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DECOMPOSING VULNERABILITY TO POVERTY

by Martina Celidoni*

Università di Padova, Italy

This paper applies the decomposition of the Foster–Greer–Thorbecke poverty index to the measurement of individual vulnerability to poverty. I highlight that poverty risk can be expressed as a function of expected incidence, expected intensity, and expected variability below the poverty line, three essential aspects for improving the design of appropriate risk-management policies. An empirical illustration is provided using the British Household Panel Survey and the Italian Survey on Household Income and Wealth.

JEL Codes: D63, I30, I32

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1. Introduction

Poverty analysis usually focuses on indexes that are sensitive to the number of people below the poverty line, the poverty gap, and the distribution of income among the poor; these three poverty aspects are usually defined in literature as the three *Is* of poverty (Jenkins and Lambert, 1997). The description of the phenomenon based on these three components has been widely used because it helps to overcome the simple headcount method by disentangling different sources of changes in poverty, allowing richer inter-temporal, inter-regional, cross-national, or inter-group comparisons (Myles and Picot, 2000).

I propose to adopt the same approach to vulnerability to poverty, that is the probability, today, of being in poverty or to fall into deeper poverty in the future, to provide information for anti-poverty policies design. Differently from the standard analysis of poverty, vulnerability is related to poverty risk with a more forward-looking perspective rather than an ex post lowness of income/consumption assessment. This concept is important because it can be considered an ex ante information source that allows the design of better protection policies to prevent households and individuals from experiencing severe welfare losses, rather than cure them when they are already poor.

Chaudhuri *et al.* (2002), for example, write that what really matters for forward-looking anti-poverty interventions is vulnerability to poverty. Zhang and

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*Correspondence to: Martina Celidoni, Dipartimento di Scienze Economiche e Aziendali "Marco Fanno," Università degli Studi di Padova, via del Santo, 33, 35123 Padova, Italy (martina.celidoni@unipd.it).

Guanghua (2008) argue that measuring vulnerability is important because it allows the identification of those who are not currently poor but may fall into poverty and, since the design of anti-poverty policies has the identification of poor individuals as prerequisite (McGregor and Nachane, 1995), the concept of vulnerability to poverty plays a relevant role in this context.

As Muller and Bibi (2010) notice, anti-poverty targeting based on predictions of household living standard, generally obtained from ordinary least squares (OLS) regressions on observed characteristics, could lead to inaccurate predictions and significant undercoverage. Alternative vulnerability to poverty measures could help in refining targeting. An empirical investigation (Celidoni, 2013) shows that, among all the individual vulnerability to poverty indexes proposed in the economic literature, it is possible to rank the measures according to their identification precision. Controlling also for targeting related errors, i.e. *leakage* and *undercoverage* (see Muller and Bibi 2010 for a detailed description), there are indexes that anticipate future poverty better than others. More precisely, according to Celidoni (2013), two groups of indexes can be identified based on empirical tests, the *high-* and *low-performers*; among the former there is also vulnerability to poverty proposed by Christiaensen and Boisvert (2000) that is the focus of this paper.

Christiaensen and Boisvert's (2000) vulnerability to poverty index can not only predict future poverty quite well, but can also be used, by applying the decomposition proposed, as a possible source of information about poverty risk characteristics, extremely important for the design of appropriate risk management policies. Once future poor are identified, another relevant aspect, from the policymaker's point of view, is the features of the poverty risk, since different strategies could be implemented to prevent welfare drops.

Similarly to decomposing poverty as a function of incidence, intensity, and inequality of income among the poor people, individual vulnerability to poverty in Christiaensen and Boisvert's (2000) version (when $\alpha = 2$), can be rewritten in terms of three potential sources of risk: the possible states of the world in which poverty is experienced (expected incidence), the expected poverty gap, and a measure of income volatility below the poverty line.

The decomposition in terms of risk sources helps in understanding the patterns in household welfare drops, information that is essential for the design of poverty reduction interventions. Each of these three components in fact describes a particular aspect of poverty risk that can potentially lead to different risk-management strategies.

Being prone to poverty can increase because there are more possibilities that the income falls below a chosen poverty threshold, independently from the magnitude of the negative income shock. This source of risk recalls in some sense the incidence in the poverty decomposition framework, where the number of poor is substituted by the possible *contingencies* that an individual faces. Very close to intensity there is instead the expected poverty gap. If the latter increases also vulnerability is higher. The third contributing factor is variability below the poverty line of income: the higher this volatility the more unpredictable is the risk faced by the individual. The focus especially on negative shocks aims at separating out threats from the overall expectations, i.e. downward risks from uncertainty in general.

