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Multidimensional Poverty and Perceived Happiness: Evidence from China, Japan and Korea*

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We compare multidimensional poverty and its associations with perceived happiness in China, Japan and Korea. Using largely comparable nationwide survey data, we focus on multidimensional poverty in terms of income, schooling, health and social protection. We find multidimensional poverty to be more prevalent in China than in Japan or Korea; sex and age-based differences are largest in Korea. We further confirm significant associations between multidimensional poverty and perceived happiness. For all three countries, the aggregated poverty dimensions could largely identify unhappy individuals, with both wider coverage and higher odds than is possible through unidimensional analyses.

Keywords: China, Japan, Korea, multidimensional poverty, perceived happiness, subjective well-being.

JEL classification codes: I31, I32.

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I. Introduction

Over the past two decades, increased attention has been directed toward multidimensional aspects of poverty and their policy implications; Anand and Sen (1997); Atkinson (2003) and Tsui (2002), among others, initiated this movement. Poverty has traditionally been measured in terms of individual or household income, but it is now widely recognized that an individual's well-being or quality of life is determined also by other poverty dimensions. Nonetheless, most empirical studies on multidimensional poverty have focused on data from Europe, the

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USA or developing countries (e.g. Whelan *et al.,* 2002; Dewilde, 2004; Waglé, 2005, 2008; Battiston *et al.,* 2013; Alkire and Santos, 2014). Moreover, associations between multidimensional poverty and subjective well-being have been insufficiently studied. In the current study, we compare multidimensional poverty and its associations with perceived happiness, a key element of subjective well-being, in three major Asian countries; namely, China, Japan and Korea.

The concept of multidimensional poverty stems from Sen's (1999) capabilities theory. Sen defines 'functionings' as the various states of human existence and activity that an individual can undertake; 'capabilities', on the other hand, are defined as an individual's freedoms or opportunities to choose from among the various combinations of functionings that he or she has reason to value. In this context, 'poverty' is defined as a lack of freedom due to the deprivation of capabilities; accordingly, it is multidimensional in nature. Deprivation of income captures just one aspect of poverty, and capabilities can be hindered by deprivations in other dimensions, such as health, education, housing and social support.

Many studies have attempted to operationalize this concept of multidimensional poverty (e.g. Bourguignon and Chakravarty, 2003; Deutsch and Silber, 2005). One well-established methodology is the dual-cutoff approach, which was established by Alkire and Foster (2011) and Alkire and Santos (2013). In the first stage of this approach, an individual is considered deprived in terms of each poverty dimension if he or she fails to satisfy a certain cutoff value in that poverty dimension. In the second stage, an individual is considered multidimensionally poor if the total number of deprivations is greater than or equal to a certain cutoff value at the aggregate level. Table 1 illustrates this approach in the case of four poverty dimensions; here, 'poverty' is defined as deprivation in at least two poverty dimensions. In this table, individuals 2 and 4 are considered to be in multidimensional poverty.

Some studies examine the multidimensional aspects of poverty in developed European countries and the USA, while reflecting on socioeconomic and

Table 1 Illustration of the dual cutoff approach: A case of three poverty dimensions and poverty defined as deprived in at least two poverty dimensions

	Poverty dimension				*Total count of deprivations*	*Poverty*
	1	*2*	*3*	*4*		
Individual 1	ND	ND	D	ND	1 [<2]	
Individual 2	D	D	ND	ND	2 [≥2]	✔
Individual 3	ND	ND	ND	ND	0 [<2]	
Individual 4	D	D	D	D	4 [≥2]	✔

Note: ND and D indicate 'not deprived' and 'deprived', respectively, evaluated by a certain cutoff for each poverty dimension. Poverty is defined as deprived in at least two dimensions in this case.

institutional backgrounds (Whelan *et al.,* 2002; Dewilde, 2004; Waglé, 2005, 2008). These empirical analyses generally argue that examinations of multidimensional poverty can capture poverty in a more comprehensive manner than is possible when the focus is solely on unidimensional aspects.

Following these previous studies, the current study has two purposes. First, it attempts to investigate what multidimensional poverty looks like in China, Japan and Korea. According to the latest OECD (2014) dataset, in 2012, the relative poverty rate (i.e. the headcount rate of individuals with an income 50 percent lower than the median income) was 16.1 percent in Japan and 14.6 percent in Korea; these numbers are well above the OECD average in 2010–2012 of approximately 11 percent. For China, Zhang *et al.* (2014) show that the national poverty rate in 2009 was approximately 12.5 percent when using the $1.25-per-day poverty threshold, and 16.8 percent when using the $1.50-per-day poverty threshold; their argument is that official estimations underestimate the prevalence of poverty in China. It is difficult to compare income poverty among three countries, especially because to the best of our knowledge, the relative poverty rate for China is unavailable. Moreover, cross-country studies of poverty dimensions other than income have been sparse in Asia. We compare multidimensional poverty among three major Asian countries using data from their nationwide surveys.

