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STUDYING INEQUALITY IN INCOME DISTRIBUTION OF SINGLE-PERSON HOUSEHOLDS IN FOUR DEVELOPED COUNTRIES

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The increasing frequency of single-person households has become a major economic phenomenon, and is likely to become an important political force. This paper focuses on differences related to inequality of income distribution among single-person households in Europe's four largest economies, i.e. France, Germany, Italy and the U.K. Income distribution was modeled in terms of individual characteristics using a parametric model with heterogeneous model parameters. Poverty differences were also broken down using the results of Biewen and Jenkins (2005) in order to understand the relationship between poverty and individual characteristics among countries.

1. Introduction

In recent decades, living alone has become an increasingly popular lifestyle among Europeans, particularly in urban areas, and the number of single-person households has increased (Wall, 1989; Kaufman, 1994). Living alone has long been common among elderly people; it is among younger adults that this recent growth has taken place (Eurostat, 2000a, 2000b). This demographic trend has attracted many researchers: Morgan (1996) studied its implications in the analysis of family practices; Scott (1997) dealt with the implications in understanding family life in the U.K.; Hatland (2001) wrote about changing family patterns as a challenge to social security; finally, Anzick and Weaver (2001) reported on poverty among elderly women. This increase in single-person households reflects radical structural changes in household composition arising from an increase in divorces and separations, and in people who choose to be singles. With the proportion of

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single-person households increasing in Europe, an international comparison of inequality in income distribution, taking into account this target group, is very interesting from a social and economic point of view. It is becoming increasingly pertinent to investigate the multivariate relationship between poverty and individual characteristics, such as gender, age, marital status, employment status and education in different European countries. An understanding of this relationship can help to identify the single-person households most exposed to risk of poverty and to improve targeting of anti-poverty policy measures.

We carried out our analysis in four European countries (Italy, France, Germany and the U.K.) having welfare systems that represent Mediterranean (Italy), continental (Germany and France) and Anglo-Saxon (U.K.) regimes (Soede *et al.*, 2004). Italy can be considered a sub-protective regime with a generous pension system, but limited provision for non-pensioners: the unemployed receive less than minimum subsistence allowances and active employment policies are non-existent. Germany and France can be considered employment-centered regimes, catering well for employees. Unemployment benefits are generally higher in Germany than in France and old-age benefits are elevated. Moreover the Germany and French systems encourage early retirement. Finally, in the U.K., benefits are close to the absolute minimum necessary to prevent poverty, and the welfare system is similar to a liberal/minimal regime that provides a higher level of protection for the unemployed than the sub-protective regime.

In order to study inequality among single-person households, the heterogeneity of this social group must obviously be considered, since the age and gender structure weighs heavily on the composition of net individual income, especially in the framework of international comparisons linked to different welfare systems. For this reason, we also present a descriptive analysis on this point (see Section 3).

We followed the methodological approach first introduced by Pudney (1999), who estimates a conditional income distribution, i.e. an income distribution according to personal characteristics, modeled directly and revised by Biewen and Jenkins (2005), using a parametric rather than a semi-parametric model. We chose the parametric approach using the Dagum distribution (Dagum, 1977). Of the three versions of the Dagum model, which account for specific assumptions regarding income receivers (Gertel *et al.*, 2001), we chose Type I, which contains three parameters and describes distributions starting from income receivers with positive income. To allow for variations in income distribution according to the characteristics of single-person households, each parameter was made heterogeneous. We judged the goodness-of-fit of this model, using the definition of Cox–Snell residuals (Cox and Snell, 1968) employed in survival analysis. The estimates obtained were then used to decompose poverty differences using results of Biewen and Jenkins (2005), in order to understand the relationship between poverty and personal characteristics of single-person households.

The data used for empirical comparative analysis is from Wave 4 (1997) of the European Community Household Panel (ECHP) survey. The ECHP is the primary European panel survey and has a common *ex-ante* structure. It is important to underline that the annual income data for each wave refers to the previous calendar year; therefore the information regarding annual income in the 1997 wave refers to 1996.

The rest of this study is organized as follows: Section 2 deals with the parametric specification used for analyzing income distribution; Section 3 describes the ECHP data and the variables used; Section 4 presents the empirical results; and Section 5 presents our conclusions.

2. Dagum Model: Definition and Main Features

2.1. *Model Specification*

Let $i = 1 \ldots N_c$ indicate the i-th individual in each country $c = 1 \ldots K$ and y_i his/her annual individual income. We assume that the income distribution complies with Dagum Type I distribution (Dagum, 1977) with parameters $\lambda > 0$, $\beta > 0$ and $\delta > 0$ in each country. This distribution includes the following cumulative distribution function (cdf):

$$F_Y(y) = \frac{1}{\left(1 + \lambda y^{-\delta}\right)^{\beta}}, \quad y \geq 0 \quad \text{and} \quad F(y) = 0, \quad y < 0 \tag{1}$$

where β and δ are equality (shape) parameters for the lower and upper tail of the distribution and λ is a scale parameter. The corresponding probability density function (pdf) is:

$$f_Y(y) = \beta\lambda\delta y^{-\delta-1}\left(1 + \lambda y^{-\delta}\right)^{-\beta-1}. \tag{2}$$

In a three-parameter version, the Dagum model provides a very flexible parametric distribution (Dagum and Lemmi, 1988) and better performance than the most widely used models (Kleiber, 1996) for a considerable number of empirical results.

In order to allow the form of income distribution to vary with personal characteristics, each model parameter may be made heterogeneous as follows:

$$\begin{aligned} \beta_i &= \exp(x_i\alpha_1) \\ \delta_i &= \exp(x_i\alpha_2), \\ \lambda_i &= \exp(x_i\alpha_3) \end{aligned} \tag{3}$$

where x_i is a $1 \times m$ vector for individual characteristics and α_1, α_2, α_3 are $m \times 1$ parameter vectors. Thus equation (1) becomes:

$$F_Y(y; x; \beta; \delta; \lambda) = \frac{1}{\left(1 + \exp(\mathbf{x}\alpha_3)\, y^{-\exp(\mathbf{x}\alpha_2)}\right)^{\exp(\mathbf{x}\alpha_1)}}. \tag{4}$$

The estimators for the distribution parameters were obtained using maximum likelihood estimation, maximizing the log-likelihood function:

$$\ln L = \sum_{i=1}^{N_c} \omega_i \ln l_i = \sum_{i=1}^{N_c} \omega_i (\ln \beta_i + \ln \lambda_i + \ln \delta_i + (-\delta_i - 1) \ln y_i - (\beta_i + 1) \ln\left(1 + \lambda_i y_i^{-\delta_i}\right)), \tag{5}$$

where ω_i is the sample weight of individual i.

