On the x-axis, we plot the change in the Gini that would have resulted from inflation effects only and as these have been reported in Figure 5. From this exercise, we find an insignificantly positive correlation. This suggests that the inflation effect on the distribution, which has been identified above, has not been compensated by a systematic income development. Figure 6 also illustrates that, while between 2001 and 2015 the ordinary Gini on

average increased by 0.020 points, the average effect of inflation was around 0.015. The inflation effects were almost as important as the changes in the income Gini arising from the actual development of incomes.

Figure 6: The Correlation of the Inflation Effects on the Gini and the Changes of the Income Gini



Notes: Country abbreviations can be found in Appendix A (Table A.2). In the main dataset, the income Gini of 2001 was missing for Cyprus, Latvia, Malta and Slovakia. We proxied it with the income Gini of 2000 for Latvia and Malta. The closest available income Gini data for Slovakia and Cyprus is 2005. Therefore, we excluded them from the table above.

In the literature on inequality measurement, it is argued that the Gini coefficient is overly sensitive to changes in the middle of the distribution (Atkinson, 1970, p. 256). Conversely, the variance of logarithms is known to be more sensitive to the changes at the tails. In order to make sure that the trend we found is robust to the use of the inequality measure, we repeat the exercise by taking the variance of logs as our inequality measure. In the interest of space, we only report the equivalents of Table 4 and Figure 5. Results are reported in Appendix D (Table D.1 and Figure D.1). Although there are small changes in the location of some countries, our main conclusions are robust.

Cross-country heterogeneity in magnitudes, presented in Figure 5, raises an interesting question. What is the source of the differential

effective inflation rates across the distribution? Why do some countries suffer more than others? In order to investigate these questions, we graph the difference between expenditure shares of the richest and the poorest decile for 30 categories over the prices of the corresponding categories at 2015 (normalized by 2001 prices). Graphs that are presented in Appendix D (Figure D.2) provide a simple picture of each country to analyze the source of the effective inflation rates for the interested readers. In general, consistent with the findings of Section 4.1, it seems that "Food" (011) and "Electricity, gas and other fuels" (045) are important drivers of the cross-country heterogeneity of the effective inflation rates in most countries. This leaves open the extent to which policy influences or general market trends are responsible for the development. We leave this as an open question for future research.

5 Conclusion

Departing from the fact that expenditure shares vary across households and prices vary across items, this paper highlights the distributional consequences of a systematic variation in expenditure shares and prices. By its very nature, the common CPI does not capture the differential effect of such a variation across households. Combining the European Union Household Budget Surveys (HBSs) and the Harmonized Index of Consumer Prices (HICP) data from Eurostat, we build a data set with 30 expenditure categories for the households in 25 countries together with prices of these categories from 2001 to 2015. Subsequently, we construct household-specific price indices in order to account for the effective inflation rates of each household in our sample.

We document the existence of a pro-rich inflation in Europe over the period 2001-15. Our point estimates reveal that the poorest decile have seen their consumption bundle becoming 10.5 percentage points more expensive than the richest decile's which translates into, on average, a 0.72 percentage point yearly difference. Our analysis highlights the importance of the substantial increase in the prices of

"Food", "Actual rentals of Housing" and "Electricity, gas and other fuels" as some of the main drivers of this phenomenon. Among 25 countries we investigate, every one of them except for Italy and Portugal have experienced this trend with different magnitudes. Furthermore, we explore the implications of pro-rich inflation on the measurement of inequality. Our thought experiment indicates that accounting for the household-specific price indices increases consumption expenditure Gini by up to 0.03 points. Cross-country heterogeneity in the magnitude of this change is large enough to affect the ranking of countries in terms of inequality measures. The same conclusion holds if inequality is measured by the variance of logs instead of the Gini coefficient.

This paper does not provide a causal explanation for the source of the cross-country heterogeneity in pro-rich inflation. Exploring the specific channels that drive such a variation across countries, we believe, is an attractive ground for future research. Moreover, as emphasized in the first section, our analysis only accounts for between-category variations in expenditure shares and prices. Using Nielsen data, an expanding body of literature is investigating the same question by exploring within-category variations for the US. It would be interesting to see how incorporating the within-category variations change the picture provided in this paper.

Finally, the paper may also explain the high public interest in distributional issues in continental Europe, although many economic studies that are based on uniform consumer price indices for recent decades find only limited increases in income inequality in non-Anglo-Saxon countries.

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Appendix

A. Data Preparation

Construction of Consistent Categories from HBSs

As it is mentioned in the Data section, HBSs contain consumption expenditure data in many aggregation levels which are represented by number of digits in the variable codes ranging from the 2-digit to the 5-digit level. For example, the variable that represents the consumption expenditure on "Food and Non-alcoholic Beverages" are 2-digit. Sub-categories of the 2-digit level of aggregation is, naturally, 3-digit categories (e.g., food, non-alcoholic beverages). Although it would be ideal for the sake of precision, it is not possible to employ categories more disaggregated than 3-digit since there are a significant number of missing price data.

An important flaw in 3-digit categories is that in around 9% of the observations, 3-digit categories do not add up to their corresponding 2-digit aggregate. If, for example, the sum of the 3-digit category "Food" and the 3-digit category "Non-alcoholic Beverages" do not add up to their 2-digit aggregate "Food and Non-alcoholic Beverages", it is natural to expect that sum of all 3-digit categories would not add up to total consumption expenditure. One approach would be to work with only 12 2-digit categories of the survey. However, since using the most disaggregated categories where possible increases precision, we deal with this issue by scaling up the 3-digit categories proportionately such that they will add up to their 2-digit aggregate.