Second, and more importantly, we examine how multidimensional poverty is associated with perceived happiness; this is an area that has remained relatively unstudied. It is reasonable to argue that poverty negatively correlates with an individual's subjective well-being, given that poverty, as per Sen's (1999) capabilities theory, is defined as a lack of freedom due to the deprivation of capabilities. Callander *et al.* (2013) found a negative correlation between multidimensional poverty and chronic health issues. Given that a strong association between health and subjective well-being has been observed in several studies (e.g. Chida and Steptoe, 2008; Steptoe *et al.,* 2015), it is reasonable to predict that multidimensional poverty is associated with perceived happiness or other aspects of subjective well-being.

Our transnational study assesses the relevance and validity of multidimensional poverty under a variety of socio-institutional backgrounds, across three countries, considering that these countries appear to have substantial differences in socio-institutional background, including labor market setup, social policies and social and familial structures. We focus on four specific poverty dimensions; namely, income, schooling, health and social protection. Although it is reasonable to predict that each of these poverty dimensions closely relates to perceived happiness, we examine whether and to what extent their combinations identify those individuals who feel unhappy, compared to measures that use individual dimensions. To the best of our knowledge, the current study is one of the first attempts at a transnational analysis of the associations between multidimensional poverty and perceived happiness, while using micro-level data that are generally comparable across countries.

II. Data

II.1. Study sample

The empirical analysis in the current study is based on micro-level data collected from large-scale nationwide surveys in China, Japan and Korea (i.e. the Chinese, Japanese and Korean General Social Surveys (CGSS, JGSS and KGSS, respectively)) that were conducted in 2010 and whose data are made available through the Interuniversity Consortium for Political and Social Research. These three survey datasets provide a comprehensive collection of information about respondents' demographic information, socioeconomic status and other aspects. They were designed almost uniformly and have common questionnaires, having been based on the framework of the General Social Survey conducted by the National Opinion Research Center at the University of Chicago; these features make the surveys and their data largely comparable with each other. The sample size (response rate) was 3866 (72.0 percent), 2496 (62.1 percent) and 1576 (63.0 percent) for the CGSS, JGSS and KGSS, respectively. We exclude students and those records with missing key variables, such as income; as a result, there are 3272 (China), 1743 (Japan) and 1336 (Korea) respondents in our full sample.

2.2. Poverty variables

In accordance with previous studies, we consider four poverty dimensions: income, schooling, health and social protection (Dewilde, 2004; Waglé, 2005, 2008; Alkire and Foster, 2011; Callander *et al.,* 2013). First, income is a key socioeconomic determinant of perceived happiness, as its presence expands an individual's opportunity set and thereby enhances his or her living standards (Frey and Stutzer, 2002); the implication is that income deprivation is likely to have a negative association with perceived happiness. We use respondents' household income (something for which both the CGSS and KGSS capture actual values), while JGSS provides category values; we use the median value of each category, for simplicity. We equivalize family income figures by dividing each figure by the square root of the number of family members, in line with the methodology applied by the OECD (2011). Next, we set the poverty line at 50 percent of the median of the equivalized income for each country, following the conventional definition employed by the OECD (2011). Then, if the respondent's equivalized household income is below the poverty line, he or she is considered poor in terms of household income.

Second, we consider each respondent's years of schooling. We consider a respondent deprived of schooling if his or her number of years of schooling is below the lowest quartile for his or her age group (i.e. 20s, 30s, 40s, 50s, 60s, 70s, 80s and above) in each country, in consideration of these three countries' different education systems and their histories.

Third, health is also expected to have a close association with perceived happiness, given the results of previous studies that examined the association

between health and subjective well-being (see Section I). Using a license obtained from the University of Sheffield, we utilize the widely used measure of Short Form 6D (SF-6D), which is derived from responses to the SF-12 questionnaire (Brazier and Roberts, 2004). Based on the respondents' self-assessments on six dimensions of health, we construct SF-6D scores and consider an individual as being in poor health when his or her score is below the lowest quartile for that respondent's age group (i.e. 20s, 30s, 40s, 50s, 60s, 70s, 80s and above) in each country.