2.2. *Goodness of Fit*

In this context, the goodness-of-fit of the parametric model has to allow for heterogeneity introduced with covariates. We propose to use a graphic method based on Cox–Snell residuals. These residuals are generally used in survival analysis and provide a check of overall fit for parametric and semi-parametric survival models.[1] According to survival analysis theory, a random variable T (called duration) denotes the time elapsed between a specified event and the time of failure. T therefore cannot be negative. If we do not think of T as a duration, but only as a positive random variable, we can compare income distribution and duration distribution, using the definitions and survival analysis theory for heterogeneous duration models related to heterogeneous income models.

This enables us to describe the distribution of incomes using the survival distribution function $S_Y(y; x; \beta; \delta; \lambda)$ which is complementary to the cumulative distribution function $F_Y(y; x; \beta; \delta; \lambda)$. We can also define the hazard rate function $r_Y(y; x; \beta; \delta; \lambda)$, which in survival analysis theory represents the instantaneous risk that the event of interest occurs. We can therefore define the Cox–Snell residual $\hat{e}_i$ for the i-th observation as the estimated cumulative hazard function of Y given **X**:

$$\hat{e}_i = \hat{\Lambda}_Y\left(y_i; x_i; \hat{\beta}_i; \hat{\delta}_i; \hat{\lambda}_i\right) = \int_0^{u_i} \hat{r}_Y\left(u; x_i; \hat{\beta}_i; \hat{\delta}_i; \hat{\lambda}_i\right) du = -\log \hat{S}_Y\left(y_i; x_i; \hat{\beta}_i; \hat{\delta}_i; \hat{\lambda}_i\right). \tag{6}$$

If the model is good, these residuals should behave like a sample from an exponential distribution with parameter 1. A plot of the ordered estimated $\hat{e}_i$ ($I = 1 \ldots n$) against the nonparametric estimates of their cumulative hazard function (CHF) $\hat{\Lambda}_e(\hat{e}_i)$[2] should therefore be roughly a straight line with slope 1 (Elandt-Johnson and Johnson, 1980).

2.3. *Inequality Measure*

It is important to note that parameters α_1, α_2, α_3 do not have a direct meaning, so the inference regarding the influence of individual characteristics may be based on differentials in synthesis measures of the estimated income distribution, such as mode, median, etc. Once the model parameters have been estimated, the idea is to consider "bench mark" individuals with a set of characteristics $\tilde{x}$ and to investigate

[1]In fact, a conditional Kolmogorov test of model specification for parametric models with covariates was proposed by Andrews (1997), but the generalization of this methodology is too complicated for our purposes. We therefore prefer to use a graphical method, as do Biewen and Jenkins (2005) in their paper.

[2]We used the Nelson-Aelen estimator (Nelson, 1972) to compute the CHF (see Elandt-Johnson and Johnson, 1980, p. 366).

whether changing these characteristics from $\tilde{x}$ to x^* causes the mode, median, mean or Gini's index of the distribution to increase or decrease.

The median for individuals with characteristics $\tilde{x}$ is derived from:

$$y_{0.5} = [\exp(\tilde{x}\alpha_3)]^{\left(\frac{1}{[\exp(\tilde{x}\alpha_2)]}\right)} \left[\left(\frac{1}{1/2} \right)^{\left(\frac{1}{[\exp(\tilde{x}\alpha_1)]}\right)} - 1 \right]^{-\left(\frac{1}{[\exp(\tilde{x}\alpha_2)]}\right)}, \tag{7}$$

and the q-th quantile y_q is:

$$y_q = [\exp(\tilde{x}\alpha_3)]^{\left(\frac{1}{[\exp(\tilde{x}\alpha_2)]}\right)} \left[\left(\frac{1}{q} \right)^{\left(\frac{1}{[\exp(\tilde{x}\alpha_1)]}\right)} - 1 \right]^{-\left(\frac{1}{[\exp(\tilde{x}\alpha_2)]}\right)}. \tag{8}$$

The Gini concentration ratio among individuals with characteristics $\tilde{x}$ is defined as:

$$G_{\tilde{x}} = -1 + \frac{\Gamma(\exp(\tilde{x}\alpha_1))\Gamma\left(2\exp(\tilde{x}\alpha_1) + \frac{1}{\exp(\tilde{x}\alpha_2)}\right)}{\Gamma(2\exp(\tilde{x}\alpha_1))\Gamma\left(\exp(\tilde{x}\alpha_1) + \frac{1}{\exp(\tilde{x}\alpha_2)}\right)} \tag{9}$$

where $\Gamma(.)$ is the complete gamma function.[3]

Similarly, we can define the poverty rate among individuals with characteristics $\tilde{x}$ as:

$$I(p, \tilde{x}) = F(p|\alpha_1, \alpha_2, \alpha_3, \tilde{x}) = \frac{1}{\left(1 + \exp(\tilde{x}\alpha_3)\, p^{-\exp(\tilde{x}\alpha_2)}\right)^{\exp(\tilde{x}\alpha_1)}} \tag{10}$$

for any chosen poverty line p and parameters α_1, α_2, α_3.

2.4. *Decomposition of Poverty Differences*

Using results of Biewen and Jenkins (2005) who decomposed poverty differences in the spirit of Oaxaca (1973) and Blinder (1973), we determined to separate the influence of differences in the conditional poverty function on one hand, and those in the distribution of poverty-relevant characteristics on the other.