In the HICP data, unfortunately, prices are not fully available on the 3-digit level. We investigate every 3-digit category to see the extent of missing price data. If the number of missing data points is too large such that an imputation could create meaningless results, we use the 2-digit aggregate of that particular strand. For example, just like HBS data, the HICP data splits the 2-digit aggregate "Education" into 3-digit categories such as "Primary Education",

"Secondary Education" etc., and reports prices both on the 2-digit and 3-digit level. If price data on the 3-digit level is missing in a significant number of country-year observations, we collapse that strand to its 2-digit aggregate and only use the 2-digit level in the analysis. If the number of missing observations is low, then we impute them. Details of the imputation procedure is provided in the next section. Table A.1 presents the 30 expenditure categories and their codes. Table A.2 contains the list of 25 countries analyzed with their abbreviations.

Table A.1: Expenditure Categories and Variable Codes

Variable Code	Expenditure Category
011	Food
012	Non-alcoholic beverages
021	Alcoholic beverages
022	Tobacco
031	Clothing
032	Footwear
041	Actual rentals of housing
042	Imputed rentals of housing
043	Maintenance and repair of the dwelling
044	Water supply and misc. services
045	Electricity, gas and other fuels
051	Furniture and furnishings, carpets and other floor coverings
052	Household textiles
053	Household appliances
054	Glassware, tableware and household utensils
055	Tools and equipment for house and garden
056	Goods and services for routine household maintenance
061	Medical products, appliances and equipment
062	Out-patient services
063	Hospital services
071	Purchase of vehicles
072	Operation of personal transport and equipment
073	Transport services
081	Postal services
082	Telephone and telefax services and equipment
09	Recreation and culture
10	Education
111	Catering services
112	Accommodation services
12	Misc. goods and services

Table A.2: List of Countries and Their Abbreviations

Abbreviation	Country	Abbreviation	Country
BE	Belgium	IT	Italy
BG	Bulgaria	LT	Lithuania
CY	Cyprus	LU	Luxembourg
CZ	Czech Republic	LV	Latvia
DE	Germany	MT	Malta
DK	Denmark	PL	Poland
EE	Estonia	PT	Portugal
EL	Greece	RO	Romania
ES	Spain	SE	Sweden
FI	Finland	SI	Slovenia
FR	France	SK	Slovakia
HU	Hungary	UK	United Kingdom
IE	Ireland		

Harmonised Index of Consumer Price Data

While preparing the HICP data, we encountered two main issues. First, as it was mentioned in the previous section, there are missing country-year price observations after constructing 30 expenditure categories. We impute missing country-year observations as follows.

- 3-digit category "Hospital Services" data is missing for Slovenia in 2001. It is proxied by the same category's 2002 price.
- 3-digit category "Hospital Services" data is missing for Estonia between 2001 and 2003. They are proxied by the same category's 2004 price.
- 3-digit category "Hospital Services" data is missing for Hungary between 2001 and 2006. They are proxied by the same category's 2007 price.
- 3-digit category "Hospital Services" data is missing for Slovakia and Romania between 2001 and 2015. They are proxied by the price of their 2-digit aggregate "Health" in the respective country-year.

- 3-digit category "Telephone and Telefax Services and Equipment" data is missing for Latvia in 2014. It is proxied by the same category's 2013 price.

It is important to note that fraction of proxied country-year price observations is around 0.002%. Moreover, the mean expenditure fraction of main problematic 3-digit category "Hospital Services" across countries is 0.02%. Therefore, we are confident that proxying missing price observations do not have a serious impact on our results.

A final issue to deal with is the 3-digit category "Imputed Rentals of Housing". Naturally, HICP does not provide any information on prices of this category. One immediate resolution for this problem would be proxying the prices of this category with prices of the 3-digit category "Actual Rentals of Housing". However, by definition, values in "Imputed Rentals of Housing" do not imply an actual expenditure. Values purely represent the rental price of the dwelling as if it is consumed by its owner. Therefore, a price increase would not imply a decline in the real expenditure of the household who owns the dwelling. In order to neutralize the effect of this category, we assume that the price of "Imputed Rentals of Housing" has not changed with respect to the base year. The fraction "Imputed Rentals of Housing" in total expenditure across deciles is not large enough to explain away our findings. The table below, presents the fractions. For this reason, this assumption is not biasing our results.

Table A.3: Simple Mean of "Imputed Rentals of Housing" for Deciles across Countries

Decile	1	2	3	4	5	6	7	8	9	10
Share	13.4%	14.5%	15.2%	15.7%	15.5%	15.6%	15.5%	15.3%	14.8%	12.7%

B. A Simple Model

We construct a simple model based on the stylized fact that poorer households spend a higher fraction of their income on necessities and

provide a simple intuition for this fact. Following that, the model yields the implication that richer has a higher ability of substituting away the goods in response to a price increase.

Consider a representative agent with a Stone-Geary utility function in an economy which consists of two goods: necessities (q_n) and luxuries (q_l). The agent maximizes

$$U = \beta_n \ln(q_n - \gamma_n) + \beta_l \ln(q_l) \tag{10}$$

over q_n and q_l such that the budget constraint $p_n q_n + q_l = y$ is satisfied. In this specification, γ_n indicates the subsistence parameter of necessities (subsistence parameter of luxuries is assumed to be zero). Let p_n be the price of necessities relative to luxuries and y is the nominal income of the agent. Finally, β_n and β_l are preference parameters. We assume $\beta_n > 0$, $\beta_l > 0$ and $\beta_n + \beta_l = 1$.