Finally, we consider social protection. We focus on respondents' answers regarding health insurance coverage, which can be considered a reliable proxy of social protection (e.g. Alkire and Foster, 2011). Social protection can reduce the cost of risk management, and it, thus, represents the *ex ante* odds of being in poverty. Hence, insufficient social protection is likely to expose individuals more to social risks, thereby making them less happy.

In theory, all citizens in Japan and Korea are covered by public health insurance, while the population coverage of public health programs in China has been rapidly increasing. However, Ikegami *et al.* (2011) stress the emerging issue of the uninsured population in Japan, reflecting in particular an increase in recent decades in the number of temporary and part-time employees. The limited coverage issue has not been fully resolved in China (especially in rural areas) or Korea (especially among self-employed workers) (Jeong and Niki, 2012; Yang, 2013). In the current study, we construct a binary variable for a lack of health insurance, where a value of 1 is assigned to those who answered through the survey that they were not covered by health insurance, either public or private.

It is noteworthy that the cutoff points of deprivation in schooling and health are chosen arbitrarily; deprivation in both these dimensions is defined by the lowest quartile in the distribution of each measure. We consider two alternative cases in assessing the robustness of the estimation results, in which cutoff points of deprivation in both schooling and health are defined by the lowest quintile (case A) and lowest tertile (case B), in addition to the base case. Case A considers how the results are affected by a widened coverage of multidimensional poverty, while case B considers the response to its narrowed coverage. We find almost no change in the general results in these two alternative cases; therefore, to conserve space we present only the results of the base case. However, the complete results of cases A and B and their comparisons with the base case are obtainable from the authors upon request.

We construct multidimensional poverty measures based on the four aforementioned poverty dimensions (1 = household income, 2 = schooling, 3 = health and 4 = social protection). In applying a dual-cutoff approach, $D(\ )$ denotes, in parentheses, the number of deprivations from among the poverty dimensions. We consider an individual multidimensionally poor if $D(\ )$ is higher than a certain cutoff point, k, at the aggregate level. For example, $D(1, 2, 3, 4) \geq 2$ indicates that an individual is deprived in at least two of the four dimensions, and $D(2, 3) = 2$ indicates an individual deprived in dimensions 2 and 3. There are 32 types of

multidimensional poverty in total, including four types of unidimensional poverty (e.g.D (1) = 1). A higher cutoff value k corresponds to a greater number of overlapping poverty dimensions.

It is necessary to define the 'union' and 'intersection' of poverty dimensions. The union of two dimensions, say 1 and 2, is a set of individuals who are deprived in either dimension 1 or 2, or both 1 and 2. This union is expressed by D (1, 2) ≥ 1 in this study. The intersection of dimensions 1 and 2 is a set of individuals who are deprived in both dimensions 1 and 2, and expressed by D (1, 2) = 2. We can apply these definitions to cases of more than two dimensions, such as D (1, 2, 3) ≥ 1 and D (1, 2, 3) = 3. However, we use the term 'intersection' in a broader sense than its conventional definition. For instance, consider D (1, 2, 3) ≥ 2, which includes individuals deprived in at least two dimensions among 1, 2 and 3. We consider this a kind of intersection of these three dimensions, although it includes a broader set of individuals than the conventionally defined intersection D (1, 2, 3) = 3, which covers individuals deprived in all three dimensions. Based on this broader definition of intersection, a higher cutoff value k corresponds to a greater number of overlapping poverty dimensions, while $k = 1$ indicates their union.

II.3. Perceived unhappiness

The CGSS asks respondents to answer the question, 'Generally speaking, do you think your life is happy or not?', using a five-point Likert scale anchored by 1 = very unhappy and 5 = very happy. The JGSS asks, 'In general, are you happy?', and the KGSS asks, 'If you were to consider your life in general these days, how happy or unhappy would you say you are, on the whole?'; both are answered on five-point scales (anchored by 1 = very happy and 5 = very unhappy). After reversing the order of responses in China, we first consider a five-point-scale variable of perceived unhappiness: we use unhappiness rather than happiness as a dependent variable, to facilitate assessments of an association with poverty in terms of the odds ratio (OR). The more an OR exceeds 1, the more closely unhappiness is associated with poverty.

In estimating ordered logistic regression models to predict perceived unhappiness (discussed later in Subsection III.3), we use a three-point-scale generated by condensing the original five-point-scale variable into (1 and 2), 3, and (4 and 5). We do so because when we use variables from the original five-point scale, the proportional odds assumption (which is required to obtain consistent estimates in ordered logit models) is violated in 75 of the 96 models estimated across the three countries (see Subsection III.1); this likely reflects the skewness of the distributions of the responses along the five-point scale. When we use the three-point scale, the number of models that violate the proportional odds assumption substantially declines, to 18. Nonetheless, caution must be exercised in interpreting estimation results.

