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Intertemporal Material Deprivation*

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Abstract

Individual well-being is multidimensional and various aspects of the quality of life need to be jointly considered in its measurement. The axiomatic literature on the subject has proposed many indices of multidimensional poverty and deprivation and explored the properties that are at the basis of these measures. The purpose of this chapter is to add intertemporal considerations to the analysis of material deprivation. We employ the EU-SILC panel data set, which includes information on different aspects of well-being over time. EU countries are compared based on measures that take this additional intertemporal information into consideration. *Journal of Economic Literature* Classification No.: D63.

Keywords: Multidimensional Material Deprivation, Intertemporal Social Index Numbers, Persistent Deprivation.

1 Introduction

Individual well-being is multidimensional and various aspects of the quality of life of an individual need to be jointly considered in its measurement. The axiomatic literature on the subject has proposed many indices of multidimensional poverty and deprivation and explored the properties that are at the basis of these measures; see, for example, Chakravarty, Mukherjee and Ranade (1998), Tsui (2002), Bourguignon and Chakravarty (2003), Diez, Lasso de la Vega and Urrutia (2008), Bossert, Chakravarty and D'Ambrosio (2009), and Alkire and Foster (2011).

The intertemporal aspect of deprivation has received relatively little attention so far. Most of the studies in the literature have been atemporal. At the same time, many contributions on unidimensional poverty have shown that chronic poverty and persistent periods of poverty are worse, in a number of ways, for individuals than are sporadic episodes. For surveys of this literature, see, among others, Rodgers and Rodgers (1993) and Jenkins (2000). These considerations gave impetus to some recent theoretical contributions on measuring income poverty over time, such as Calvo and Dercon (2009), Foster (2009), Hojman and Kast (2009), Hoy and Zheng (2011), Dutta, Roope and Zank (2011) and Bossert, Chakravarty and D'Ambrosio (2012). The *Journal of Economic Inequality* has recently published a special issue on measuring poverty over time. We refer the reader to its introduction (Christiaensen and Shorrocks, 2012) for an exhaustive summary of the literature. See also Hoy, Thompson and Zheng (2012), Gradin, del Rio and Cantó (2012) and Mendola and Busetta (2012).

The purpose of this chapter is to bring these two strands of the poverty and deprivation literature together by employing the EU-SILC panel data set, which includes information on different aspects of well-being over time. We analyze the role of intertemporal considerations in material deprivation and compare EU countries based on this additional information. The only other paper similar in spirit that we are aware of is Nicholas and Ray (2012). These authors propose generalizations of the contributions of Foster (2009) and Bossert, Chakravarty and D'Ambrosio (2012) and apply the indices to the study of multidimensional deprivation in Australia during the period from 2001 to 2008.

The distinction between multidimensional poverty and material deprivation we adopt in this chapter is that endorsed by the EU. In particular, a multidimensional poverty measure takes into consideration all dimensions of well-being that may be of relevance (including non-material attributes such as health status and political participation), whereas an index of material deprivation restricts attention to functioning failures regarding material living conditions. According to EU policy, indices

of material deprivation are to be combined with income-based poverty measures and indicators of low employment.

In the multidimensional framework, each person is assigned a vector of several attributes that represent different dimensions of well-being. For measuring multidimensional poverty, it then becomes necessary to check whether a person has "minimally acceptable levels" of these attributes; see Sen (1992, p.139). These minimally acceptable quantities of the attributes represent their threshold values or cut-offs that are necessary for an adequate standard of living. Therefore, a person is treated as deprived or poor in a dimension if the requisite observed level falls below this cut-off. In this case we say that the individual is experiencing a functioning failure. Material deprivation at the individual level is an increasing function of these failures.

The identification of the poor in a multivariate framework can be performed with different methods. One possible way of regarding a person as poor is if the individual experiences a functioning failure in every dimension, which identifies the poor as those who are poor in all dimensions. This is known as the *intersection* method of identification of the poor. But if a person is poor in one dimension and non-poor in another, then trading off between the two dimensions may not be possible. Lack of access to essential durables, say, cannot be compensated by housing. In view of this, a person may be treated as poor if she is poor in at least one dimension. This is the *union* method of identifying the poor; see Tsui (2002) and Bourguignon and Chakravarty (2003). In between these two extremes lies the *intermediate* identification method which regards a person as poor if she is deprived in at least $m \in \{1, \ldots, M\}$ dimensions, where M is the number of dimensions on which human well-being depends. Our approach to identification follows the union method: a person is considered poor if she is poor in at least one dimension.