Usual FOCs yield the following demand functions.

$$q_n^* = \gamma_n + \frac{\beta_n}{p_n}(y - p_n\gamma_n) \tag{11}$$

$$q_l^* = \beta_l(y - p_n\gamma_n) \tag{12}$$

Resulting demand functions are simple and intuitive. The agent sets aside the subsistence level of necessities and allocate the rest of her income depending on prices and preference parameters. Following this, we derive the optimal expenditure share of necessities in total demand.

$$s_n^* = \frac{[\gamma_n p_n + \beta_n(y - p_n\gamma_n)]}{[\gamma_n p_n + \beta_n(y - p_n\gamma_n)] + \beta_l(y - p_n\gamma_n)p_l} \tag{13}$$

Given $\beta_l > 0$, an increase in income causes a higher increase in denominator due to higher scaling factor ($\beta_n + \beta_l > \beta_n$). Hence, $\frac{\partial s_n^*}{\partial y} < 0$.

Intuitively, each household has to spend on necessities at least as much as the subsistence level which is a constant. As the subsistence level-income ratio decreases in income, richer households spend a lower fraction on necessities given that the luxury good is at least marginally desirable ($\beta_l > 0$).

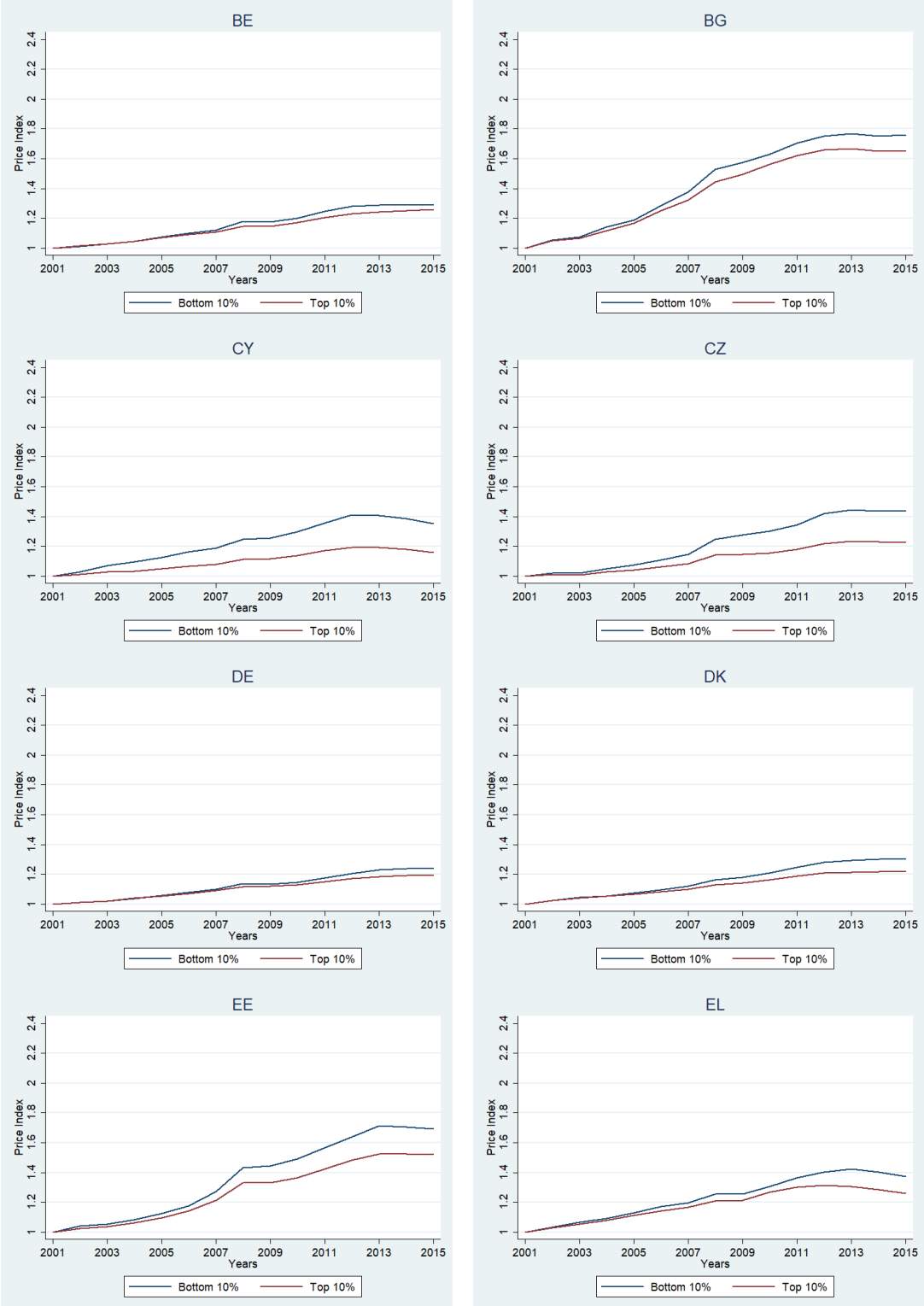
Another implication of the model is that rich has a higher ability in substituting away the goods in response to a price increase. Let the price elasticity of demand of necessities be as follows.