III. Method

III.1. General strategy

One problem inherent in empirical studies of multidimensional poverty is that there is no rigorous theory to advise on choices of poverty dimensions and how to combine them into a multidimensional poverty measure. In the current study, we explore which type of multidimensional poverty is most effective in identifying individuals who feel unhappy; this is done by comparing various types of multidimensional poverty. This would substitute for searching for appropriate weights to be placed on poverty dimensions based on associations with perceived unhappiness.

In this analysis, we are likely to face a tradeoff between the coverage of multidimensional poverty and the odds of perceived unhappiness; a wider coverage of poverty may lead to lower odds of perceived unhappiness among those who are considered poor. In contrast, pursuing overly high odds of perceived unhappiness may lead to an overly limited coverage of poverty. We explicitly address this potential tradeoff and explore practically relevant types of multidimensional poverty under its constraints.

In descriptive and regression analyses, we use sampling weights. The CGSS and JGSS datasets provide them for China and Japan, respectively; for Korea, we construct sampling weights based on the country's age and sex structure, as weights are not available from the KGSS dataset.

3.2. Descriptive analysis

We first calculate the headcount ratio, H, for each multidimensional poverty variable; this is done by counting the number of respondents with a number of deprivations in the poverty dimensions above a certain cutoff point, at the aggregate level. This headcount ratio, albeit intuitively understandable and straightforward, bears a conceptual weakness: even if a (multidimensionally) poor respondent becomes newly poor in an additional dimension, the headcount ratio will remain the same. Hence, we consider the adjusted headcount ratio, M_0, as a product of the headcount ratio and the average deprivation share among the poor respondents (i.e. the average extent of a poor respondent's deprivation).

Specifically, the headcount ratio H, and the adjusted headcount ratioM_0, for k-dimensional poverty are defined as follows (Alkire and Foster, 2011). Suppose that there are N individuals and D dimensions in poverty. Individual i is defined as k-dimensionally deprived if he or she is deprived in k or more dimensions ($i = 1, \ldots, N$; $k = 1, \ldots, D$). Furthermore, suppose that the number of k-dimensionally deprived individuals is equal to M. Then, the headcount ratio H is computed as the proportion of such individuals in the population; that is, $H = M/N$. Next, for each k-dimensionally deprived individual, we define the deprivation share A_i, which is the ratio of the number of dimensions in which he or

she is deprived to the number of dimensions (D). Then, we compute the average of the deprivation share A_i among M individuals who are k-dimensionally deprived, and denote it by A. The adjusted headcount ratio M_0 is computed as a product of the headcount ratio H, and the average deprivation share A; that is, $M_0 = HA$.

In this study, we calculate the headcount ratios and their adjusted values for $k = 1$, 2, 3 and 4, using all four poverty dimensions. A higher k value is expected to result in a lower headcount ratio. We also calculate the contribution of each dimension to multidimensional poverty; this is done by calculating the ratio of the respondents deprived in each dimension to all those in multidimensional poverty, in the case of $k = 2$. Decomposing multidimensional poverty can help assess the relative importance of each poverty dimension. Finally, we compare multidimensional poverty by sex and age (that is to say, young (aged 59 or below) and old (aged 60 or above)) to determine the country-specific features of multidimensional poverty.

III.3. Regression analysis

In our regression analysis, we estimate logistic regression models to predict perceived unhappiness by multidimensional poverty, along with covariates (sex, age and marital status). Regarding multidimensional poverty, we consider 32 types of poverty in total (including four unidimensional types). Based on the estimation results, we assess the analytical effectiveness of multidimensional poverty.

First, we exclude the types of poverty that cover less than 1 percent of the entire sample, and/or are not significantly associated with perceived unhappiness. The lower bound of the coverage, 1 percent, is arbitrarily given, but increasing it to a somewhat higher level (say, 3 or 5 percent) does not affect the overall results.

Then, we consider a type of poverty an effective predictor of perceived unhappiness if no other type of poverty covers more individuals in poverty and has a higher OR of perceived unhappiness. For example, suppose that poverty defined by $D\,(1, 2, 3) \geq 1$ covers 10 percent of the entire sample with an OR of perceived unhappiness of 2.0. If poverty defined by $D\,(1, 2, 4) \geq 1$ covers 20 percent of the entire sample and with an OR of 3.0, then poverty defined by $D\,(1, 2, 3) \geq 1$ is considered ineffective, as it covers a smaller proportion of the entire sample and with a lower OR of perceived unhappiness than that defined by $D\,(1, 2, 4) \geq 1$. The analytical effectiveness of the latter type of poverty should be assessed by undertaking comparisons with other types of poverty.