We define poverty in the population as:

$$I(p) = \int_{z \in Z} I(p|z)\, dG(z), \tag{11}$$

[3]See Dagum (1977, p. 424).

where $I(p|z)$ is the conditional poverty function, i.e. the poverty rate of a subpopulation with characteristics $z \in Z$, p the poverty line, and $G(.)$ the distribution of characteristics in the population.[4]

Considering (11), the difference in poverty rates between country A and country B may be defined as:

$$
\begin{aligned}
(12) \qquad & I_A(p_A) - I_B(p_B) = \\
& \int_{z \in Z} I_A(p_A|z)\,dG_A(z) - \int_{z \in Z} I_B(p_B|z)\,dG_B(z) = \int_{z \in Z} I_A(p_A|z)\,dG_A(z) - \\
& \int_{z \in Z} I_B(p_B|z)\,dG_A(z) + \int_{z \in Z} I_B(p_B|z)\,dG_A(z) - \int_{z \in Z} I_B(p_B|z)\,dG_B(z) = \\
& (I_{AA} - I_{BA}) + (I_{BA} - I_{BB}).
\end{aligned}
$$

In fact, the cross-national poverty difference may be decomposed into $(I_{AA} - I_{BA})$ due to cross-national differences in the conditional poverty function and into $(I_{BA} - I_{BB})$ due to differences in the distribution of individual characteristics between the two countries.

In other words, this decomposition explains how high the poverty rate in country A would have been if the population there had faced the poverty function of country B and vice versa.

3. Data and Variables

The empirical analysis is based on the European Community Household Panel (ECHP) survey, which provides comparable information for many socio-economic variables, including income, at European level. The ECHP survey has been conducted in different European countries by the European Union statistics office (Eurostat) since 1994. We use information from the User's Data Base and only Wave 4 (1997). As we highlighted in Section 1, income data refers to 1996.

Our analysis was only concerned with the distribution of disposable monetary income, i.e. the total annual net income (total personal income after taxes and transfer payments) referring to the previous calendar year in each wave. Income is expressed in PPS (Purchasing Power Standard) to enable comparison of "real" purchasing power between countries. Table 1 shows that the percentage of individuals over 16 years of age constituting single-person households was 17 percent in the four countries taken together. It also shows that the percentage of households that were single-person households was 28 percent.

Of the four nations studied, Germany had the highest percentage of individuals living in single-person households (21 percent) and Italy the lowest (12 percent). The percentage of single-person households was 35 percent in Germany and 20 percent in Italy. Differences in these single-person household rates across countries are of course related to the age structure of the respective populations, but they also reflect social and economic differences. For example, in Italy the economic

[4]Computed as: $G(z) = G(\tilde{x}) = \left(\sum_{i=1}^{n} w_i\right)^{-1} \sum_{i=1}^{n} w_i 1\{\tilde{x}_i \le \tilde{x}\}$ where $1\{.\}$ is the indicator function.

TABLE 1

SAMPLE COMPOSITION BY COUNTRY

Country	Number of Individuals	Individuals in Single-Person Households	Individuals in Single-Person Households (%)	Single-Person Households (%)*
France	11,268	1,584	17	30
Italy	11,890	1,020	12	20
Germany	11,044	1,338	21	35
U.K.	8,728	1,206	16	28
All countries (EU-4)	42,930	5,148	17	28

Source: ECHP, weighted data wave 4, 1997.

TABLE 2

PERCENTAGE OF INDIVIDUALS LIVING IN SINGLE-PERSON HOUSEHOLDS BY COUNTRY, AGE AND GENDER

	Age, Class and Gender								
Country	Males under 35	Males 35–55	Males 55–70	Males over 70	Females under 35	Females 35–55	Females 55–70	Females over 70	Total
France	14	13	7	7	11	9	13	26	100
Italy	6	10	8	7	4	6	20	39	100
Germany	14	14	7	4	11	8	15	27	100
U.K.	12	12	7	8	11	8	12	30	100

Source: ECHP weighted data, wave 4, 1997.

squeeze may prolong the time young adults live at home. In the other countries a more relaxed attitude to divorce may boost the frequency of separations. In any case, this evidence alone is not completely informative because age and gender structure together influence the rate of single-person households in each country. The ageing of the population generally causes an increase in the number of single-person households. In order to analyze this phenomenon in greater detail, the percentages of individuals living alone are shown by age and gender in Table 2.

Comparison of men and women showed some important age and gender-related differences. European populations are ageing, as shown by the high percentage of single-person households among elderly people. The gender influence is also considerable: the percentage of women over 70 years was high in all countries and highest in Italy. This much larger proportion of elderly women than men living alone can be explained by women's longer life expectancy and men's higher age at marriage. Moreover, in all countries, people living alone are generally concentrated in young age classes among men and old age classes among women. Again, the Italian picture is different, being characterized by the lowest percentage of young men and young women living alone. This may depend on different causes, such as strong ties with the household of origin, and a catholic tradition that limits divorce with respect to more relaxed traditions. Reluctance to marry and high divorce rates also contribute to the number of single-person households (Table 3).

In Italy, divorced people constitute 13 percent of single-person households; this value deviates considerably from the average of the four countries (20

TABLE 3
PERCENTAGE OF INDIVIDUALS LIVING IN SINGLE-PERSON HOUSEHOLDS BY COUNTRY AND MARITAL STATUS

Country	Divorced	Widow	Never Married	Total
France	19	37	44	100
Italy	13	56	31	100
Germany	21	36	43	100
U.K.	21	40	22	100
Total	20	39	41	100

Source: ECHP, weighted data, wave 4, 1997.

percent), while the other countries have smaller deviations from the average. In Italy, 31 percent have never married; in the U.K., this value is 22 percent. France and Germany have very similar rates (44 and 43 percent respectively). The influence of gender, related as it is to age and marital status on the composition of single-person households, raises interesting issues about the composition of net individual income by gender. Total individual net income is the result of several income components: labor income, non-work income and total social benefits.[5] For many persons, labor income is by far the largest income component; gender can influence this composition by virtue of the fact that it is correlated with age and/or marital status. Table 4 shows the percentages of different sources of individual income by gender.

In all countries, men had the highest percentage of income from wage and salary earnings: the values range from a minimum of 43 percent in Italy to a maximum of 58 percent in France. However, for women the highest percentage of income was from old-age-survivors' benefits (the values range from a minimum of 43 percent in the U.K. to a maximum of 72 percent in Italy). Another interesting result is that the share of self-employment income for men was only high in Italy and Germany. For both genders, the sum of sickness and other social benefits was only high in the U.K. We will discuss later the decomposition of the total net income, because it helps us to understand inequalities.