We follow what Atkinson (2003) refers to as the *counting* approach. The counting measure of individual poverty consists of the number of dimensions in which a person is poor, that is, the number of the individual functioning failures. Since some of the dimensions may be more important than others, an alternative counting measure can be obtained by assigning different weights to different dimensions and then adding these weights for the dimensions in which functioning failure is observed. In this chapter we follow both suggestions and produce results for two different weighing schemes: equal weights and Eurobarometer weights, where the latter reflect EU citizens' views on the importance of the dimension of well-being under consideration. For a discussion of weighing schemes in EU indicators, see Guio, Fusco and Marlier (2009). A survey on the use of weights in multidimensional indices of well-being can be found in Decancq and Lugo (2012).

The intertemporal aspect is included in three alternative specifications following

the proposals of Foster (2009), Bossert, Chakravarty and D'Ambrosio (2009), and Hojman and Kast (2009) for income poverty.

The measures proposed by Foster (2009) are generalizations of the Foster-Greer-Thorbecke (1984) class and allow for time to matter. The individual Foster index is the arithmetic mean over time of per-period Foster-Greer-Thorbecke indices. In a similar spirit, the corresponding individual intertemporal index of material deprivation is the average material deprivation experienced by the individual over time.

Bossert, Chakravarty and D'Ambrosio (2012) take into account persistence in the state of poverty. Their measure pays attention to the length of individual poverty spells by assigning a higher level of poverty to situations where, ceteris paribus, poverty is experienced in consecutive rather than separated periods. The individual index is calculated as the weighted average of the individual per-period poverty values where, for each period, the weight is given by the length of the spell to which this period belongs. Similarly, the corresponding individual intertemporal index of material deprivation is calculated as the weighted average of the individual indices of material deprivation where, for each period, the weight is given by the length of the spell to which this period belongs.

Hojman and Kast's (2009) index of poverty dynamics trades off poverty levels and changes (gains and losses) over time and is consistent with loss aversion. The loss aversion property captures the idea that, given income streams with the same levels of deprivation but in a different sequence, an individual is better off with an increasing sequence of outcomes than a decreasing one. The individual measure characterized by Hojman and Kast (2009) is an increasing function of absolute levels of poverty at each period and also of changes in poverty. We follow a similar proposal for material deprivation according to which the individual intertemporal index of material deprivation is the sum of two components: the first is the average material deprivation experienced by the individual over time, the same index applied in the approach inspired by Foster (2009), the second component is the average of the weighted changes in material deprivation experienced over time, where the weights can be consistent with loss aversion. While the first two approaches can be found in Nicholas and Ray (2012), Hojman and Kast's (2009) approach has, so far, not been generalized in this manner.

The remainder of the chapter proceeds as follows. Section 2 contains a description of the intertemporal indices of material deprivation. The application of these measures to illustrate the evolution of material deprivation in the European Union using the EU-SILC dataset can be found in section 3. Section 4 provides some brief concluding remarks.

2 Measuring material deprivation

Suppose there are $N \in \mathbb{N}\backslash\{1\}$ individuals in a society, $M \in \mathbb{N}\backslash\{1\}$ characteristics (or dimensions of material deprivation) and $T \in \mathbb{N}\backslash\{1\}$ time periods. For each individual $n \in \{1,\dots,N\}$, for each time period $t \in \{1,\dots,T\}$ and for each characteristic $m \in \{1,\dots,M\}$, we observe a binary variable $x_m^{nt} \in \{0,1\}$. A value of one indicates that individual n is poor with respect to dimension m in period t, a value of zero identifies a characteristic with respect to which the individual is not poor in that period. For all $n \in \{1,\dots,N\}$ and for all $t \in \{1,\dots,T\}$, we let $x^{nt} = (x_1^{nt},\dots,x_M^{nt}) \in \{0,1\}^M$. For all $n \in \{1,\dots,N\}$, we define $x^n = (x^{n1},\dots,x^{nT}) \in \left(\{0,1\}^M\right)^T$. Furthermore, we let $x = (x^1,\dots,x^N) \in \left(\left(\{0,1\}^M\right)^T\right)^N$.

For each individual $n \in \{1,\dots,N\}$ and each time period $t \in \{1,\dots,T\}$, individual n's material deprivation in t is given by

$$\sum_{m=1}^{M} x_m^{nt}\alpha_m$$

where $\alpha_m \in \mathbb{R}_{++}$ is a parameter assigned to dimension $m \in \{1,\dots,M\}$. In the applied part of the paper, we examine two different weighing schemes—one with identical weights for all dimensions, one with weights that are derived from the Eurobarometer survey. See section 3 for details.