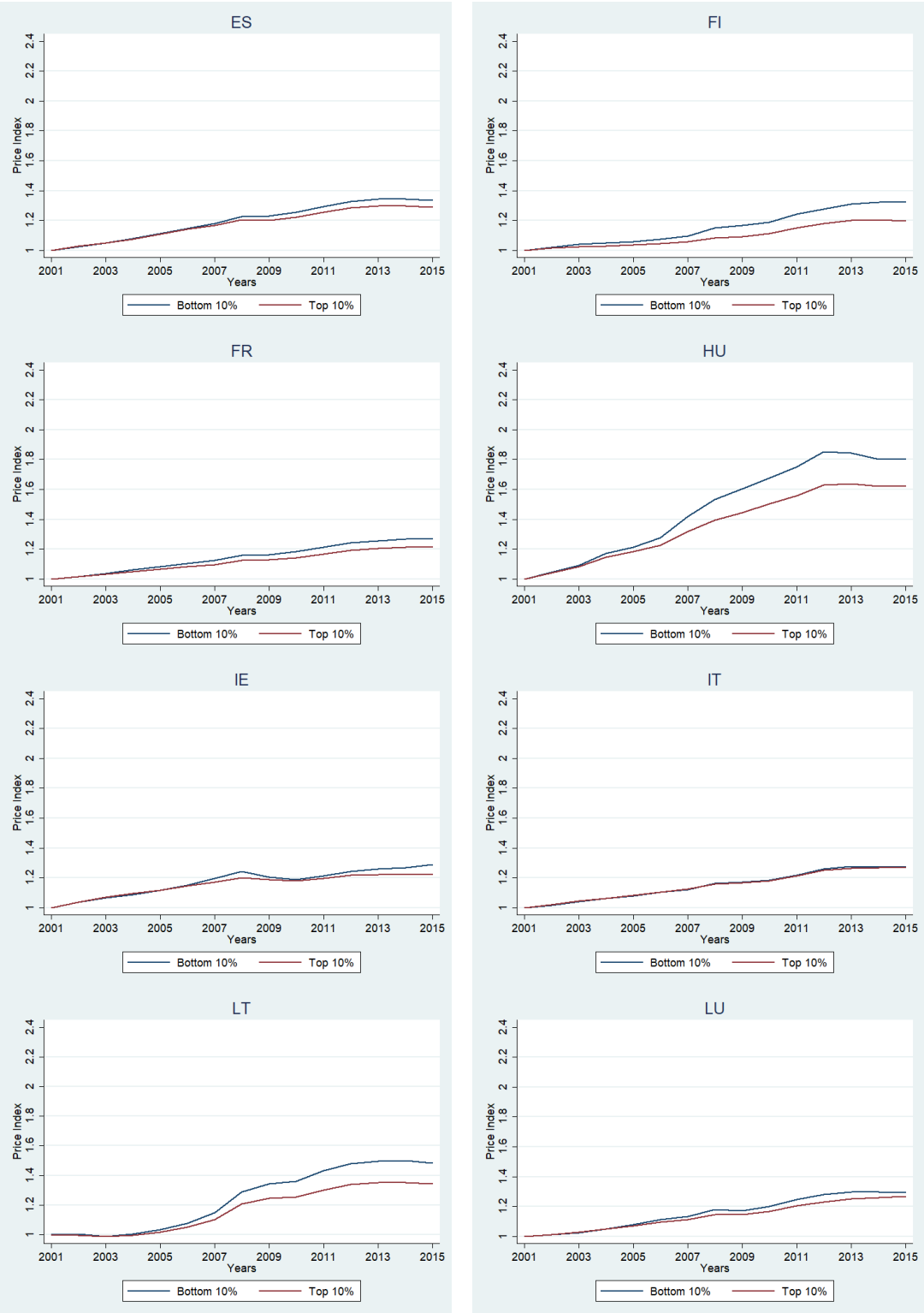
$$\epsilon_n = \frac{\partial q_n^*/q_n^*}{\partial p_n/p_n} = \frac{\frac{\partial q_n^*}{\partial p_n}}{\frac{q_n^*}{p_n}} = \frac{-\beta_n y}{p_n\gamma_n + \beta_n(y - p_n\gamma_n)} = \frac{-\beta_n y}{p_n\gamma_n + \beta_n y - \beta_n p_n\gamma_n} \tag{14}$$