In all the regression models, we control for sex, age (20s, 30s, 40s, 50s, 60s, 70s, and 80s or above) and marital status (married (including cohabitation), unmarried, and divorced or widowed) as covariates. These factors have been found in other studies to be associated with perceived happiness, including Tesch-Römer *et al.* (2008) for sex, Easterlin (2006) for age, and Stutzer and Frey (2006) for marital status.

IV. Results

IV.1. Descriptive analysis

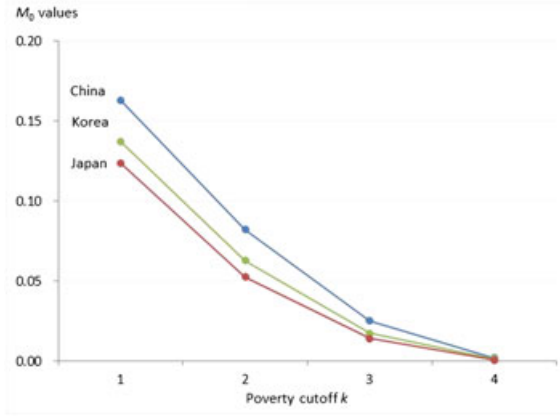
Table 2 summarizes the headcount ratios of unidimensional and multidimensional poverty for the three study countries. Regarding unidimensional poverty, income deprivation is almost the same between China and Korea, and it is lowest in Japan. However, in Korea, the income deprivation (18.3 percent) was much higher than the OECD's estimate of the relative poverty rate in 2012 (14.6 percent), suggesting that the Korean dataset (KGSS) sample used in the current study was biased toward the lower end of income distribution and not uniform at the national level. Hence, caution is recommended when comparing the levels of income-related poverty measures across these three countries. Turning to dimensions other than income, deprivation in terms of social protection and schooling are the highest in China. Health deprivation is in the range of 20.2–23.7 percent, reflecting its definition that relates to the lowest quartile of SF-6D scores in each country.

Regarding multidimensional poverty, in all three countries, the headcount ratio declines substantially with an increase in the cutoff point, from 1 to 4: a cutoff point of 4 ($k=4$) drives the coverage down to as low as 0.1–0.2 percent. This indicates that unions of poverty dimensions reduce the coverage of individuals in poverty. Among the three study countries, China's headcount ratios were highest at all cutoff point levels, followed by those of Korea and then Japan. Even after adjusting for deprivation intensity, we observe similar results. Figure 1 illustrates the results of the adjusted headcount ratios at different cutoff

Table 2 Headcount ratios of unidimensional and multidimensional poverty

	China	*Japan*	*Korea*
Unidimensional poverty			
Headcount ratio (H)			
Income	0.216	0.159	0.183
Schooling	0.124	0.095	0.110
Health	0.222	0.202	0.237
Social protection	0.110	0.027	0.058
Multidimensional poverty: $D\ (1, 2, 3, 4) \geq k$			
Headcount ratio (H)			
$k=1$	0.483	0.372	0.431
$k=2$	0.152	0.093	0.126
$k=3$	0.035	0.016	0.027
$k=4$	0.002	0.001	0.003
Adjusted headcount ratio (M_0)			
$k=1$	0.163	0.124	0.137
$k=2$	0.082	0.053	0.063
$k=3$	0.025	0.014	0.017
$k=4$	0.002	0.001	0.001
Observations (n)	3,272	1,743	1,336

Figure 1 Adjusted headcount ratios (M_0) of multidimensional poverty based on the results shown in Table 2



point levels ($k = 1$–4); it shows clear downward curves that converge to nearly zero at $k = 4$ for all three countries.

Table 3 compares the contribution of each poverty dimension to multidimensional poverty in the case of $k = 2$, for all three countries. Figures indicate the share of individuals who were both multidimensionally poor and were deprived in each dimension of the entire sample. Figures in parentheses indicate the percentage contribution of each poverty dimension to multidimensional poverty. The adjusted headcount ratio, which is given at the bottom of the table and reproduced from the middle part of Table 1, is equivalent to the average of these proportions.