In analyzing income inequality across the four countries, we are interested in specifying a statistical model that relates income to certain covariates observed in the population. We have seen that certain population variables are related to household structure (gender, age, marital status) and it is therefore interesting to determine whether they have a significant influence on income distribution.

Other variables such as professional/occupational status and education can of course modify income distribution in the specific countries and cause different rates of poverty. We therefore consider them as other potential covariates.

[5]Labor income is the sum of two components: wage and salary earnings, and self-employment income. Total social benefits is the sum of the following components: unemployment related benefits, old-age/survivors' benefits, old-age related benefits, family-related allowances, sickness/invalidity benefits, education-related allowances, any other (personal) benefits, assigned social assistance, and assigned housing allowance.

TABLE 4

Composition (%) of Individual Net Income by Country and Gender

Country		Wage and Salary Earnings	Self-Employment Income	Non-Work Private Income	Unemployment Related Benefits	Old Age Related Benefits/Survivors' Benefits	Sickness	Other Social Benefits
France	F	37	2	7	1	49	1	2
	M	58	3	6	4	22	3	3
Italy	F	17	2	4	0	72	4	1
	M	43	18	5	1	31	2	1
Germany	F	26	3	19	2	48	1	1
	M	53	16	9	4	15	2	1
U.K.	F	33	4	11	0	43	5	5
	M	54	8	8	1	18	7	5

Source: ECHP weighted data, wave 4, 1997.

TABLE 5
MEDIAN INCOME AND POVERTY LINES (IN 1,000 PPS, 1996)

Country	Median Income	Poverty Line	Poverty Rate (a)* (%)	Poverty Rate (b)** (%)
France	11.02	6.61	17.31	17.45
Italy	8.75	5.25	18.34	32.54
Germany	12.28	7.37	19.30	15.26
U.K.	10.36	6.21	21.99	25.82
All countries	11.18	6.71		

Notes: *Poverty rate (a) is computed using different poverty lines for each country.
**Poverty rate (b) is computed using a common poverty line for all countries defined as 60% of the median income of single person households.
Source: ECHP weighted data, wave 4, 1997.

4. RESULTS AND DISCUSSION

4.1. *Descriptive Analysis*

The Statistical Office of the European Commission (Eurostat) uses median income to describe income levels in each country.[6] The poverty line is defined as 60 percent of the median income. Table 5 shows poverty lines and median incomes, including of single-person households in each country, in order to highlight differences in economic well-being. Poverty rate (a) is computed using a different poverty line for each country, and poverty rate (b) using a common poverty line for the four countries, in order to make comparisons in terms of poverty rates.

A word about the "level of poverty line" is in order before commenting on the results. According to Betti *et al.* (2005), the level of poverty line stands for the population level at which the income distribution is pooled for the purpose of defining the poverty line. Considering the aim of our analysis and the fact that the general concept of social exclusion only makes sense in relation to the conditions people see around them, we chose to define a poverty line at the single-person household level. By taking a single-person household's poverty line, we in fact provide a relative measure of poverty, determined only by the income distribution within single-person households, irrespective of disparities between households in each country.

Italy was the least prosperous of the four countries, with a median income level less than or equal to 8.75 PPS. Germany was the most prosperous. A single-person household in Germany has an extra 3.50 PPS over the median income level in Italy. The U.K. and France have median incomes around the EU-4 average. The emerging picture in terms of poverty rate (b) (see the last column of Table 5) puts Italy at the top (of the ranking of countries): 32.54 percent of single-person households are at risk of income poverty. Germany and France had the smallest number of single-person households at risk of income poverty (15.26 percent and 17.45 percent, respectively), whereas the U.K. had a higher rate (25.82 percent), although it was lower than that of Italy.

[6]We decided to follow Eurostat recommendations to select the median as a central measure (Eurostat, 1996). We are aware that using median income rather than mean income may be censured by certain authors who are highly critical on this point.

TABLE 6

PARAMETER ESTIMATES OF DAGUM MODEL WITHOUT INDIVIDUAL HETEROGENEITY (INCOME IN 1,000 PPS, 1996)

Country	β	δ	λ	Mean Log-Likelihood	Median	Gini Index	Poverty Rate (a) (%)	Poverty Rate (b) (%)	P90/P10 Ratio
France	0.57*	3.60*	14,250*	–15.27	11.21	0.33	19.95	20.52	4.78
Italy	0.48*	3.91*	15,816*	–13.30	8.78	0.32	21.20	32.63	4.86
Germany	0.57*	3.47*	13,792*	–34.81	12.16	0.34	21.61	18.15	5.04
U.K.	0.67*	3.01*	2,171*	–20.17	10.54	0.37	21.42	24.59	5.55

Source: ECHP weighted data, wave 4, 1997.

4.2. *Model Estimation*

Table 6 illustrates the maximum likelihood estimates for a Dagum type I model without individual heterogeneity.

We only comment on parameters β and δ, because they help us to interpret inequality. A rise in β would reflect a welfare improvement in groups of the population at the lower tail of the distribution, in other words those with the lowest incomes. On the contrary, δ increases with improvement in the welfare situation of population groups in the middle and upper tail of the income distribution. The lowest value of β is in Italy, and the highest in the U.K. The situation regarding the parameter δ is completely the opposite, i.e. the lowest value of δ was in the U.K. and the highest in Italy.

In Table 6 we also compute the P90/P10 ratio[7] which characterizes the economic distance between the richest and poorest in a society. The highest income inequality was found in the U.K. where P90/P10 was 5.55 (see also values of the Gini index). The economic distance between the poorest and the richest in Italy was 4.86; this means that a rich person in Italy has an average income about five times higher than that of a poor person. In terms of median income, the classification of these countries remains unchanged with respect to the classification based on statistical data.

Although these results are very interesting, they do not explain which factors have a significant influence on income inequality, as does the Dagum model with individual heterogeneity. We therefore specified heterogeneity according to equation (3), where x_i is a 1×8 vector of the individual characteristics presented in Table 7 (constant included) and α_1, α_2, α_3 are 8×1 parameter vectors to be estimated.