This view in terms of contributing factors that I propose meets the need, highlighted by Dercon (2001), of describing the different types of risk faced by individuals. He argues that risk is quite different in size, likelihood, and frequency over time and different features correspond to different implications for the ability to cope with them as well as for policy purposes. Also Morduch (2000) says that it is important considering some of the patterns related to risk, since they have quite different impacts on the ability to cope with them for individuals, households, communities, and other institutions. For instance it is possible to distinguish between *catastrophic versus non-catastrophic risks* according to the size of the shock. The former could be very unlikely with nonetheless a large impact so that it takes a long time before recovering from them. Different patterns of risk could also have different effects on the decision-making of individuals about investments in education or health.

Few studies make an effort to distinguish between these components, as observed by Naschold and Barrett (2011), even if relevant from the policy perspective; this paper presents a new approach that helps in addressing this issue. The layout is as follows. Section 2 presents the decomposition. Section 3 describes the data and some basic facts that justify the choice of the two illustrative examples, Section 4 presents the empirical strategy, and Section 5 discusses the applications using British and Italian data. Section 6 concludes.

2. The Three Vulnerability Contributing Factors

In poverty analysis the FGT family of poverty indexes (1) includes the *headcount ratio*, H, if $\alpha = 0$, the *poverty gap ratio*, I, if $\alpha = 1$, and the *poverty severity* if $\alpha = 2$ (Foster *et al.*, 1984). When $\alpha = 2$, (1) can be expressed as a function of headcount ratio, the poverty gap ratio,[1] and the squared *coefficient of variation* of income among the poor, CV^2, as inequality index.

$$P_\alpha(\mathbf{y};\mathbf{z}) = \frac{1}{N}\sum_{h=1}^{Q}\left[\frac{z - y_h}{z}\right]^\alpha, \tag{1}$$

$$P_{\alpha=2}(\mathbf{y};\mathbf{z}) = H\left[I^2 + (1-I)^2 CV_p^2\right], \tag{2}$$

$$H = Q/N, \tag{3}$$

$$I = \frac{1}{Q}\sum_{h=1}^{Q}\left[\frac{z - y_h}{z}\right], \tag{4}$$

$$CV_p^2 = \frac{1}{Q}\sum_{h=1}^{Q}\frac{(\mu_p - y_h)^2}{\mu_p^2}. \tag{5}$$

[1]Note that expression (1) for $\alpha = 1$ is different from (4): the latter is the poverty gap among the poor while the former considers the overall population, N.

In the expressions (1)–(5), Q represents the number of households whose income y_h is below the chosen poverty line, z, N is the size of the population, and μ_p is the average income of poor households. The parameter α can be considered the weight attached to extreme poverty; the higher this value the greater the aversion for deep poverty.

$$V_{\alpha=2,h}(\tilde{\mathbf{y}};\mathbf{z}) = \sum_{s=1}^{S_h} p_s \left[\frac{z-\tilde{y}_s^h}{z}\right]^2. \tag{6}$$

The analogy in the vulnerability framework proposed by Christiaensen and Boisvert (2000), when $\alpha = 2$, is contained in (6). Differently from the poverty context, it focuses on the individual level rather than on the society. Instead of considering a vector of actual household incomes, $\mathbf{y} = (y_1, y_2, \ldots, y_N)$, as the poverty index does, in the vulnerability analysis there is a vector of possible income values at $t + 1$ for the household h, $\mathbf{y}_s^h = \left(y_1^h, y_2^h, \ldots, y_N^h\right)$, where N are the *possible states of the world* that the household could face. I assume here that the number of possible states of the world for each household is the same, but nothing changes if N is substituted by N_h. Let us consider, for expositional convenience, a new vector $\tilde{\mathbf{y}}_s^h$, which represents a permutation of $\mathbf{y}_s^h$, so that the elements are non-decreasingly ranked, i.e. for all $\tilde{y}_s^h$, $\tilde{y}_1^h \le \tilde{y}_2^h \le \ldots \le \tilde{y}_{S_h}^h \ldots \le \tilde{y}_N^h$. I denote S_h the number of states in which the welfare measure is expected to fall below the poverty threshold, z, and p_s the probability that the s^{th} state occurs. The index of vulnerability ($\alpha = 2$) for the household h will be a sum of possible poverty gaps in $t + 1$, weighted by their probability.

The decomposition proposed by Foster *et al.* (1984), applied to vulnerability to poverty, can be performed as follows (see Appendix for the mathematical formulation of the decomposition): *EH* is the *expected incidence*, i.e. the number of states in which the household is expected to be poor; the aggregate poverty gap is substituted by *EI*, the *expected intensity* or expected poverty gap; and finally ECV^2 replaces the inequality among the poor and describes in this context the *expected variability below the poverty line* for the household income, where μ_h is the expected average income for the household h during poverty,

$$V_{\alpha=2,h}(\tilde{\mathbf{y}};\mathbf{z}) = EH_h\left[EI_h^2 + (1-EI_h)^2\, ECV_h^2\right] \tag{7}$$

$$EH_h = \frac{S_h}{N} = p(\tilde{y} < z) \tag{8}$$

$$EI_h = \sum_{s=1}^{S_h} \frac{1}{S_h}\frac{\left(z-\tilde{y}_s^h\right)}{z}, \quad \frac{1}{S_h} = p(s \mid \tilde{y} < z) \tag{9}$$

$$ECV_h^2 = \sum_{s=1}^{S_h} \frac{1}{S_h}\frac{\left(\mu_h-\tilde{y}_s^h\right)^2}{\mu_h^2}, \quad \frac{1}{S_h} = p(s \mid \tilde{y} < z). \tag{10}$$