A measure of intertemporal material deprivation for individual $n \in \{1,\dots,N\}$ is a function $D^n\colon \left(\{0,1\}^M\right)^T \to \mathbb{R}_+$ which assigns a non-negative individual intertemporal material deprivation value to each x^n in its domain. A measure of aggregate intertemporal material deprivation is a function $D\colon \left(\left(\{0,1\}^M\right)^T\right)^N \to \mathbb{R}_+$ that assigns a non-negative intertemporal material deprivation value to each x in its domain.

The first approach to be analyzed here is inspired by Foster (2009). For each individual n, intertemporal material deprivation F^n is the average material deprivation experienced throughout the T periods. That is, for all $x^n \in \left(\{0,1\}^M\right)^T$,

$$F^n(x^n) = \frac{1}{T}\sum_{t=1}^{T}\sum_{m=1}^{M} x_m^{nt}\alpha_m.$$

Aggregate intertemporal material deprivation F is the arithmetic mean of the individual intertemporal material deprivation values. Thus, we obtain, for all $x \in$

$\left(\left(\{0,1\}^M\right)^T\right)^N$,

$$F(x) = \frac{1}{N}\sum_{n=1}^{N} F^n(x^n) = \frac{1}{N}\frac{1}{T}\sum_{i=1}^{N}\sum_{t=1}^{T}\sum_{m=1}^{M} x_m^{nt}\alpha_m.$$

In order to discuss our adaptation of Bossert, Chakravarty and D'Ambrosio's (2012) approach to the intertemporal setting, we require some additional definitions. Let $n \in \{1,\ldots,N\}$ and $x^n \in \left(\{0,1\}^M\right)^T$. We say that n is deprived in period $t \in \{1,\ldots,T\}$ in x^n if and only if there exists $m \in \{1,\ldots,M\}$ such that $x_m^{nt} = 1$. That is, in order to be deprived in period t in x^n, individual n must be deprived with respect to at least one dimension in this period. This corresponds to the union method of identifying the deprived. Thus, individual n is not deprived in period t in x^n if and only if $x_m^{nt} = 0$ for all $m \in \{1,\ldots,M\}$.

To capture the notion of persistence in a state of material deprivation, we introduce functions $P^{nt}\colon \left(\{0,1\}^M\right)^T \to \{1,\ldots,T\}$ for each $n \in \{1,\ldots,N\}$ and for each $t \in \{1,\ldots,T\}$. If n is deprived in period t in x^n, we let $P^{nt}(x^n)$ be the maximal number of consecutive periods including t in which n is deprived. Analogously, if n is not deprived in period t in x^n, $P^{nt}(x^n)$ is the maximal number of consecutive periods including t in which n is not deprived. To illustrate this definition, suppose $T = 7$ and x^n is such that n is deprived in periods one, four, five, and seven. The length of the first spell of material deprivation is one and, thus, $P^{n1}(x^n) = 1$. This is followed by a spell out of deprivation of length two (in periods two and three), which implies $P^{n2}(x^n) = P^{n3}(x^n) = 2$. The next two periods are periods with deprivation and we obtain $P^{n4}(x^n) = P^{n5}(x^n) = 2$. Period six is a single period without deprivation and, thus, $P^{n6}(x^n) = 1$. Finally, there is a one-period spell of material deprivation and we have $P^{n7}(x^n) = 1$.

Following Bossert, Chakravarty and D'Ambrosio (2012), intertemporal material deprivation BCD^n for individual $n \in \{1,\ldots,N\}$ is a weighted mean of the individual material deprivation values where, for each period, the weight is given by the length of the spell to which this period belongs. Thus, according to this approach, individual intertemporal material deprivation BCD^n is given by

$$BCD^n(x^n) = \frac{1}{T}\sum_{t=1}^{T} P^{nt}(x^n)\sum_{m=1}^{M} x_m^{nt}\alpha_m$$

for all $x^n \in \left(\{0,1\}^M\right)^T$. Again, aggregate intertemporal material deprivation BCD is the arithmetic mean of the individual intertemporal material deprivation values.

Thus, for all $x \in \left(\left(\{0,1\}^M\right)^T\right)^N$,

$$BCD(x) = \frac{1}{N}\sum_{n=1}^{N} BCD^n(x^n) = \frac{1}{N}\frac{1}{T}\sum_{i=1}^{N}\sum_{t=1}^{T} P^{nt}(x^n)\sum_{m=1}^{M} x_m^{nt}\alpha_m.$$

Hojman and Kast (2009) propose to include variability as a determinant of individual intertemporal material deprivation. Their individual measure HK^n has two components: the level of individual intertemporal material deprivation and the changes of individual material deprivation over time. The level is measured by means of F^n and the changes are given by the weighted sum of upward and downward movements of individual material deprivation over time. In the terminology of Hojman and Kast (2009), there is poverty creation whenever deprivation increases and poverty destruction whenever deprivation decreases.