Parameter estimates are presented in Table 8. Most variables were significant ($p < 0.05$) in all countries. As mentioned in Section 2, parameters α_1, α_2, α_3 do not have a direct meaning for income distribution, which means that inference on the influence of individual characteristics must be based on a number of measures that summarize the estimated income distribution. We therefore do not make any comment about the estimated coefficients.

[7]The P90/P10 ratio is defined as the ratio of the 90th to 10th quantile (Dagum, 1980).

TABLE 7
DESCRIPTION OF COVARIATES

Covariates	Definition
Gender	
GENDER	1 if male
Age	
AGE35	1 if under 35 years of age
AGE35–55	1 if 35–55 years
AGE55–70	1 if 55–70 years (reference class)
AGE70	1 if over 70 years
Marital status	
NEVMAR	1 if never married
DIVOR	1 if divorced
WIDOW	1 if widow (reference class)
Education	
ISCED1	1 if less than second stage of secondary education completed ISCED0–2 (reference class)
ISCED2	1 if second stage of secondary level education completed ISCED3
ISCED3	1 if recognized third level education completed ISCED5–7
Professional/work condition	
WHITE	1 if legislator, senior official and manager, professional, service worker and shop technician and associate professional, clerk
BLUE	1 if skilled agricultural and fishery worker, craft and related trades worker, plant and machine operator and assembler, elementary occupation
INACTIVE	1 if inactive person (reference class)
UNEMPLOYMENT	1 if unemployed person

With regard to the goodness of fit of the models, we first note that the fit improved when covariates were included in the model; this emerged from comparison of the mean log-likelihood of the heterogeneous models and the corresponding homogeneous ones.[8] The overall fit of the heterogeneous models was judged by the graphic method described in Section 2. The Cox–Snell residuals are shown in Figure 1. The results indicate that the fit of the Dagum distribution was quite good for all countries. In fact, very few observations deviated from the 45-degree line. Indeed, only 5 percent of deviations were greater than 3 (see Figure 1) which is negligible for overall fit. We therefore concluded that the heterogeneous Dagum model can be used as a theoretical model for all countries.

4.3. *Statistical, Economic and Social Interpretation*

Parameter estimates were used to obtain median incomes and other statistical measures (Gini index, poverty rate and P90/P10 ratio) for individuals with selected characteristics. Three different individuals, named BASE in Tables 9, 10 and 11, were created in order to identify particular social aspects of relevance for studying single-person households.

We then changed one characteristic at a time to study different aspects of inequality. Table 9 shows the data for a woman, aged 55–70 years, inactive,

[8]In fact, we computed a likelihood ratio test and in all cases the hypothesis of the restricted model was rejected with a significance of 5 percent.

TABLE 8

PARAMETER ESTIMATES WITH INDIVIDUAL HETEROGENEITY (INCOME IN 1,000 PPS, YEAR 1996)

Variables	Country			
	France	Italy	Germany	U.K.
Parameter α_1				
Constant	–0.5043*	–0.3801*	–0.9962*	+0.2328*
ISCED3	+0.0145	–0.2898*	+0.1275*	–0.2299*
ISCED2	+0.0771*	–0.1929*	+0.2861*	+0.1627*
BLUE	+0.8542*	–0.1488*	–0.1099*	+0.5790*
WHITE	+0.7948*	+0.0500	–0.0086	+0.6186*
UNEMPLOYED	+0.3372*	–0.5781*	–1.0945*	–0.4355*
GENDER	–0.1097*	+0.0154	+0.1773*	+0.0497*
AGE35	–1.3555*	–1.4433*	–0.2426*	–0.8230*
AGE35–55	–0.7722*	–0.7716*	+0.6750*	+0.3300*
AGE70	–0.0087	–0.1154*	–0.3401*	+1.3764*
NEVMAR	–0.1135*	–0.6515*	+0.3057*	–1.3895*
DIVOR	+0.0863*	–0.4523*	+0.5675*	–0.9825*
Parameter α_2				
Constant	+1.4194*	+1.5292*	+1.6294*	+1.2921*
ISCED3	+0.0377*	+0.0504*	–0.3601*	+0.0731*
ISCED2	+0.0974*	–0.0415*	–0.1089*	+0.0781*
BLUE	–0.2404*	–0.0943*	+0.1833*	–0.0083
WHITE	–0.2732*	–0.1127*	+0.2597*	–0.2388*
UNEMPLOYED	–0.2764*	–0.2220*	+0.5636*	+0.3654*
GENDER	–0.0297*	–0.1010*	+0.1296*	–0.0595*
AGE35	+0.7290*	+1.2444*	–0.0780*	+0.5181*
AGE35–55	+0.3746*	+0.5512*	–0.3146*	+0.1000*
AGE70	–0.0336*	+0.1034*	+0.1792*	–0.1601*
NEVMAR	+0.0718*	+0.2802*	–0.2008*	+0.1146*
DIVOR	+0.0456*	+0.1619*	–0.2399*	+0.0212*
Parameter α_3				
Constant	+10.141*	+10.092*	+13.471*	+7.5146*
ISCED3	+3.2608*	+6.6423*	–2.181*	+1.9990*
ISCED2	+2.2871*	+1.5035*	–0.9227*	+0.7697*
BLUE	–3.2720*	+0.5977*	+3.3341*	+0.4063*
WHITE	–2.3603*	+0.9719*	+4.5883*	–1.4479*
UNEMPLOYED	–4.3134*	–3.5341*	+6.5899*	+5.2992*
GENDER	+0.4410*	–0.2425*	+1.8665*	+0.0805
AGE35	+10.719*	+36.015*	–1.2860*	+7.7148*
AGE35–55	+4.9019*	+11.437*	–4.2068*	+0.8658*
AGE70	–0.6087*	+0.8752*	+2.6858*	–3.3482*
NEVMAR	+0.4270*	+3.4784*	–3.3750*	+2.8851*
DIVOR	+0.1230	+1.2999*	–4.7038*	+0.8491*
Mean log-likelihood	–14.27	–12.26	–32.73	–18.48

*$p < 0.05$.

Source: ECHP weighted data, wave 4, 1997.

widow, with an educational level of ISCED0–2. We studied the effect of changing her educational level, employment status, gender, age and civil status.