It is possible to also derive an expression for the change in vulnerability ($\alpha = 2$), which will depend on ΔEH_h, ΔEI_h and ΔECV_h^2 that represent respectively the variations between time 0 and 1 of EH_h, EI_h and ECV_h^2. The change of $V_{\alpha=2,h}$ between times 0 and 1, $\Delta V_{\alpha=2,h}$, can then be expressed as

$$\Delta V_{\alpha=2,h} = EH_{h,1}\left[EI_{h,1}^2 + \left(1 - EI_{h,1}\right)^2 ECV_{h,1}^2\right] - EH_{h,0}\left[EI_{h,0}^2 + \left(1 - EI_{\boldsymbol{h},0}\right)^2 ECV_{h,0}^2\right], \tag{11}$$

$$\Delta V_{\alpha=2,h} = f\left(\Delta EH_h, \Delta EI_h, \Delta ECV_h^2\right) \tag{12}$$

where the subscripts 0 and 1 are used referring to the period in which the components are measured. In the Appendix I describe the Shapley decomposition of (11) to derive the contributions of ΔEH_h, ΔEI_h and ΔECV_h^2 to the overall change in vulnerability as suggested by Chakravarty *et al.* (2008).

3. Background and Data

I provide two examples to highlight the features of the decomposition. I will estimate vulnerability to poverty and its three components using data of the British Household Panel Survey (BHPS) with an inter-temporal perspective and the Italian Survey on Household Income and Wealth (SHIW) for an inter-regional empirical illustration.

The BHPS follows a representative sample of British households yearly; I consider especially the period 1991–2004. Additional sub-samples were added in 1997 and 1999, respectively Scotland–Wales and Northern Ireland, to increase the relative small Scottish and Welsh samples size and to cover NortherIreland properly, for a U.K. analysis rather than England only. In the empirical application I do not include those sub-samples in order to allow a more straightforward inter-temporal comparison, therefore the focus will be on England only. The disposable annual equivalized household income is used as welfare measure; this information is provided in the survey for those households in which all eligible adults gave a full interview. The final sample is composed by 1973 households, whose characteristics are summarized in the Appendix (Table A.1). Especially I selected those households that were present in the panel for at least three times in the periods 1991–97 and 1998–2004, to have sufficient observations for the vulnerability computation and the inter-temporal comparison. It is interesting to compare vulnerability in the British case between the two periods, since much effort has been devoted to the fight against poverty through the welfare reform implemented by the government in the late 1990s.

According to Gregg (2008), the objective of the government in 1996/1997 was to increase economic activity, limit welfare dependency and, at the same time, reduce poverty. To meet these goals, the government proposed a strategy based on the following measures: incentives to work, welfare payments conditional on behavioral requirements, minimum income secure for vulnerable groups, and incentives for self-protecting savings among low income groups. Also Brewer *et al.*

(2006) report that the reduction of poverty among pensioners and households with children has formed an important part of the Labour Government's agenda, especially during its second term in office (2000/01–2004/05). Poverty, measured as the number of families whose income is below the 60 percent of the median equivalized income, fell by 2.1 percent, considering incomes after housing costs, during Labour's first term (1996/97–2000/01), and slightly faster during the second term (2.5 percent).

For an inter-regional illustration, the SHIW is used; it collects information for a representative sample of the Italian population about households' disposable income and consumption. In this case in which both income and consumption are available, I use the latter, deflated to 1991 prices, as welfare measure since it incorporates the risk-management strategies of the household. The Italian survey is slightly different from the BHPS because it is conducted every two years (with an exception between the years 1995 and 1998); the time period that I will consider for the analysis is 1989–2004. For the SHIW, the final sample is composed of 2,519 households and is described in the Appendix (Table A.1). The sample selection in this case is different from the previous case; since I am interested only in comparing vulnerability across regions, I selected those households that were present in the year 2004 and were observed for at least three times.

The Italian case is interesting if we consider that new strategies for regional development came along with major changes in the locus of decision making. On this policy trend, Barca *et al*. (2004, p. 9) write that "since the 90s, several countries have decentralized a large share of their policies to regional and local governments; cooperation and networks among different levels of government and between public and private agents are replacing traditional top-down decision-making in the design of policies and projects." They also point out that this shift raises a challenge in terms of knowledge and information needs, since regions have the fundamental role of selecting projects, allocating resources among them, and monitoring their implementation. The well-functioning of this institutional setup therefore has as prerequisite the exchange (with government upper levels) and use of reliable, timely, and meaningful quantitative information for evaluating the territorial dimension of phenomena and design of appropriate policies.