To illustrate, consider a situation with $T = 3$ and $x^n, y^n \in \left(\{0,1\}^M\right)^T$ such that n is deprived in periods one and three in x^n, and in periods two and three in y^n. According to the Hojman and Kast (2009) approach, n is intertemporally more deprived in y^n than in x^n. The levels of individual intertemporal material deprivation are the same in x^n and in y^n. However, in x^n, there is poverty destruction (in the move from period one to period two) and poverty creation (in the move from period two to period three), whereas in y^n, there is only poverty creation (in the move from period one to period two).

In general, for a fixed level of individual material deprivation, each movement that decreases material deprivation decreases the overall index and each movement that increases material deprivation increases the index. To provide a formal definition, we introduce two sets of functions $g^{nt}\colon \{0,1\}^M \to \{0,1\}$ and $\ell^{nt}\colon \{0,1\}^M \to \{0,1\}$ for $n \in \{1,\ldots,N\}$ and $t \in \{1,\ldots,T-1\}$ that are intended to capture gains (decreases in individual material deprivation) and losses (increases in material deprivation). They are defined by letting, for all $x^{nt} \in \{0,1\}^M$,

$$g^{nt}(x^{nt}) = \begin{cases} 1 & \text{if } \sum_{m=1}^{M} x_m^{nt}\alpha_m > \sum_{m=1}^{M} x_m^{n(t+1)}\alpha_m \\ 0 & \text{otherwise} \end{cases}$$

and

$$\ell^{nt}(x^{nt}) = \begin{cases} 1 & \text{if } \sum_{m=1}^{M} x_m^{nt}\alpha_m < \sum_{m=1}^{M} x_m^{n(t+1)}\alpha_m \\ 0 & \text{otherwise.} \end{cases}$$

For each individual n, intertemporal material deprivation HK^n is given by

$$HK^n(x^n) = \frac{1}{T}\sum_{t=1}^{T}\sum_{m=1}^{M} x_m^{nt}\alpha_m + \frac{1}{T}\sum_{t=1}^{T}\left(\gamma_t \ell^{nt}(x^{nt}) - \delta_t g^{nt}(x^{nt})\right)$$

for all $x^n \in \left(\{0,1\}^M\right)^T$, where $\gamma_t, \delta_t \in \mathbb{R}_{++}$ are parameters such that $\gamma_t \geq \delta_t$ for all $t \in \{1, \ldots, T-1\}$. When $\gamma_t = \delta_t$, gains and losses are perfect substitutes: any increase in deprivation can be compensated by any decrease of the same amount. When $\gamma_t > \delta_t$, losses weigh more than gains. This second possibility is what we assume for the application presented in the following section.

Finally, aggregate intertemporal material deprivation HK is the arithmetic mean of the individual intertemporal material deprivation values. Thus,

$$\begin{aligned} HK(x) &= \frac{1}{N} HK^n(x^n) \\ &= \frac{1}{N}\frac{1}{T}\sum_{n=1}^{N}\sum_{t=1}^{T}\sum_{m=1}^{M} x_m^{nt}\alpha_m + \frac{1}{N}\frac{1}{T}\sum_{n=1}^{N}\sum_{t=1}^{T}\left(\gamma_t \ell^{nt}(x^{nt}) - \delta_t g^{nt}(x^{nt})\right) \end{aligned}$$

for all $x \in \left(\left(\{0,1\}^M\right)^T\right)^N$.

3 Data and results

In this section, we apply the indices defined above to measure material deprivation over time in the EU. The dataset we use is EU-SILC, which is employed by European Union member states and the Commission to monitor national and EU progress towards key objectives for the social inclusion process and the Europe 2020 growth strategy. Our analysis covers the years from 2006 to 2009 and, since we are interested in intertemporal material deprivation, we focus only on the longitudinal component of the dataset. The variables that may be used in the measurement of material deprivation are available mainly at the household level. We follow a conservative approach in the sense that we treat the households reporting a missing value like those reporting not to experience the functioning failure. As a result, we may be underestimating material deprivation since we are attributing a functioning failure exclusively to households who explicitly claim to have the failure. The unit of our analysis is the individual, that is, the household failure is attributed to each household member and we analyze the distribution of functioning failures among individuals.

The variables at the basis of the measures of material deprivation are listed in Table 1.