The first row in Table 9 shows that the BASE individual faces a very high risk of poverty in all countries, which is plausible because this hypothetical individual has socio-economic disadvantages. Table 9 shows the poverty rate (a) based on country-specific poverty lines and the poverty rate (b) based on a common poverty line. When we compared them for males and females we observed major differ-

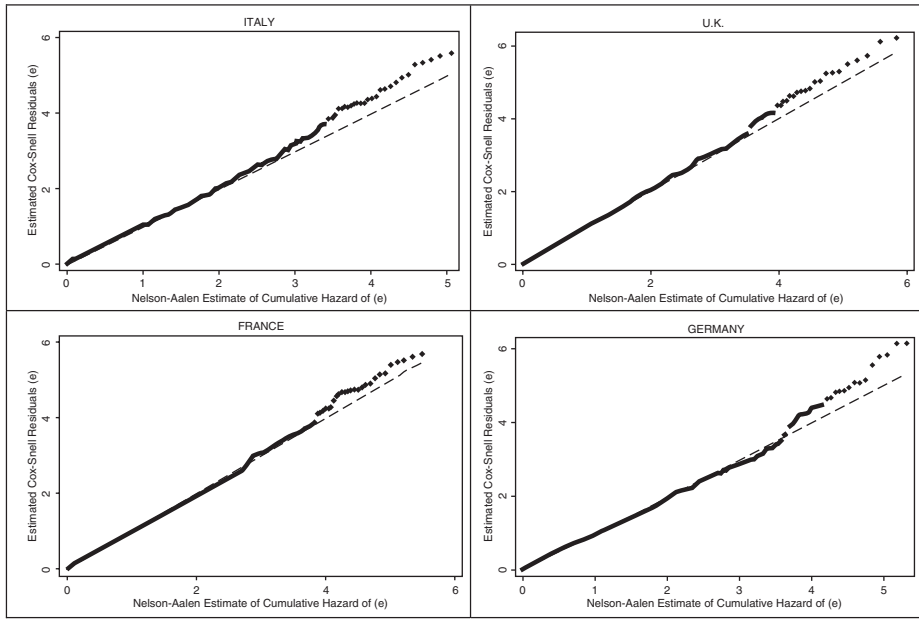

Figure 1. Cox–Snell Residuals Versus their Empirical Integrated Hazard

ences. Women were the underprivileged group in each country: the poverty rate (a) was 23 percent for women and 19 percent for men in France, 17 percent for women and 12 percent for men in Italy, 29 percent for women and 19 percent for men in Germany and 21 percent for women and 12 percent for men in the U.K.

This result confirms that women have higher poverty rates than men (all other social aspects being equal). It is also interesting that this situation is common to all countries. Poverty rate (b) revealed the worst situation in Italy. This BASE individual has a poverty rate (b) of 35 percent in Italy compared to 27 percent in the U.K., and 23 percent in France and in Germany.

In terms of median income, the worst condition was again in Italy, where this individual has a median income of 7.89 (in 1000 PPS) compared to 8.58 in the U.K., 9.65 in France and 10.03 in Germany. Inequality, in terms of P90/P10 ratio, was highest in Germany (4.20), followed by France (3.73). In Italy and the U.K., these indices were similar (3.04 and 3.07 respectively). The Gini index was around 0.25 in all countries (0.28 for Germany and France, 0.26 in the U.K. and 0.24 in Italy).

One characteristic of the BASE individual was changed at a time in order to illustrate the effect on these indicators. Almost all the other characteristics produced an improvement in terms of poverty rate (a) and median income in all countries. The same was also true for poverty rate (b).

A high educational level was associated with lower poverty rates, especially in France and Italy. In fact, in Italy the poverty rate was 1 percent with ISCED5–7 and 9 percent with ISCED3 compared to 17 percent with ISCED0–2; in France it was 4 percent with ISCED5–7 and 8 percent with ISCED3 compared to 23 percent

TABLE 9

INFLUENCE OF COVARIATES; BASE IS FEMALE, 55–70 YEARS, INACTIVE, WIDOW, ISCED0–2

	France				Italy			
	Median Income	Gini Index	Poverty Rate a (b) (%)	Economic Distance	Median Income	Gini Index	Poverty Rate a (b) (%)	P90/P10 Ratio
BASE	9.65	0.28	23 (24)	3.73	7.89	0.24	17 (35)	3.04
Effect of change to . . .								
ISCED5–7	19.08	0.27	4 (4)	3.52	25.30	0.26	1 (2)	3.41
ISCED3	13.28	0.25	8 (8)	3.16	11.24	0.27	9 (16)	3.58
Blue collar	9.54	0.29	20 (21)	3.39	10.52	0.28	11 (20)	3.72
White collar	13.40	0.30	7 (7)	3.60	13.01	0.27	5 (10)	3.37
Male	10.92	0.30	19 (20)	4.20	9.32	0.27	12 (24)	3.39
Aged over 70	8.93	0.29	28 (29)	3.93	7.36	0.23	21 (40)	2.89
Never married	8.69	0.27	29 (30)	3.68	6.88	0.25	28 (48)	3.43
Divorced	9.28	0.26	23 (24)	3.34	6.34	0.25	34 (55)	3.36
	Germany				U.K.			
	Median Income	Gini Index	Poverty Rate a (b) (%)	Economic Distance	Median Income	Gini Index	Poverty Rate a (b) (%)	P90/P10 Ratio
BASE	10.03	0.28	29 (25)	4.20	8.58	0.26	21 (27)	3.07
Effect of change to . . .								
ISCED5–7	15.93	0.37	17 (15)	6.64	11.36	0.25	9 (11)	3.06
ISCED3	12.13	0.28	18 (15)	3.80	9.36	0.23	13 (18)	2.71
Blue collar	11.27	0.26	22 (18)	3.65	11.90	0.24	3 (5)	2.72
White collar	11.81	0.23	17 (13)	3.05	12.03	0.30	6 (9)	3.50
Male	11.14	0.23	19 (15)	3.08	10.21	0.27	13 (16)	3.24
Aged over 70	9.28	0.29	35 (30)	4.72	7.08	0.26	37 (44)	2.91
Never married	8.65	0.30	38 (32)	4.25	7.67	0.37	39 (44)	7.53
Divorced	7.58	0.28	48 (40)	3.69	6.85	0.34	43 (49)	5.37

Source: ECHP weighted data, wave 4, 1997.