Given the role of regional institutions in Italy, an inter-regional comparison of vulnerability to poverty and its component could provide useful information for anti-poverty policy purposes.

4. Empirical Strategy

Let us consider an income/consumption generating function as in (13), where $w_{h,t}$ is our welfare measure at time t for the household h. $w_{h,t}$ is expressed in real terms and depends on a polynomial in age, $f(age_{h,t})$ and macro effects captured by time dummies, D_t. Vulnerability is computed using the residuals $e_{h,t}$.[2]

$$w_{h,t} = \alpha + f\left(age_{h,t}\right) + \sum_t \beta_t D_t + e_{h,t}. \tag{13}$$

[2]Referring to (6) therefore, $\mathbf{y}_s^h$ are the residuals of the net yearly real household income equivalized using the square root of the household size regressed on a polynomial in age and time effects.

In this way I eliminate the temporal dynamic and compare properly income and consumption levels across different periods of time, considering inflation, aggregate shocks, and age effects.

If inflation is not taken into account, nominal income or consumption do not reflect the welfare and the purchasing power dynamic over time. Real values are then regressed on time effects and an age polynomial. Time effects are removed through year dummies which should identify other macro aggregate shocks, that inflation does not capture; moreover, since aggregate shocks are not insurable and I focus on those that are idiosyncratic and potentially insurable for policy purposes, they should be taken away. Given that age effects can be considered individual time effects, I include the age of the head of household and its square in the regression. Work experience and skills acquisition in fact grow with age, leading to an increase in income over time. Age effects can also be confused with anti-poverty policy changes between periods, especially problematic for the British case. This strategy recalls for instance what Brunello *et al.* (2009, p. 10) did to illustrate the effects of school reforms on years of schooling: they purge the latter from the influence of country effects, country specific trends, individual and macro controls. This procedure allows one to eliminate macro and age effects, to focus on idiosyncratic risk, and to properly compare vulnerability, especially between periods.

For England, Christiaensen and Boisvert's (2000) vulnerability index will be computed in two periods of time, splitting the dataset in two parts with equal numbers of waves, 1991–97 and 1998–2004, and corresponding to two different anti-poverty policy contexts; vulnerability will then be compared between periods, for each household. By doing this, I assume implicitly that, within periods, I observe for each household income values drawn from the same distribution. Whereas between periods the distribution could have also changed due to policy interventions, and this is what this empirical application tries to investigate. The poverty lines used are the 60 percent of the median income/consumption, adjusted for macro and age effects, respectively in 1997 and 2004; even if the poverty line is computed as relative conditional on the two years, it acts effectively as absolute since macro and age effects have been eliminated. For England I also propose the Shapley decomposition, in order to understand which factor, among the three listed (8, 9 and 10), contributed the most in explaining the changes in poverty risk.

In line with parametric estimates of vulnerability to poverty, probabilities, p_{s_h}, are computed assuming a normal distribution for each household centered at the mean of the logarithm of the adjusted income/consumption; standard deviation is computed using the same values. Possible income realizations are therefore those already experienced by the household in the past adjusted for macro and age effects, assuming that the data are informative about all the possible idiosyncratic shocks. Parametric strategies already implemented in the past to compute vulnerability to poverty (e.g., Chaudhuri, 2003), assume implicitly that individuals or households with similar characteristics register the same variability in income/consumption. This means estimating vulnerability across groups of individuals/households and losing the idiosyncratic nature of shocks, information that is very important in this type of analysis. By estimating probabilities on household means and standard deviations, I adopt a more idiosyncratic perspective.

Translating the vulnerability concept into an empirical index is not straightforward, because it incorporates a forward looking perspective and the idea of the future distribution of households' income/consumption. Some strategies have been proposed in the literature to overcome this problem, mostly based on past values. Pritchett *et al.* (2000), for instance, used panel data to compute vulnerability to poverty as the probability that the income falls below a chosen poverty threshold, z. Very similar is the poverty risk estimated in Chaudhuri (2003), where the heteroskedasticity of cross-sectional households data is exploited. Other examples which aim at measuring vulnerability to poverty adopt the same implicit assumption, i.e. the past can be used to have an idea of the welfare measure future distribution.

One can criticize this approach by saying that past and future could be very different, and what we observe is not necessarily fully informative about all the possible realizations, but there are at least three reasons that support the strategy used in the literature so far. The first argument is related to the index predictive power. It is shown in the literature that vulnerability to poverty, in Christiaensen and Boisvert's (2000) version, based on past adjusted income values, is among the best predictors of the short-term poverty status.