[Table 1 here]

They are grouped according to three domains of quality of life: financial difficulties, housing conditions and durables, for a total of twelve indicators. These are the

same variables chosen by Fusco, Guio and Marlier (2010). For other EU studies on material deprivation on different dimensions of well-being see, among others, Guio (2009), Guio, Fusco and Marlier (2009).

We use two weighing schemes: identical weights for all dimensions and weights that are constructed from the views of EU citizens as surveyed in 2007 in the special Eurobarometer 279 on poverty and social exclusion (see TNS Opinion & Social, 2007). This weighing method has first been proposed by Guio, Fusco and Marlier (2009). For each variable, with this weighing scheme, we use as weight the percentage of the EU27 citizens answering "absolutely necessary, no one should have to do without" to the requisite question as expressed by these instructions: "In the following questions, we would like to understand better what, in your view, is necessary for people to have what can be considered as an acceptable or decent standard of living in (OUR COUNTRY). For a person to have a decent standard of living in (OUR COUNTRY), please tell me how necessary do you think it is ... (if one wants to)." The possible answers also included "necessary," "desirable but not necessary" and "not at all necessary."

The results of the intertemporal indices are reported in Tables 2, 3 and 4. In each table we include the value of the index and the rankings of the countries (where 1 indicates the country with minimum deprivation) using both weighing schemes. In Figures 1 and 2 we plot, for each weighing scheme, the rankings of the intertemporal material deprivation indices. As a benchmark, we also compute the indices of material deprivation for each year. These are contained in Table 5 (results with equal weights) and in Table 6 (results with Eurobarometer weights).

[Figures 1 and 2 here]

A clear message is conveyed from looking at the figures: the rankings obtained by applying the HK indices are very different from the other two. F and BCD agree more with the Eurobarometer weighing scheme with differences being observed only for the extremes.

When time is not taken into consideration, in all the years under analysis and for both weighing schemes, the Netherlands is the least deprived country followed by Sweden, Luxembourg, Finland and the UK. When time is taken into account, the picture that emerges is very different. The weighing scheme has now an impact on the rankings of the countries. When the dimensions are weighed equally, in all three approaches Sweden is the least deprived country, followed by Luxembourg and the Netherlands. When we use Eurobarometer weights, the Netherlands gains back the best position only according to F while BCD and HK confirm the rankings of equal weighing. This fact indicates that there is more persistence of poverty in

the Netherlands compared to Sweden and Luxembourg and that, on average, the material deprivation profiles of individuals are not decreasing over time. Finland and the UK follow these three countries. The position of the UK worsens for both weighing schemes according to the HK index suggesting that the improvements in material deprivation observed over time are not enough to compensate the losses.

At the opposite side of the rankings, the worst position in the yearly material deprivation index is occupied by Bulgaria, for both weighing schemes. Latvia follows in the ranking in all the years, but in 2009, for equal weights when this position is occupied by Hungary. Hungary is a country whose position is clearly worsening over time. Poland is the third-worst country in 2006 and 2007 for equal weights, and the fourth-worst in the following two years. When we use Eurobarometer weights, in 2007 Poland gains two positions against Hungary and Cyprus. When time is taken into account, the picture that emerges is, as before, very different. Latvia and Hungary follow Bulgaria. Poland is the country whose ranking improves the most for Eurobarometer weights, when material deprivation over time is measured according to the HK index, indicating that the individual paths have sufficient improvements to overcome the trends and the losses. A similar picture emerges for mid-ranked countries such as Lithuania and the Czech Republic for both weighing schemes. Slovenia, on the contrary, sees its position worsening when movements in material deprivation are taken into account.

4 Concluding remarks

In this chapter we analyze the role of intertemporal considerations in material deprivation and compare EU countries based on this additional information. If we follow the path of material deprivation experienced by each individual over time we obtain a different picture from the yearly results. We analyze three alternative indices inspired by some recent proposals on the measurement of poverty over time. The generalization of the proposals by Foster (2009) and Bossert, Chakravarty and D'Ambrosio's (2012) tend to produce a similar ranking of countries. The approach based on Hojman and Kast (2009) conveys a different picture and tends to advantage countries whose individuals experience an improvement in their material deprivation scores. Since the measurement of material deprivation is used by the EU member states and the European Commission to monitor national and EU progress in the fight against poverty and social exclusion, these results suggest that time cannot be neglected. Countries should not only be compared based on their yearly results but additional information is gained by following individuals over time and producing an aggregate measure once time is taken into account.