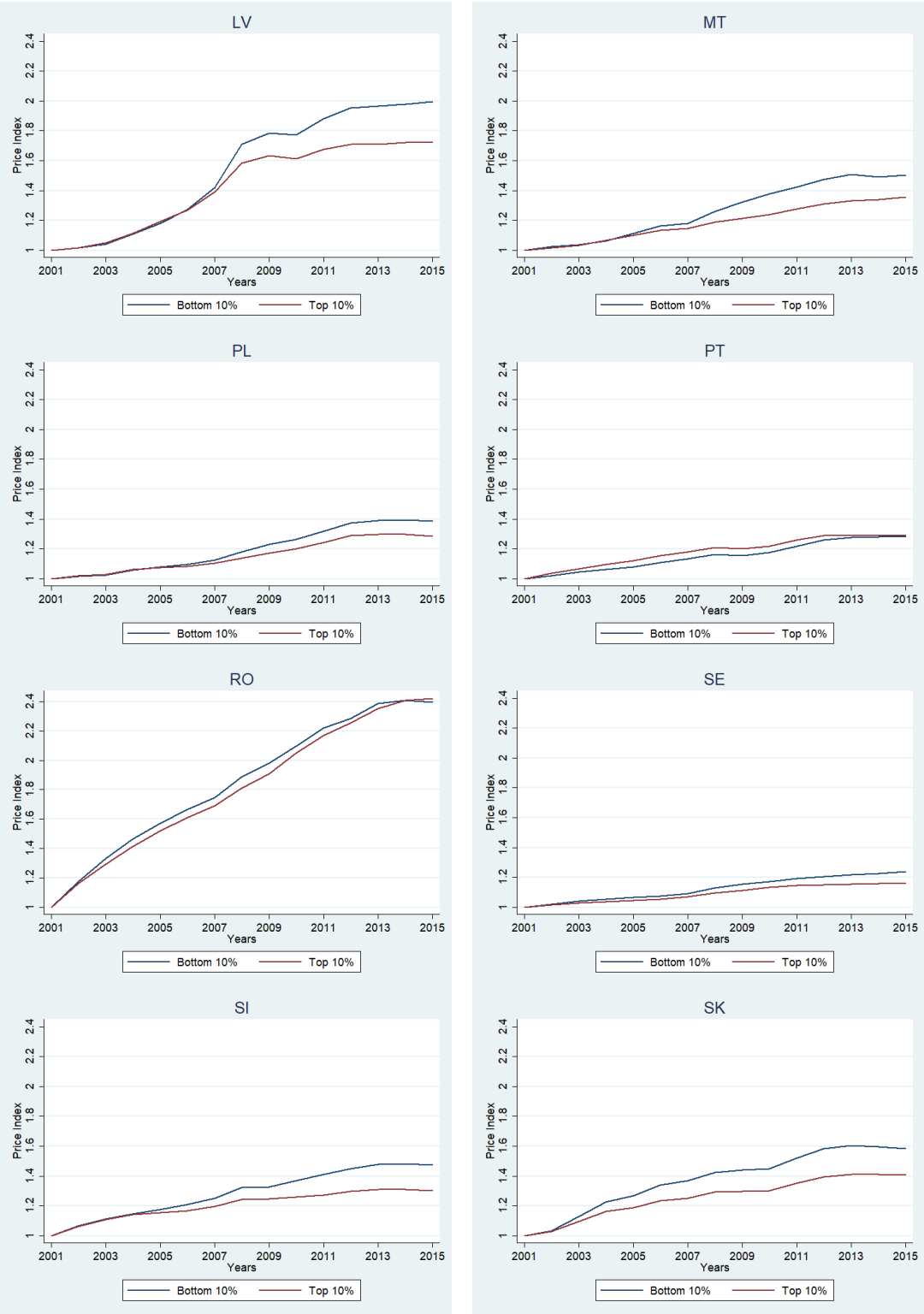
Note that $|\epsilon_n| < 1$. Hence, $\frac{\partial|\epsilon_n|}{\partial y} > 0$, which means that the price elasticity of demand for necessities is increasing in income. The intuition behind this result is as simple as the previous one. The agent can only substitute the expenditures that is left after setting aside the subsistence level. Given that poorer households are left with a lower amount after paying for the subsistence, their ability to substitute is lower compared to richer households.

C. Effective Inflation Rates by Country

Figure C.1: Effective Inflation Rates of the Poorest and the Richest Deciles over Time by Country




ES
FI
FR
HU
IE
IT
LT
LU
Price Index
Years
Bottom 10%
Top 10%


LV
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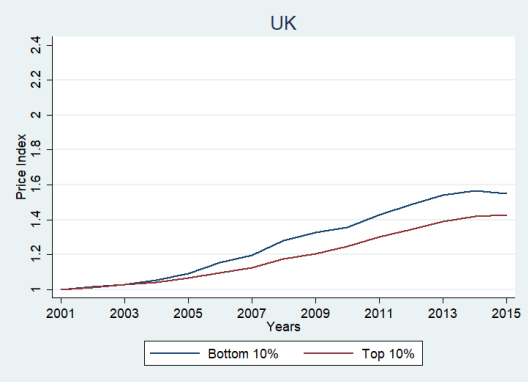
SE
SI
SK
Price Index
Years
Bottom 10%
Top 10%



Notes: Country abbreviations can be found in Appendix A (Table A.2)

D. Inequality Analysis

Table D.1: Baseline Variance of Log Expenditure Measures by Country

Country	Variance of Log Expenditure	Adjusted Variance of Log Expenditure
Portugal	0.371	0.370
Estonia	0.369	0.419
Malta	0.349	0.390
United Kingdom	0.314	0.366
Latvia	0.312	0.367
Italy	0.303	0.303
Cyprus	0.284	0.338
Lithuania	0.282	0.322
Greece	0.280	0.307
France	0.273	0.289
Spain	0.262	0.275
Finland	0.261	0.295
Romania	0.254	0.282
Luxembourg	0.250	0.260
Poland	0.243	0.266
Ireland	0.238	0.263
Germany	0.231	0.241
Bulgaria	0.226	0.277
Belgium	0.215	0.222
Slovenia	0.206	0.243
Sweden	0.198	0.215
Hungary	0.196	0.231
Denmark	0.168	0.181
Slovakia	0.155	0.184
Czech Republic	0.146	0.184

Figure D.1: Absolute Change in Variance of Log Expenditure after Applying Household-specific Price Indices