Based on these calculations, the figures in parentheses are the percentage contribution of each dimension to multidimensional poverty. As seen in this table, each of income and health deprivations account for around one-third of multidimensional poverty, underscoring their dominant roles therein. Compared to these

Table 3 Contribution of each poverty dimension to multidimensional poverty evaluated at $k = 2$

	China	*Japan*	*Korea*
1. Income	0.110 (33.3%)	0.079 (37.6%)	0.085 (33.9%)
2. Schooling	0.068 (20.7%)	0.052 (24.5%)	0.048 (19.0%)
3. Health	0.102 (31.0%)	0.065 (30.8%)	0.089 (35.4%)
4. Social protection	0.049 (14.9%)	0.015 (7.1%)	0.029 (11.6%)
Adjusted headcount ratio (M_0)	0.082 (100%)	0.053 (100%)	0.063 (100%)

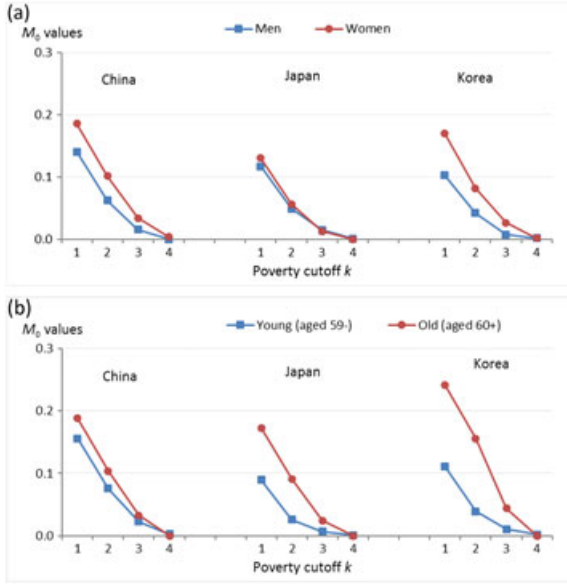
Note: Figures indicate the shares of individuals who were both multidimensionally poor and deprived in each dimension out of the entire sample. Figures in parentheses indicate percentage contributions of each poverty dimension to multidimensional poverty.

two dimensions, schooling and social protections make smaller contributions in all three countries.

Figure 2 compares the adjusted headcount ratios by sex (top panel) and age (bottom). We first find that in Korea and China, women face multidimensional poverty much more frequently than do men. This trend is not evident in Japan. We decompose the difference between the sexes into poverty dimensions and calculate their contributions, as in Table 2, although we do not report the full results, in order to conserve space (these results are available upon request to the authors). According to this decomposition (evaluated at $k=2$), a substantial portion of the difference between men and women in China can be attributed to schooling (40.0 percent) and health (36.7 percent), whereas in Korea, health (38.4 percent) and income (37.7 percent) are the two largest contributors to the difference between the sexes. In Japan, meanwhile, the contributions from the four dimensions roughly offset each other.

Regarding differences between younger (aged 59 or below) and older (aged 60 and above) individuals, we first find that all three countries show a higher prevalence of poverty among the elderly. This age-based difference is largest in Korea, followed by Japan and then China. Income deprivation is a key contributor to the differences among all three countries, explaining 40.2–48.0 percent of the difference. Income deprivation among older individuals is most remarkable in Korea, where it produces the largest difference between the age groups there.

Figure 2 Adjusted headcount ratios of multidimensional poverty by (a) sex and (b) age



4.2. Regression analysis

Table 4 presents the estimated results that we obtain from applying separate estimated logistic regression models for China, after controlling for covariates (i.e. sex, age and marital status). The second column indicates the proportion of individuals in the entire sample considered to be in poverty. The third and fourth

Table 4 Estimated associations between different types of poverty and perceived unhappiness in China