TABLE 10

INFLUENCE OF COVARIATES; BASE IS FEMALE, UNDER 35 YEARS, BLUE COLLAR, NEVER MARRIED, ISCED3

	France				Italy			
	Median Income	Gini Index	Poverty Rate a (b) (%)	Economic Distance	Median Income	Gini Index	Poverty Rate a (b) (%)	P90/P10 Ratio
BASE	10.14	0.20	16 (16)	2.58	8.73	0.32	28 (37)	7.36
Effect of change to . . .								
White collar	12.11	0.21	11 (11)	2.79	10.41	0.28	20 (28)	5.33
Unemployed	7.99	0.27	37 (38)	4.38	6.21	0.45	44 (52)	32.2
Male	11.05	0.21	14 (15)	2.88	10.95	0.34	24 (30)	8.79
Divorced	10.95	0.18	10 (11)	2.34	11.40	0.30	20 (26)	6.34
Aged 35–55	11.74	0.21	8 (9)	2.59	9.88	0.33	25 (33)	8.04
	Germany				U.K.			
	Median Income	Gini Index	Poverty Rate a (b) (%)	Economic Distance	Median Income	Gini Index	Poverty Rate a (b) (%)	P90/P10 Ratio
BASE	11.09	0.31	25 (21)	4.53	10.10	0.23	18 (21)	3.29
Effect of change to . . .								
White collar	12.81	0.28	16 (13)	3.74	13.62	0.28	13 (15)	4.29
Unemployed	5.66	0.36	65 (60)	8.95	5.19	0.32	61 (67)	7.39
Male	13.14	0.26	13 (10)	3.31	11.99	0.24	13 (15)	3.38
Divorced	9.84	0.29	29 (23)	3.88	10.73	0.21	11 (14)	2.67
Aged 35–55	13.40	0.29	11 (7)	3.57	12.77	0.21	4 (5)	2.55

Source: ECHP weighted data, wave, 1997.

TABLE 11

THE INFLUENCE OF COVARIATES; BASE IS FEMALE, UNDER 35 YEARS, BLUE COLLAR, DIVORCED, ISCED3

	France				Italy			
	Median Income	Gini Index	Poverty Rate a (b) (%)	Economic Distance	Median Income	Gini Index	Poverty Rate a (b) (%)	P90/P10 Ratio
BASE	10.95	0.18	10 (11)	2.34	11.40	0.30	20 (26)	6.34
Effect of change to . . .								
Male	12.02	0.20	9 (10)	2.56	14.67	0.32	19 (21)	7.49
Aged 35–55	12.56	0.20	5 (5)	2.43	11.52	0.33	17 (27)	7.03
Aged 55–70	14.17	0.24	2 (2)	2.77	11.01	0.33	21 (25)	5.83
	Germany				United Kingdom			
	Median Income	Gini Index	Poverty Rate a (b) (%)	Economic Distance	Median Income	Gini Index	Poverty Rate a (b) (%)	P90/P10 Ratio
BASE	9.84	0.29	28 (23)	3.88	10.73	0.21	11 (14)	2.67
Effect of change to . . .								
Male	11.96	0.24	14 (10)	2.98	12.77	0.21	7 (9)	2.75
Aged 35–55	10.85	0.29	19 (14)	3.44	11.68	0.21	3 (5)	2.48
Aged 55–70	12.20	0.25	13 (9)	3.06	10.91	0.25	10 (13)	3.02

Source: ECHP weighted data, wave 4, 1997.

with ISCED0–2. Active employment status, even if less intense, was associated with a lower poverty rate and a higher median income in all countries. Differences were particularly evident for white collar workers. The poverty rate decreased from 23 percent to 7 percent in France, from 17 percent to 5 percent in Italy, from 29 percent to 17 percent in Germany and from 21 percent to 6 percent in the U.K.

The effect of age showed an opposite pattern in all countries. Women over 70 years had a much higher poverty rate everywhere. In the U.K. it increased to 37 percent, in Germany to 35 percent, in Italy to 21 percent and in France to 28 percent.

The effect of marital status was interesting; women who had never married had low median incomes and very high poverty rates in all countries. We observed the same effect for divorce except in France where the poverty rate did not change. On the contrary, in Germany and Italy, divorce had a strong effect on poverty rate. German divorced women had a poverty rate of 48 percent; in Italy this value was 34 percent.

Inequality computed by the Gini index and P90/P10 ratio showed differences across countries. In Italy, the Gini index ranged from a minimum of 0.23 (P90/P10 = 2.89) for an individual aged over 70 to a maximum of 0.28 for a blue collar worker (P90/P10 = 3.72). In France, it ranged from 0.25 for individuals with ISCED3 (P90/P10 = 3.16) to 0.30 for males (P90/P10 = 4.20) and white collar workers (P90/P10 = 3.60). In Germany, the range was greater, from 0.23 for males (P90/P10 = 3.08) and for white collar workers (P90/P10 = 3.05) to 0.37 (P90/P10 = 6.64) for individuals with ISCED5–7. Finally, in the U.K. the Gini index ranged from 0.23 (P90/P10 = 2.71) for individuals with ISCED3 to 0.37 (P90/P10 = 7.53) for individuals who had never married.

Table 10 shows the influence of covariates for young women. The BASE individual was a woman, under 35 years of age, blue collar worker, never married and with an educational level of ISCED3. These are characteristics typical of middle socio-economic status, but youth makes this individual subject to the risk of poverty. Poverty rates (a) showed rather high values: 28 percent in Italy, 25 percent in Germany, 16 percent in France and 18 percent in the U.K.

As expected, when gender was changed to male, the poverty rate decreased and the median income increased in each country. In Italy, poverty rate (a) was 28 percent for such women and 24 percent for men. The effect of age was also interesting. A change to age class 35–55 years was associated with a decrease in poverty rate. This effect was strong in France, Germany and the U.K. and less evident in Italy. Employment status had a great effect in all countries; being a white collar worker decreased poverty rate and being unemployed increased it sharply. The P90/P10 ratio was highest in Italy and France, and was high for unemployed people everywhere.