Borrowing from Celidoni (2013) with a different distribution assumption, I propose in Table 1 an analysis of the index predictive power compared to other vulnerability measures for England. All the indexes are rich in terms of information summarized and they focus on different and equally relevant aspects of vulnerability. The index proposed by Pritchett *et al.* (2000) or Chaudhuri (2003) for instance summarizes upward and downward variability of income, stressing the role of fluctuations in general; Christiaensen and Boisvert's (2000) version instead focuses especially on the variability below the poverty line and accounts for different types of weights that can be attached to extreme poverty, highlighting implicitly that not only does the number of cases in which poverty is experienced matter, but also the magnitude of the shock could be relevant in predicting the poverty status. Calvo and Dercon (2013) instead consider the risk attitude to be important; finally Dutta *et al.*'s (2011) measures are different from the others because they suggest that the current financial situation affects, in two opposite ways, the importance of the potential drops in income.

As precision criterion I use the area under the receiver operating characteristic (ROC) curve, that can provide a summary of the degree to which vulnerability acts as a signal for poverty. This method is specifically designed to deal with dichotomous variables and was originally used in the field of engineering or disease diagnosis to measure the extent to which a given signal can detect an underlying condition (Egan, 1975; Spackman, 1989; Thompson and Zucchini, 1989; Swets *et al.*, 2000). This approach has also been proposed in the multidimensional poverty analysis (Madden, 2011) to assess the degree of overlapping between dimensions and for vulnerability to poverty to evaluate the predictive power of indexes (Landau *et al.*, 2012; Celidoni, 2013). In this context the underlying condition for England is income poverty in 1998 and 2005, respectively, for periods I and II while vulnerability represents the symptom of poverty; by analyzing the areas under the ROC curve of each vulnerability measure it is therefore possible to understand which index is the most reliable signal of poverty. More precisely

TABLE 1
VULNERABILITY TO POVERTY, INDEX PRECISION, ENGLAND

	Obs	Pearson	Spearman	Area ROC	SE	95% CI	
1991–1997							
PC	1740	–0.2235	–0.2279	0.7611	0.0146	0.73238	0.78978
C	1740	–0.3568	–0.3721	0.8121	0.0153	0.78216	0.84208
CD (rel.)	1740	–0.2901	–0.4913	0.7664	0.0129	0.74105	0.79170
CD (abs.)	1740	–0.2885	–0.2532	0.8662	0.0129	0.84086	0.89150
DFM1	1740	–0.1470	–0.1128	0.8224	0.0129	0.79714	0.84768
DFM2	1740	–0.1182	–0.1253	0.8515	0.0140	0.82412	0.87888
FGT (alpha = 1)	1740	–0.2206	–0.1884	0.8598	0.0129	0.83448	0.88509
FGT (alpha = 2)	1740	–0.2966	–0.2613	0.8669	0.0129	0.84156	0.89221
1998–2004							
PC	1740	–0.2279	–0.3574	0.6498	0.0197	0.6112	0.68837
C	1740	–0.3721	–0.5279	0.7258	0.0189	0.68874	0.76288
CD (rel.)	1740	–0.3153	–0.4340	0.6911	0.0167	0.65845	0.72379
CD (abs.)	1740	–0.2532	–0.4829	0.7385	0.018	0.70325	0.77379
DFM1	1740	–0.1128	–0.4525	0.7167	0.0173	0.68275	0.75070
DFM2	1740	–0.1253	–0.4508	0.7168	0.0182	0.68114	0.75243
FGT (alpha = 1)	1740	–0.1884	–0.4777	0.7350	0.0179	0.69997	0.77007
FGT (alpha = 2)	1740	–0.2613	–0.4835	0.7389	0.0180	0.70361	0.77420

Notes: PC = Pritchett *et al*. (2000) and Chaudhuri (2003); C = Chaudhuri (2003); CD = Calvo and Dercon (2013); DFM = Dutta *et al*. (2011); FGT = Christiaensen and Boisvert (2000) that recalls Foster *et al*.'s (1984) index.

the larger the area, the more precise is the index. Looking at Table 1, where the Pearson and Spearman correlation coefficients are also provided as alternative precision criteria, it is possible to notice that in both periods the Christiaensen and Boisvert (2000) version of the index is one of the best predictors of future poverty. Similar results, not reported here for the sake of brevity, can also be found for Italy, when vulnerability is a symptom of poverty in 2006.

It is also possible to show how the empirical strategy used identifies reasonably and correctly idiosyncratic risk factors associated with poverty episodes since it captures demographic (i.e., change in the household type, marital status, household size, number of children) or economic shocks (i.e., change in employment status, in the number of employed and retired people in the household, and large income drops).[3]

Finally, in favor of past information as proxy for the future, it can be also argued that having experienced poverty makes people more likely to experience it again, as largely documented in the poverty literature using transition probabilities (see, for instance, Jenkins, 2011). According to Cappellari and Jenkins (2004, p. 598) moreover, ". . . the experience of poverty itself might induce a loss of motivation, lowering the chances that individuals with given attributes escape poverty in the future." This can be seen as the importance of past episodes in shaping future events, especially in the poverty context. Using past values therefore seems a plausible and informative strategy for translating vulnerability to poverty into an empirical measure to analyze the poverty risk characteristics for policies purposes.