[Table 2 here]

[Table 3 here]

[Table 4 here]

[Table 5 here]

[Table 6 here]

References

[1] Alkire, S. and J. Foster, Counting and multidimensional poverty measurement. *Journal of Public Economics*, 95:476–487, 2011.

[2] Atkinson, A.B., Multidimensional deprivation: contrasting social welfare and counting approaches. *Journal of Economic Inequality*, 1:51–65, 2003.

[3] Bossert, W., S.R. Chakravarty and C. D'Ambrosio, Multidimensional poverty and material deprivation. Working Paper 12-2009, CIREQ, 2009.

[4] Bossert, W., S.R. Chakravarty and C. D'Ambrosio, Poverty and time. *Journal of Economic Inequality*, 10:145–162, 2012.

[5] Bourguignon, F. and S.R. Chakravarty, The measurement of multidimensional poverty. *Journal of Economic Inequality*, 1:25–49, 2003.

[6] Calvo, C. and S. Dercon, Chronic poverty and all that: the measurement of poverty over time. In: T. Addison, D. Hulme and R. Kanbur, editors, *Poverty dynamics: interdisciplinary perspectives*, 29–58. Oxford University Press, Oxford, 2009.

[7] Chakravarty, S.R., D. Mukherjee and R. Ranade, On the family of subgroup and factor decomposable measures of multidimensional poverty. *Research on Economic Inequality*, 8:175–194, 1998.

[8] Christiaensen, L. and T. Shorrocks, Measuring poverty over time. *Journal of Economic Inequality*, 10:137–143, 2012.

[9] Decancq, K. and M. Lugo, Weights in multidimensional indices of well-being: an overview. *Econometric Reviews*, 2012, forthcoming.

[10] Diez, H., C. Lasso de la Vega and A. Urrutia, Multidimensional unit- and subgroup consistent inequality and poverty measures: some characterization results. *Research on Economic Inequality*, 16:189–211, 2008.

[11] Dutta, I., L. Roope and H. Zank, On intertemporal poverty: affluence-dependent measures. EDP 1112, University of Manchester, 2011.

[12] Foster, J., A class of chronic poverty measures. In: T. Addison, D. Hulme and R. Kanbur, editors, *Poverty dynamics: interdisciplinary perspectives*, 59–76. Oxford University Press, Oxford, 2009.

[13] Foster, J., J. Greer and E. Thorbecke, A class of decomposable poverty indices. *Econometrica*, 52:761–766, 1984.

[14] Fusco, A., A.-C. Guio and E. Marlier, Income poverty and material deprivation in European countries. Population and social conditions, methodologies and working papers, Eurostat, 2010.

[15] Gradin, C., C. del Rio and O. Cantó, Measuring poverty accounting for time. *Review of Income and Wealth*, 58:330–354, 2012.

[16] Guio, A.-C., What can be learned from deprivation indicators in Europa. Population and social conditions, methodologies and working papers, Eurostat, 2009.

[17] Guio, A.-C., A. Fusco and E. Marlier, An EU approach to material deprivation using EU-SILC and Eurobarometer data. Working Paper 2009-19, IRISS, 2009.

[18] Hojman, D. and F. Kast, On the measurement of poverty dynamics. Faculty Research Working Paper Series RWP09-35, Harvard Kennedy School, 2009.

[19] Hoy, M., B.S. Thompson and B. Zheng, Empirical issues in lifetime poverty measurement. *Journal of Economic Inequality*, 10:163–189, 2012.

[20] Hoy, M. and B. Zheng, Measuring lifetime poverty. *Journal of Economic Theory*, 146:2544–2562, 2011.

[21] Jenkins, S.P., Modelling household income dynamics. *Journal of Population Economics*, 13:529–567, 2000.

[22] Mendola, D. and A. Busetta, The importance of consecutive spells of poverty: a path-dependent index of longitudinal poverty. *Review of Income and Wealth*, 58:355–374, 2012.

[23] Nicholas, A. and R. Ray, Duration and persistence in multidimensional deprivation: methodology and an Australian application. *Economic Record*, 88:106–126, 2012.

[24] Rodgers, J. and J. Rodgers, Chronic poverty in the United States. *Journal of Human Resources*, 28:25–54, 1993.

[25] Sen, A., *Inequality Re-examined*. Harvard University Press, Cambridge, MA, 1992.

[26] TNS Opinion & Social (2007), Poverty and Exclusion, Report on the Special Eurobarometer No. 279/Wave 67.1, available at:
http://ec.europa.eu/public_opinion/archives/ebs/ebs_279.pdf.

[27] Tsui, K.-Y., Multidimensional poverty indices. *Social Choice and Welfare*, 19:69–93, 2002.