An interesting social aspect for single-person households was also the effect of divorce in respect to gender and age at divorce. Table 11 shows the influence of covariates for a woman, aged under 35 years, blue collar worker, divorced with ISCED3. The impact of divorce was worse for women than for men, and was more evident in Germany and the U.K. than France or Italy. In fact, in Italy the poverty rate (a) for the BASE individual was 20 percent and for men 19 percent, whereas in Germany it was 28 percent for women and 14 percent for men. The effect of age

TABLE 12

DECOMPOSITION OF CROSS-NATIONAL POVERTY DIFFERENCES (VALUES IN BRACKETS ARE PERCENTAGES OF TOTAL DIFFERENCE)

A	B	I_{AA}–I_{BB}	I_{AA}–I_{BA}	I_{BA}–I_{BB}
Italy	U.K.	0.003	0.012	–0.009
		(100)	(434)	(–334)
Italy	France	0.037	0.090	–0.053
		(100)	(241)	(–141)
Italy	Germany	0.048	0.062	–0.014
		(100)	(128)	(–28)
U.K.	France	0.040	0.033	0.007
		(100)	(83)	(17)
U.K.	Germany	0.054	0.039	0.014
		(100)	(74)	(26)
France	Germany	0.032	0.033	–0.001
		(100)	(103)	(–3)

Notes: (I_{AA}–I_{BA}) is the part of poverty accounted for by differences in conditional poverty. (I_{BA}–I_{BB}) is the part of poverty accounted for by differences in the distribution of characteristics.

Source: ECHP weighted data, wave 4, 1997.

was also strong. Both younger and older divorced women run the risk of poverty in Italy and the U.K.; a different pattern was observed in Germany and France where the older cohorts were better off.

Inequality in the Gini index and P90/P10 ratio was accentuated in Italy; indeed, Gini indices were the highest and P90/P10 was far greater than in the other three countries.

We now comment on the results obtained, decomposing differences in poverty (Table 12), by applying equation (12).[9] Poverty was higher in Italy than in the U.K., France and Germany because the risk of poverty for given individual characteristics was higher. In fact, the contribution from differences in the conditional poverty function was positive ($I_{AA} > I_{BA}$) in the first three rows of Table 12, as poverty would have been lower in Italy if the U.K. or French or German poverty function were applied there. The distribution of poverty-relevant characteristics was more favorable in Italy than in the U.K., France and Germany because $I_{BA} < I_{BB}$. This means that poverty would be lower in these last three countries if the distribution of personal characteristics was as in Italy. In any case, the contribution to total differences caused by differences in the distribution of personal characteristics was lower than the contribution due to the conditional poverty function. The percentages were –334 percent for Italy compared to the U.K., –141 percent for Italy compared to France and –28 percent for Italy compared to Germany.

On the other hand, 83 percent of the cross-national poverty difference between the U.K. and France was due to differences in conditional poverty function (the U.K. would be lower if the poverty function of France were applied there); the remaining 17 percent is due to differences in the distribution of char-

[9]We used the common poverty line defined in Table 5 for this analysis.

acteristics (U.K. poverty-relevant characteristics were less favorable than in France). The same situation was observed between the U.K. and Germany with very similar percentages (row 5).

Finally, comparison of France and Germany suggested that Germany had an advantage over France in the conditional poverty function whereas France had an advantage over Germany in poverty-relevant characteristics, but the contribution of poverty-relevant characteristics is very small.

5. Some Concluding Remarks

This paper used ECHP data to study inequality in income distribution of single-person households across four industrialized countries—France, Italy, Germany and the U.K. Individual heterogeneity was found to play a determinant role in the income distribution in each country. Apart from the empirical results, this paper also specified the Dagum model with observable individual heterogeneity and demonstrated the utility and power of this specification in analyzing income inequality in relation to individual characteristics, confirming the conclusions of Biewen and Jenkins (2005). However, specification of a heterogeneous model involves an assumption about functional form that depends on the vector of covariates. The problem of misspecification of the model increases as the number of covariates increases. We examined the overall fit of the model using Cox–Snell residuals. Residual analysis in heterogeneous income models emerged as an interesting tool for solving problems of misspecification, and could be the subject of future work.

In considering single-person households and their structural changes in modern countries, and the relationship between poverty (and income distribution in general) and personal characteristics, the results of the study are of special interest for policy makers.

The picture of the four countries, emerging from the main results of empirical analysis, showed similar effects of the covariates considered. In almost all cases, the influence of the different characteristics acted in the same direction, even if estimates indicate that poverty rates are higher in Italy than in other countries. This means that in Italy, single-person households are generally at a disadvantage.

The effect of gender was strong in all countries, indicating that women are at a greater disadvantage than men. Higher educational qualifications had a favorable effect on income; this was most pronounced in France and Italy. The effect of employment status favored young and middle aged white collar workers. The effect of marital status is also interesting among women: the results showed that in the older generations (with the characteristics specified in Table 9) divorce increased the poverty rate, whereas among younger generations (with characteristics specified in Table 10) divorce decreased the poverty rate.

The worst income inequality was found in Italy among young generations: Gini indices were the highest and economic distances were much greater than in other countries (Tables 10 and 11). Differences were less marked for individuals of the type specified in Table 9 (female, 55–70 years, inactive, widow, ISCED0–2). This is presumably because young people generally show wider inequality due to economic life-cycle.

The breakdown of poverty into various components showed that poverty risk depends on differences in the poverty conditional function and poverty-relevant characteristics. Cross-national poverty differences were almost entirely explained by higher conditional poverty, whereas differences in the distribution of characteristics played a minor role. In particular, poverty related to personal characteristics was generally higher in Italy than in the U.K., France and Germany, in that order.

In conclusion, in terms of different welfare systems, our results confirm that the Italian Mediterranean regime penalizes younger generations which suffer from very high poverty rates and remarkable inequality with respect to older generations. On the other hand, the Continental and Anglo Saxon regimes seem to favor younger generations. Breakdown of the poverty rate revealed sharp differences due to the conditional poverty function between Italy and the other three countries. These differences need to be compensated by a negative effect of the distribution of personal characteristics. Differences in the conditional poverty function were less evident between the other three countries, which is further evidence of the poor relative position of Italy.

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