[3]Descriptive statistics are available upon request.

Very similar to the English case is the computation of vulnerability for Italy, with the only difference that I consider one period, because I am interested in comparing poverty risk across regions. The poverty line is computed as 60 percent of the median equivalized household consumption in 2004 at the macro-regional level to take into account the different cost of living across regions (see Appendix, Figure A.1, for a graphical representation). Also in this case the relative poverty line acts as aboslute when comparing across different periods of time, since age and macro shocks effects have been removed. Considering region-specific poverty lines, as suggested by Mogstad *et al.* (2007), helps in avoiding possible sources of bias in terms of poverty that Italy could register due to different prices of goods and services as well as norms and habits across regions.

Furthermore, I define aggregate vulnerability as the arithmetic mean of the individual vulnerability to poverty indices, as for instance Bossert *et al.* (2012) do for their aggregate intertemporal poverty index.[4]

5. Inter-Temporal and Inter-Regional Illustrations

The decomposition described for Christiaensen and Boisvert's (2000) vulnerability index for $\alpha = 2$ is now applied to England and Italy as illustrative examples respectively for an inter-temporal and inter-regional comparison of the poverty risk and its contributing factors.

Given all the innovations in the British welfare system from period I to period II in favor of low-pay workers, families with children, vulnerable groups, and pensioners, England offers an interesting illustrative example for the inter-temporal analysis of poverty risk and its factors.

The aim of this empirical application is not to test causal effects or to evaluate the effectiveness of these policies, but to describe how the poverty risk and its features have evolved in a period of relevant changes.

Looking at Table 2, where the averages of the whole index and its contributing factors are reported, it is possible to observe that vulnerability to poverty has decreased between the two periods, from 0.0155 to 0.0120. This difference is statistically different from zero according to the paired t-test where the null hypothesis of equality in poverty risk between the two periods analyzed is rejected. This result is in line with other studies. Piachaud and Sutherland (2000), for instance, attempted to evaluate the potential impacts of the government initiatives on child poverty, and, using micro-simulation modeling, they estimated an increase in incomes of the poorest more than those better-off and of households with children more than others. They also simulated a decrease in the proportion of children in poverty (living in households with equivalized disposable income below 50 percent of mean value) from 26 percent to 20 percent and a reduction in the size of the poverty gap. Moreover Gregg (2008) argues that there has been a decline in poverty among families with children which came about partly through increased employment and partly through the increased generosity of benefits.

[4]Multi-period poverty deals with the same type of information used in this analysis; I thank an anonymous referee for noticing that. However vulnerability is more concerned with anticipating poverty and preventing welfare drops rather than measuring multi-period poverty ex post.

TABLE 2

Vulnerability to Poverty and its Contributing Factors, England

	BHPS (1997–2004)			
	$V_{\alpha=2}$ **(SD)**	*EH* **(SD)**	*EI* **(SD)**	ECV^2 **(SD)**
t = I	0.0155 (0.0499)	0.1725 (0.2784)	0.0415 (0.0947)	0.0122 (0.1636)
t = II	0.0120 (0.0393)	0.1395 (0.2385)	0.0310 (0.0772)	0.0157 (0.2107)
Vulnerability to Poverty				
		Obs	**Mean**	**SD**
diff		1973	0.0035	0.0509
	Ho: mean(diff) = 0	Ha: mean(diff) ≠ 0	Pr(|*T*| > |*t*|) = **0.0021**	
Expected Incidence				
		Obs	**Mean**	**SD**
diff		1973	0.0329	0.2274
	Ho: mean(diff) = 0	Ha: mean(diff) ≠ 0	Pr(|*T*| > |*t*|) = **0.0000**	
Expected Intensity				
		Obs	**Mean**	**SD**
diff		1973	0.0106	0.0884
	Ho: mean(diff) = 0	Ha: mean(diff) ≠ 0	Pr(|*T*| > |*t*|) = **0.0000**	
Expected Variability below the Poverty Line				
		Obs	**Mean**	**SD**
diff		1973	–0.0035	0.1415
	Ho: mean(diff) = 0	Ha: mean(diff) ≠ 0	Pr(|*T*| > |*t*|) = 0.2742	

Notes: $V_{\alpha=2}$ is the average vulnerability. Period I: 1991–97. Period II: 1998–2004.