Figure 1: Rank comparison between F, BCD and HK, symmetric weights

Figure 2: Rank comparison between F, BCD and HK, Eurobarometer weights

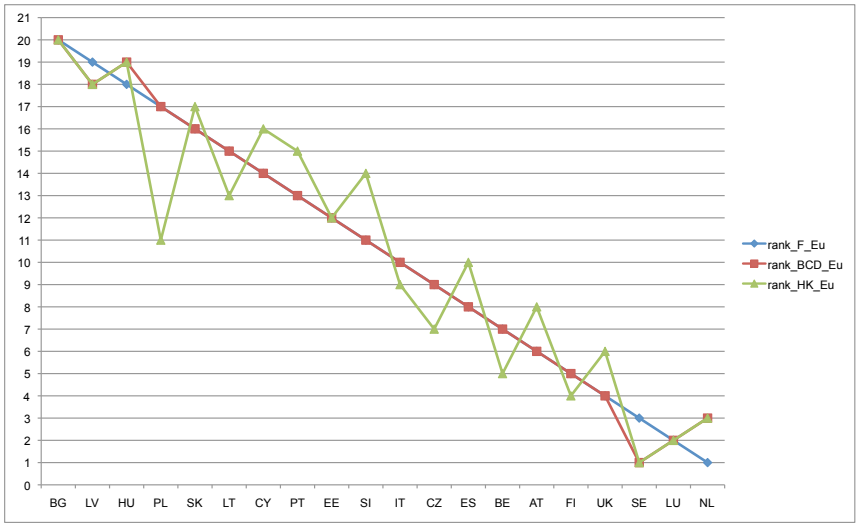

Table 1: Material deprivation variables

Financial difficulties		
	1.	Has been in arrears at any time in the last 12 months on: - mortgage or rent payments (hs010) - utility bills (hs020) - hire purchase installments or other loan payments (hs030)
	2.	Cannot afford paying for one week annual holiday away from home (hs040)
	3.	Cannot afford a meal with meat, chicken, fish (or vegetarian equivalent) every other day (hs050)
	4.	Lacks the capacity to face unexpected required expenses (hs060)
Durables		
	5.	Cannot afford a telephone (including mobile phone) (hs070)
	6.	Cannot afford a colour tv (hs080)
	7.	Cannot afford a computer (hs090)
	8	Cannot afford a washing machine (hs100)
	9.	Cannot afford to have a car (hs110)
Housing Conditions		
	10.	Lacks the ability to keep the home adequately warm (hh050)

Source: EU-SILC dataset

N.B. For a selected number of countries in years 2007, 2008 and 2009, variable hs010, hs020 and hs030 has been replaced by new variables labeled hs011, hs021, hs031 respectively. The two set of variables measure the same dimensions. While hs010, hs020 and hs030 are binary variables (1-yes, 2-no), variable hs011, hs021 and hs031 take three values (1-yes, once; 2-yes, twice or more times; 3-no). We recode hs011, hs021 and hs031 as binary and use them in place of hs010, hs020 and hs030.

Table 2: Intertemporal Material Deprivation: F

country	F	rank_F	F_Eu	rank_F_Eu
AT	0.068	7	0.042	6
BE	0.065	6	0.043	7
BG	0.287	20	0.247	20
CY	0.119	13	0.105	14
CZ	0.101	11	0.056	9
EE	0.102	12	0.076	12
ES	0.075	8	0.051	8
FI	0.059	4	0.037	5
HU	0.188	19	0.138	18
IT	0.086	9	0.056	10
LT	0.157	16	0.115	15
LU	0.031	2	0.019	2
LV	0.187	18	0.147	19
NL	0.037	3	0.019	1
PL	0.181	17	0.131	17
PT	0.128	14	0.099	13
SE	0.030	1	0.019	3
SI	0.090	10	0.064	11
SK	0.151	15	0.115	16
UK	0.059	5	0.036	4

Source: our calculations based on EU-SILC 2009 longitudinal dataset.

Table 3: Intertemporal Material Deprivation: BCD

country	BCD	rank_BCD	BCD_Eu	rank_BCD_Eu
AT	0.143	7	0.089	6
BE	0.140	6	0.092	7
BG	0.648	20	0.568	20
CY	0.261	13	0.231	14
CZ	0.225	12	0.124	9
EE	0.220	11	0.164	12
ES	0.156	8	0.109	8
FI	0.126	5	0.080	5
HU	0.445	19	0.331	19
IT	0.185	9	0.124	10
LT	0.340	16	0.254	15
LU	0.064	2	0.040	2
LV	0.394	17	0.327	18
NL	0.077	3	0.040	3
PL	0.413	18	0.302	17
PT	0.285	14	0.228	13
SE	0.058	1	0.038	1
SI	0.194	10	0.140	11
SK	0.337	15	0.258	16
UK	0.123	4	0.074	4

Source: our calculations based on EU-SILC 2009 longitudinal dataset.