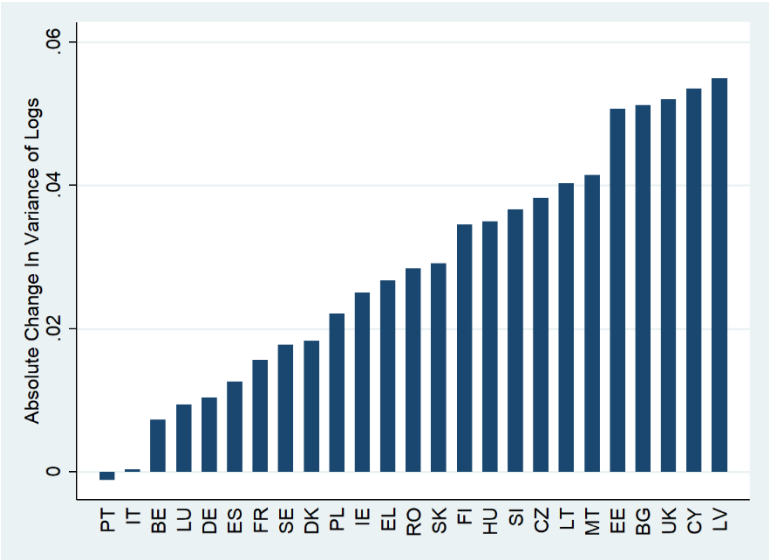
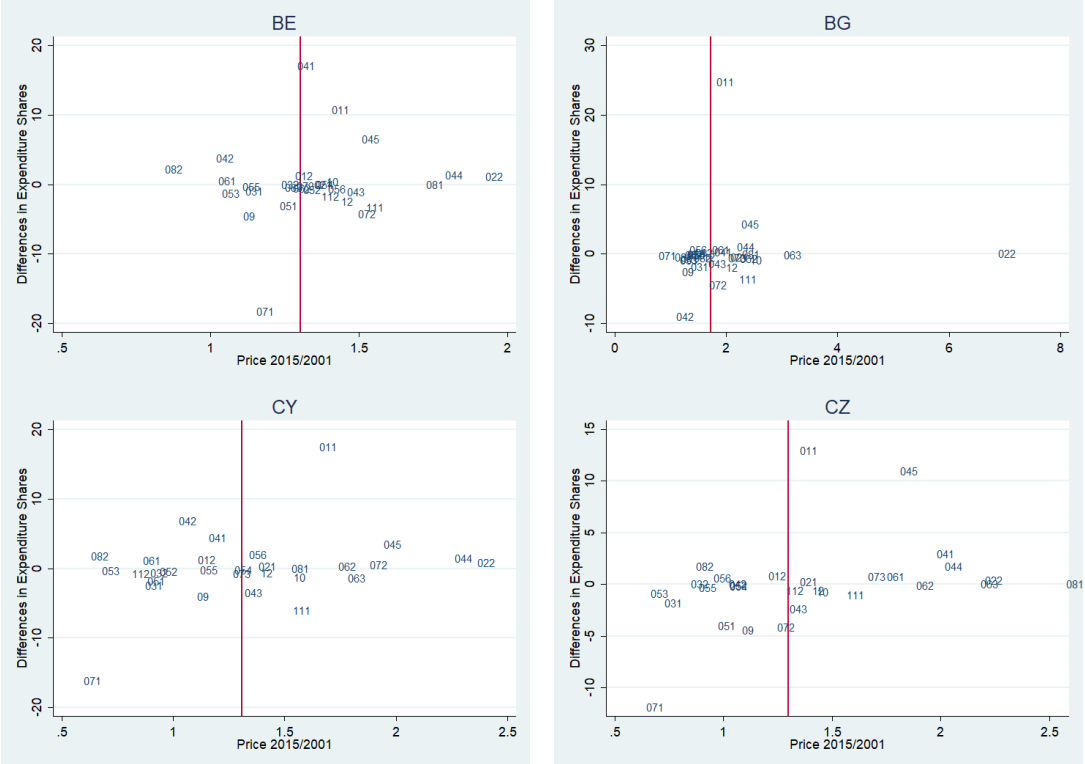
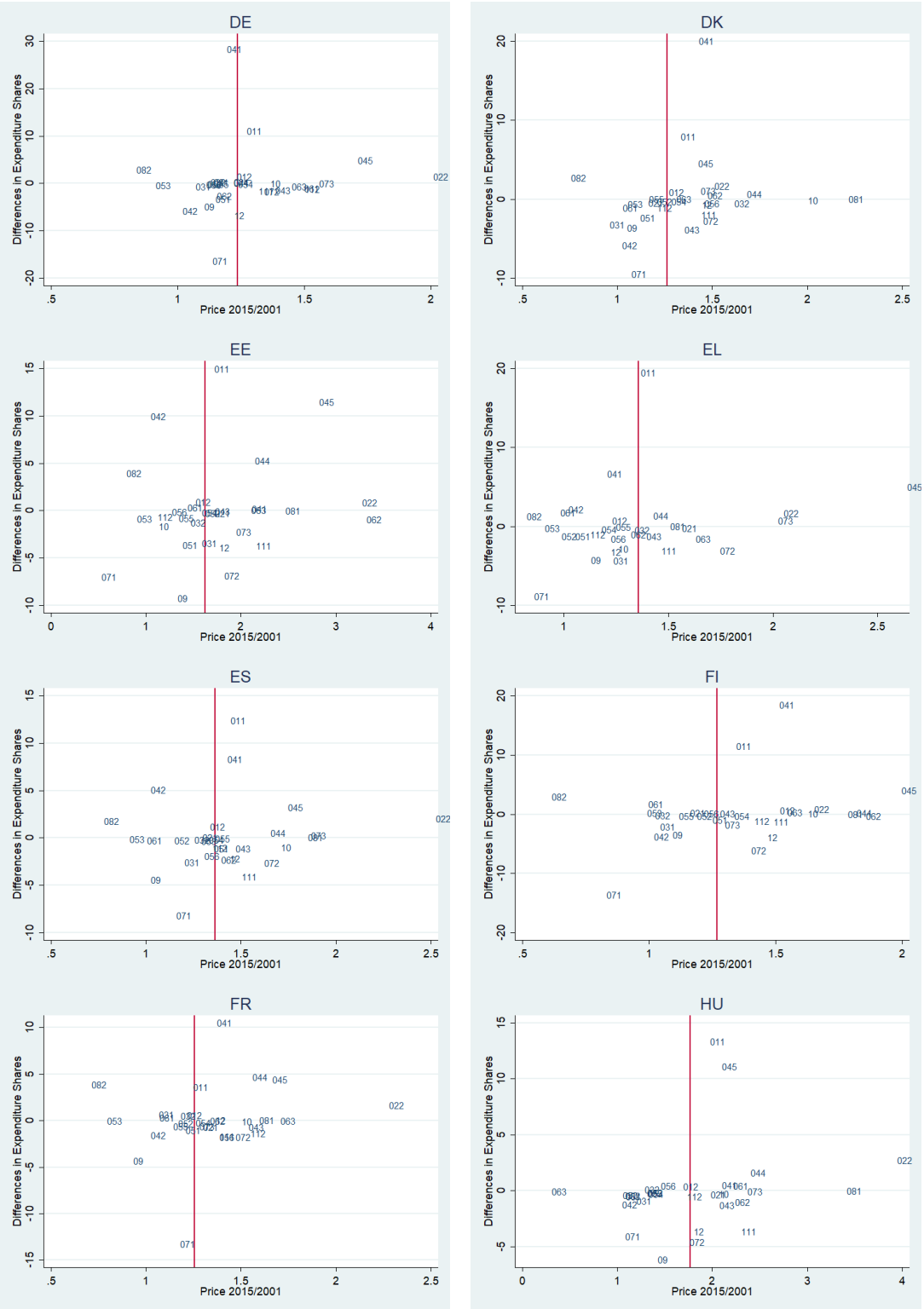
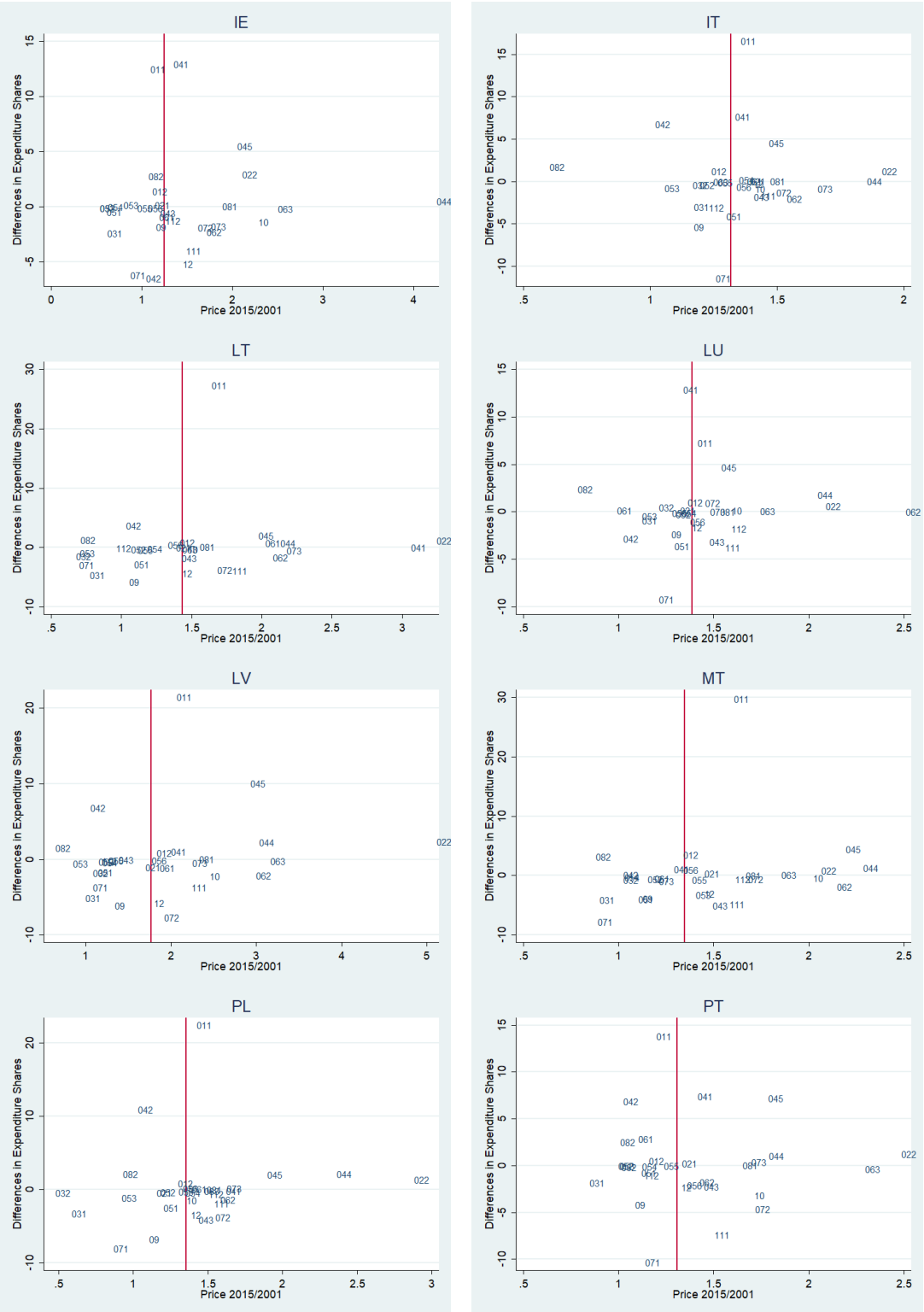
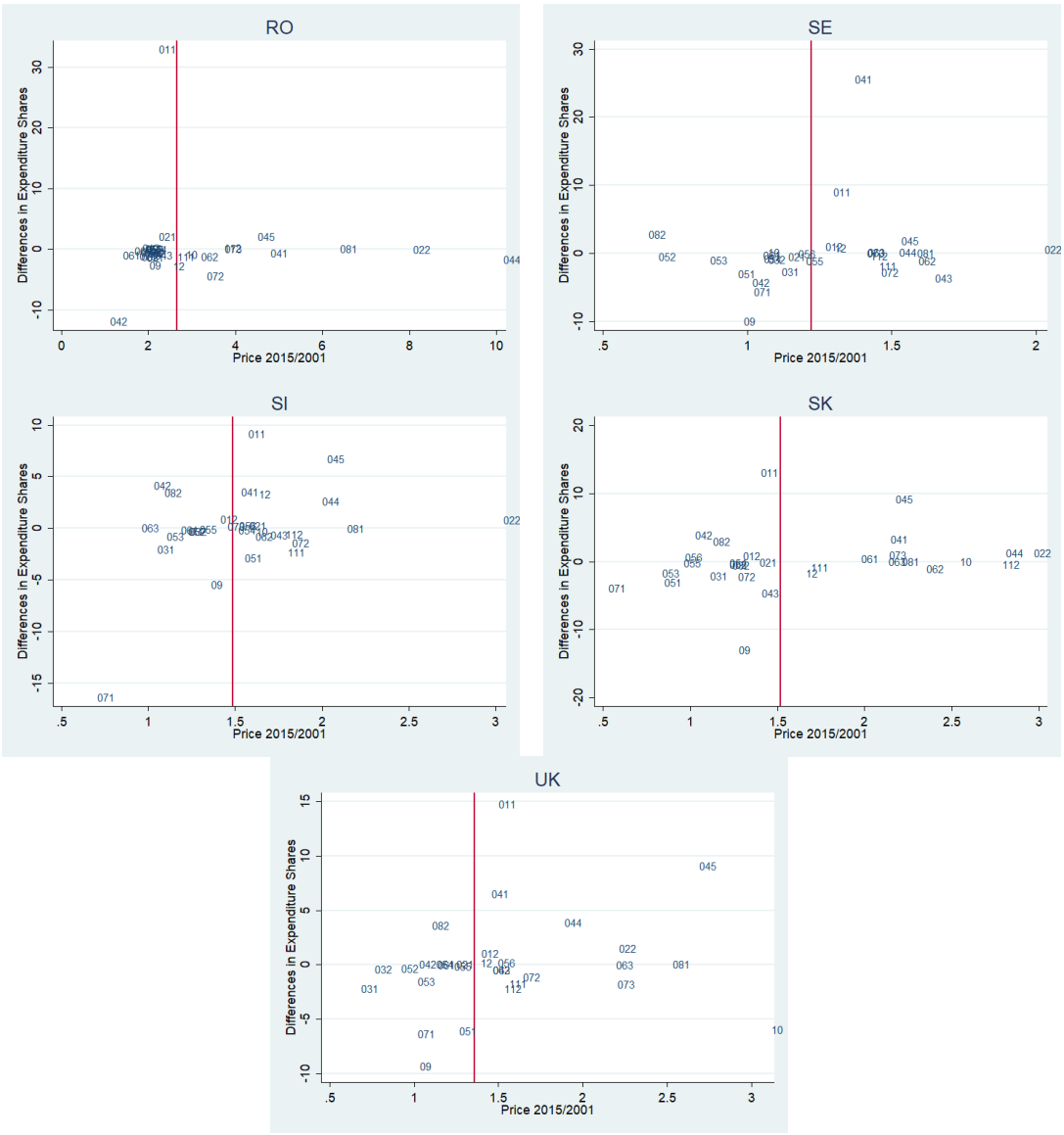


Figure D.2: Expenditure Share Differentials and Prices by Country




DE
DK
EE
EL
ES
FI
FR
HU
Differences in Expenditure Shares
Price 2015/2001


IE
IT
LT
LU
LV
MT
PL
PT
Differences in Expenditure Shares
Price 2015/2001



Notes: Y- axis is the difference in the expenditure shares of the richest and the poorest decile. X-axis is the price of the corresponding category in 2015 divided by the 2001 price. Explanations of the category codes and country abbreviations can be found in Appendix A (Table A.1 and Table A.2).