Figure 1 and Table 3 also offer a description of the overall vulnerability to poverty distribution. Figure 1 shows the distributions for strictly positive values; it is possible to notice that between the two periods analyzed the distribution moved to the left with a higher concentration on lower values of vulnerability, suggesting an improvement in terms of more limited poverty risk. Table 3 reports the number of households with vulnerability equal to zero and some selected percentiles of the drawn distributions. Also in this case, it can be observed that there is a reduction of vulnerable households, i.e. with non-zero poverty risk, and a lower value for almost every percentile.

After having decomposed the vulnerability index ($\alpha = 2$), it is possible to notice that the reduction in poverty risk is driven by the expected incidence that decreases from 0.1725 to 0.1395, and expected intensity (0.0415 in the first period, 0.0310 in the second); both differences are statistically different from zero. Variability below the poverty line stays quite constant between the two periods; performing the test the null hypothesis of equality is accepted. This result is consistent with Figure 1d, where the distribution of expected variability below the poverty line does not change between the two periods. Looking at Table 4, where the contributions of each factor variation have been estimated using the Shapley decomposition, it can be noticed moreover that variability below the poverty line

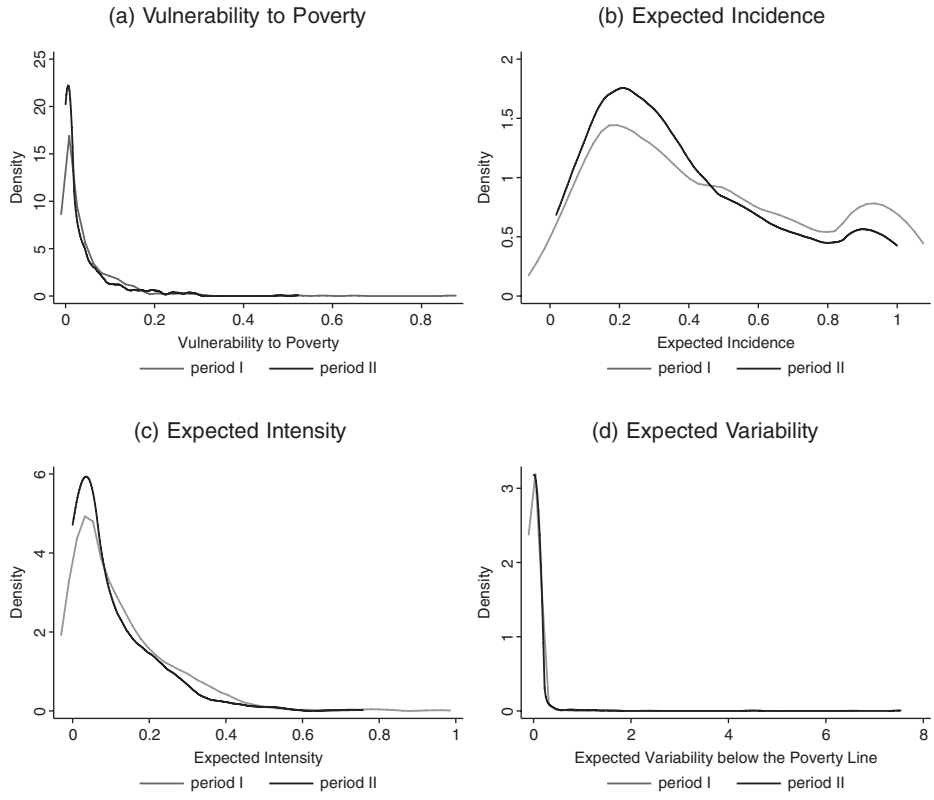

Figure 1. Distributions, $V_{\alpha=2} > 0$, England

TABLE 3

Vulnerability to Poverty Distribution, England

		$V_{\alpha=2} > 0$, **Selected percentiles**				
	$V_{\alpha=2} = 0$	**Mean**	**25%**	**50%**	**75%**	**90%**
t = I	1307	0.0459	0.0032	0.0201	0.0579	0.1206
t = II	1357	0.0384	0.0018	0.0118	0.0458	0.1800

TABLE 4

Vulnerability to Poverty Decomposition, England

BHPS, Contributing Factors			
$\Delta V_{\alpha=2}$ **(SD)**	**C(**ΔEH**) (SD)**	**C(**ΔEI**) (SD)**	**C(**ΔECV^2**) (SD)**
–0.0035 (0.0509)	–0.0011 (0.0259)	–0.0024 (0.0320)	0.0000375 (0.0412)

explains a small part of the inter-temporal variation. The whole index has decreased because of a reduction in the possible states in which the household experiences poverty and in the expected poverty gap, but understanding which policy has especially driven this result remains to be explored. Even if the causal

TABLE 5
VULNERABILITY TO POVERTY AND ITS CONTRIBUTION FACTORS, ITALY

	ITALY (1989–2004)				
	Obs.	$V_{\alpha=2}$ **(SD)**	*EH* **(SD)**	*EI* **(SD)**	ECV^2 **(SD)**
North	1155	0.0023 (0.0154)	0.0966 (0.1616)	0.0081 (0.0385)	0.0013 (0.0161)
Centre	564	0.0024 (0.0136)	0.1027 (0.1752)	0.0090 (0.0376)	0.0009 (0.0051)
South	803	0.0035 (0.0137)	0.1241 (0.1945)	0.0135 (0.0440)	0.0021 (0.0131)

effect must be documented, the attempt to favor work participation or to condition financial support to active job search seems to be a possible successful strategy for reducing expected incidence through earnings.