Table 4: Intertemporal Material Deprivation: HK ($\gamma_t = 1$, $\delta_t = 0.5$)

country	HK	rank_HK	HK_Eu	rank_HK_Eu
AT	0.137	7	0.118	8
BE	0.110	5	0.087	5
BG	0.376	20	0.350	20
CY	0.185	11	0.180	16
CZ	0.154	8	0.108	7
EE	0.188	12	0.165	12
ES	0.166	10	0.147	10
FI	0.102	4	0.081	4
HU	0.339	19	0.304	19
IT	0.163	9	0.136	9
LT	0.205	14	0.173	13
LU	0.069	2	0.056	2
LV	0.279	18	0.245	18
NL	0.072	3	0.057	3
PL	0.210	16	0.163	11
PT	0.209	15	0.180	15
SE	0.064	1	0.053	1
SI	0.196	13	0.177	14
SK	0.217	17	0.183	17
UK	0.116	6	0.096	6

Source: our calculations based on EU-SILC 2009 longitudinal dataset.

Table 5: Yearly Material Deprivation: Equal Weights

country	I_2006	rank_2006	I_2007	rank_2007	I_2008	rank_2008	I_2009	rank_2009
AT	0.07	6	0.075	7	0.086	8	0.071	7
BE	0.085	7	0.073	6	0.071	6	0.066	6
BG	0.407	20	0.369	20	0.303	20	0.343	20
CY	0.169	14	0.179	16	0.132	13	0.142	14
CZ	0.123	11	0.103	9	0.1	10	0.102	9
EE	0.127	12	0.113	11	0.096	9	0.119	11
ES	0.098	8	0.093	8	0.084	7	0.098	8
FI	0.058	4	0.052	4	0.052	4	0.052	4
HU	0.208	16	0.211	17	0.204	18	0.228	19
IT	0.103	9	0.107	10	0.106	11	0.105	10
LT	0.21	17	0.168	15	0.159	16	0.157	16
LU	0.046	3	0.049	3	0.049	3	0.046	3
LV	0.267	19	0.232	19	0.21	19	0.225	18
NL	0.039	1	0.036	1	0.034	1	0.03	1
PL	0.243	18	0.212	18	0.186	17	0.177	17
PT	0.152	13	0.153	13	0.149	14	0.142	13
SE	0.042	2	0.038	2	0.038	2	0.034	2
SI	0.113	10	0.116	12	0.119	12	0.119	12
SK	0.19	15	0.162	14	0.15	15	0.155	15
UK	0.067	5	0.059	5	0.062	5	0.058	5

Source: our calculations based on EU-SILC 2009 longitudinal dataset.

Table 6: Yearly Material Deprivation: Eurobarometer Weights

country	I_Eu2006	rank_2006	I_Eu2007	rank_2007	I_Eu2008	rank_2008	I_Eu2009	rank_2009
AT	0.042	5	0.046	6	0.054	7	0.045	7
BE	0.057	7	0.048	7	0.045	6	0.041	6
BG	0.342	20	0.305	20	0.256	20	0.295	20
CY	0.148	15	0.156	18	0.114	16	0.125	16
CZ	0.071	10	0.058	8	0.055	8	0.056	8
EE	0.092	12	0.081	11	0.071	10	0.09	12
ES	0.067	8	0.064	9	0.058	9	0.07	9
FI	0.037	4	0.034	4	0.035	4	0.035	4
HU	0.151	16	0.154	17	0.15	18	0.171	18
IT	0.071	9	0.074	10	0.073	11	0.074	10
LT	0.151	17	0.119	14	0.112	15	0.117	14
LU	0.03	3	0.032	3	0.031	3	0.029	3
LV	0.198	19	0.171	19	0.156	19	0.171	19
NL	0.021	1	0.02	1	0.018	1	0.016	1
PL	0.177	18	0.153	16	0.132	17	0.126	17
PT	0.114	13	0.115	13	0.112	14	0.107	13
SE	0.027	2	0.023	2	0.024	2	0.022	2
SI	0.081	11	0.085	12	0.086	12	0.088	11
SK	0.141	14	0.119	15	0.109	13	0.117	15
UK	0.043	6	0.038	5	0.039	5	0.037	5

Source: our calculations based on EU-SILC 2009 longitudinal dataset.