Type of poverty likelihood	*Proportion (%)*	*OR*	*95% CI*	*Effectiveness*	*Log*
$D\ (1, 2, 3, 4) \geq 1$	48.3	2.78	(2.32, 3.33)	Effective	−2405.04 [4]
$D\ (1, 3, 4) \geq 1$	43.0	2.81	(2.35, 3.37)	Effective	−2401.61 [3]
$D\ (1, 2, 3) \geq 1$	42.6	2.86	(2.38, 3.43)	Effective	−2400.03 [2]
$D\ (2, 3, 4) \geq 1$	37.8	2.52	(2.10, 3.03)		−2420.89
$D\ (1, 2, 4) \geq 1$	36.8	2.18	(1.82, 2.61)		−2439.45
$D\ (1, 3) \geq 1$	36.6	2.95	(2.46, 3.54)	Effective	−2395.95 [1]
$D\ (3, 4) \geq 1$	30.6	2.74	(2.27, 3.31)		−2412.05
$D\ (2, 3) \geq 1$	30.4	2.58	(2.13, 3.12)		−2423.35
$D\ (1, 2) \geq 1$	29.8	2.26	(1.86, 2.74)		−2439.42
$D\ (1, 4) \geq 1$	29.5	2.24	(1.86, 2.70)		−2439.43
$D\ (3) = 1$	22.2	2.92	(2.38, 3.59)		−2415.22
$D\ (2, 4) \geq 1$	22.0	1.74	(1.40, 2.15)		−2469.40
$D\ (1) = 1$	21.6	2.45	(1.99, 3.02)		−2437.25
$D\ (1, 2, 3, 4) \geq 2$	15.2	3.23	(2.53, 4.12)	Effective	−2421.28 [6]
$D\ (2) = 1$	12.4	1.51	(1.12, 2.04)		−2481.30
$D\ (1, 2, 3) \geq 2$	11.7	3.04	(2.31, 4.01)		−2438.99
$D\ (4) = 1$	11.0	1.88	(1.44, 2.45)		−2473.14
$D\ (1, 3, 4) \geq 2$	10.6	3.99	(3.01, 5.30)	Effective	−2415.37 [5]
$D\ (1, 2, 4) \geq 2$	7.7	2.74	(1.96, 3.83)		−2460.27
$D\ (2, 3, 4) \geq 2$	7.4	3.14	(2.24, 4.42)		−2453.10
$D\ (1, 3) = 2$	7.1	4.07	(2.90, 5.72)	Effective	−2434.52 [7]
$D\ (2, 3) = 2$	4.2	2.49	(1.57, 3.96)		−2474.86
$D\ (1, 2) = 2$	4.2	2.08	(1.31, 3.29)		−2479.27
$D\ (1, 2, 3, 4) \geq 3$	3.5	4.20	(2.56, 6.88)	Effective	−2459.27 [9]
$D\ (1, 4) = 2$	3.1	4.53	(2.84, 7.22)	Effective	−2458.76 [8]
$D\ (3, 4) = 2$	2.7	3.78	(2.32, 6.17)		−2467.87
$D\ (1, 2, 3) = 3$	1.9	3.57	(1.80, 7.07)		−2475.49
$D\ (2, 4) = 2$	1.4	2.57	(1.05, 6.28)		−2482.68
$D\ (1, 3, 4) = 3$	1.1	6.50	(3.25, 13.0)	Effective	−2469.57 [10]
$D\ (1, 2, 4) = 3$	0.5	—			
$D\ (2, 3, 4) = 3$	0.4	—			
$D\ (1, 2, 3, 4) = 4$	0.2	—			

Note: OR indicate the estimated odds ratios of perceived unhappiness obtained from the ordered logistic regression models predicting perceived unhappiness from poverty and covariates (sex, age, and marital status). *D* denotes the number of deprivations on the dimensions in the subsequent parentheses, where 1 = income, 2 = schooling, 3 = health and 4 = social protection. Figures in brackets indicate the rank order of likelihood of predicting perceived unhappiness among the effective types of poverty.

columns report the odds ratios (OR) of perceived unhappiness for each type of poverty and their 95 percent confidence intervals (CI), respectively. The fifth column indicates whether the poverty type is effective. Finally, the sixth column shows the (pseudo) log likelihood values of the regression model, with their ranking order among the effective types of poverty in brackets. The results are reported in descending order of the proportion of individuals in poverty, which tends to decline with a higher cutoff point at the aggregate level. As mentioned, we remove from the regression analysis three poverty types with coverage lower than 1 percent (see the bottom of the table).

The association between poverty and perceived unhappiness, measured in terms of OR, is highly significant for all definitions of poverty ($p < 0.001$ for all). Meanwhile, increasing the cutoff point at the aggregate level (i.e. defining multidimensional poverty as a higher intersection of poverty dimensions) tends to increase the OR. In addition, increasing the cutoff points to greater than 1 considerably reduces the proportion of individuals considered to be in poverty.

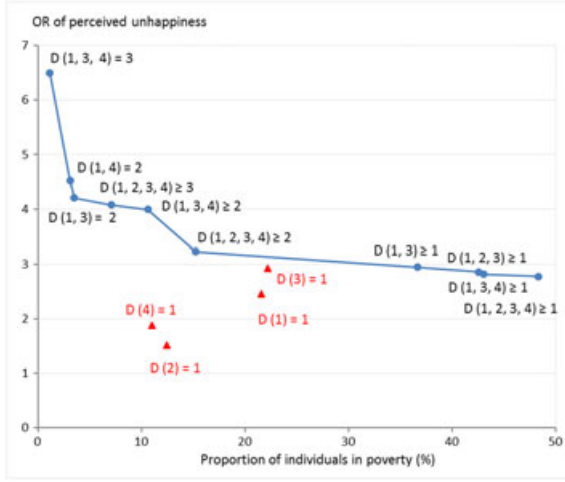
Another focus is the analytical effectiveness of multidimensional poverty. As mentioned, we consider a type of poverty an effective predictor of perceived unhappiness if no other type of poverty covers more individuals in poverty and has a higher OR of perceived unhappiness. In applying this definition, we find that 10 types of poverty are effective; we also find that no type of unidimensional poverty is effective.