I also propose a second example: the inter-regional comparison of vulnerability to poverty using Italian data. According to the Italian National Institute of Statistics (ISTAT), Italy is characterized by a strong territorial difference in poverty rates; from 1997 to 2006 in the South, the incidence of poverty is about five times higher than in the North. Italy therefore represents an interesting example for an inter-regional comparison to highlight how risk changes according to regions or groups of regions. In this case I consider three groups of regions: those in the North-, Centre-, and South-Italy.[5]

As expected, Table 5 shows how the poverty risk in the sample is mainly concentrated in South-Italy; the index is in fact higher than in North- and Centre-Italy. Performing t-tests of equality in vulnerability among regions, not reported here for the sake of brevity, it can be found that between North- and Centre-Italy there is no statistically significant difference, while vulnerability does differ in the South.

For a more detailed description of poverty risk, it is possible to look at the three contributing factors: expected incidence is on average 0.12 in the South while about 0.10 in the other Italian regions; the average expected poverty gap is about 0.013 compared to 0.008 and 0.009; respectively, in the North and in the Centre; and finally the variability below the poverty line is much larger in the South. The t-tests provide the same results in terms of significance for expected incidence and expected intensity, while expected variability below the poverty line seems to be on average the same in the three Italian macro-regions.

The overall picture of vulnerability in Italy confirms the strong territorial component of the poverty phenomenon, characterized by a persistent large gap between poverty risk in the North-/Centre-Italy and the South.

If we are interested in a more detailed regional breakdown (see Appendix), it can be observed that the decomposition offers useful information for policymakers. In Figure A.1, the darker the color the higher the vulnerability to poverty. Let us consider for instance the Puglia region: the overall index is not so high compared to the other South-regions, where households are exposed to a more severe poverty risk. If the decomposition is performed, it is possible to highlight that the poverty risk is driven by a high expected incidence rather than other contributing factors, suggesting to policymakers strategies that should reduce the number of welfare drops. Another different example could be the

[5]I include islands in the South-Italy category.

Veneto region, that records a poverty risk driven by a high unpredictability of large negative shocks, suggesting prima facie better risk-management financial strategies to recover fast from welfare drops and smooth consumption more effectively.

6. Conclusions

For a more complete description of the phenomenon, poverty is usually described in terms of the number of people below the poverty line, the poverty gap, and the distribution of income among the poor, as Sen (1976) proposed.

Using the decomposition of one of the FGT poverty indices ($\alpha = 2$) (Foster *et al*., 1984), I suggest that individual vulnerability to poverty (when $\alpha = 2$) should also be expressed as a function of the three contributing factors, expected incidence, expected intensity, and expected variability below the poverty line. This approach to poverty risk can be useful as information source for policies design, since different patterns of risk faced by individuals could lead to different risk management policies (Dercon, 2001).

It provides information for policy makers who follow especially the World Development Report 2000/01's directions, where it is argued how optimal design should aim to strengthen, complement, and replace existing coping strategies. The importance of overcoming the traditional *safety net policies*, which allow households to survive the consequences of poor outcomes in favor of welfare drops prevention, is also stressed. From this point of view therefore it is worthwhile also examining poverty risk measures in terms of their contributing components, to provide more accurate information about the ex ante risk faced by households. In the process proposed by Dercon (2001) for optimal policy design, this analysis is related especially to the first step about understanding the poverty risk. If for instance poverty risk is due mostly to volatility and the inability of smoothing consumption (i.e., large expected downward volatility), risk-insurance programs or incentives for self-protecting savings are the candidates for helping households avoid poverty. As Naschold and Barrett (2011) argue, short-term stochastic welfare fluctuations could be better addressed by stabilizing household incomes and/or by improving the access to financial products aiming at smoothing consumption. If instead rare catastrophic events are poverty triggers (i.e., large expected intensity), adequate financial support is needed to recover faster from them. When, on the contrary, there are several poverty episodes (i.e., large expected incidence) and the phenomenon becomes *structural*, the solution cannot be only financial but must be also based on non-monetary strategies (e.g., stimulating asset accumulation and productivity growth).

Few studies make an effort to distinguish between these components, as observed by Naschold and Barrett (2011), even if relevant from the policy perspective; this paper presents an approach that tries to address this issue.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table A.1: Sample Characteristics
Figure A.1: Vulnerability to poverty—Italy, by region