It is difficult to determine which type among the 10 effective types of poverty is most appropriate for predicting perceived unhappiness. If we wanted to identify individuals who face the highest risk of perceived unhappiness, then the most appropriate poverty indicator would be $D\ (1, 3, 4) = 3$, which has the highest OR (6.50); however, this indicator covers only 1.1 percent of the total population. In contrast, if we wanted to identify unhappy individuals as widely as possible, then $D\ (1, 2, 3, 4) \geq 1$ would be most appropriate, as it covers 48.3 percent of the population with a relatively high OR (2.78). Under this tradeoff, the likelihood of predicting perceived unhappiness declines with either wider coverage or higher cutoff points. However, the likelihood was higher for unions of poverty dimensions ((1)–(4)) than it was for their intersections ((5)–(10)), indicating the superiority of the former in terms of its association with perceived unhappiness.

Based on the results in Table 4, Figure 3 depicts the ‘effective poverty curve’, which plots a combination of the coverage of individuals in poverty and the OR of perceived unhappiness for each of the 10 types of poverty that effectively predict perceived unhappiness. The effective poverty curve has a downward slope, reflecting the tradeoff between the coverage of individuals in poverty and the OR of perceived unhappiness. As a reference, we add four dots that correspond to unidimensional poverty; namely, $D\ (1) = 1$, $D\ (2) = 1$, $D\ (3) = 1$ and $D\ (4) = 1$.

The figure indicates that the four dots that correspond to unidimensional poverty lie below the effective poverty line, suggesting that unidimensional poverty is generally ineffective in identifying unhappy individuals. However, we cannot conclude that unidimensional poverty is completely ineffective. Table 4 shows

Figure 3 The effective poverty curve for perceived unhappiness in China



that the 95 percent CI of the OR for $D(3)=1$ is (2.38, 3.59), indicating that there is a possibility that the dot of $D(3)=1$ could be located on the effective poverty curve at the 5-percent significance level.

It is not easy to choose among multidimensional poverty measures located on the effective poverty curve. However, comparisons with unidimensional poverty measures are practically helpful. The poverty types located in the upper-left (which reflect higher intersections of poverty dimensions) have higher OR but exhibit much more limited coverage than unidimensional poverty measures, making their superiority ambiguous. In contrast, poverty types located in the lower right (which correspond to unions of poverty dimensions) have both much wider coverage and a higher OR, or limited reduction from individual unidimensional poverty measures. Thus, we can argue that with respect to the case of China, unions of poverty dimensions are generally more useful in identifying unhappy individuals than are intersections.

Table 5 presents the results for Japan and Korea. It reports only the results for the effective types of poverty, all of which are highly associated with perceived unhappiness ($p<0.001$, except for $D(1, 2, 3)=3$ in Korea ($p<0.01$)). The data in this table reveal patterns almost identical to those seen in Table 4. Increasing the cutoff point at the aggregate level tends to increase the OR and reduce the coverage. The likelihood of predicting perceived unhappiness is generally higher for unions of poverty dimensions than for intersections; one noteworthy exception is that unidimensional poverty defined by $D(3)=1$ is effective in both Japan and Korea.

Figures 4 and 5 show the effective poverty curves of Japan and Korea, respectively. Japan's curve as seen in Figure 4 is very similar to China's curve in Figure 3; meanwhile, unlike in China, the dot for health deprivation, $D(3)=1$,

Table 5 Estimated associations between multidimensional poverty and perceived unhappiness in Japan and Korea

Type of poverty	*Proportion (%)*	*OR*	*95% CI*	*Log likelihood*
Japan				
$D(1, 2, 3, 4) \geq 1$	37.2	2.29	(1.86, 2.82)	−1388.04 [6]
$D(1, 2, 3) \geq 1$	36.1	2.35	(1.91, 2.90)	−1386.39 [4]
$D(1, 3) \geq 1$	31.4	2.38	(1.92, 2.96)	−1386.98 [5]
$D(2, 3, 4) \geq 1$	29.1	2.52	(2.03, 3.13)	−1383.12 [3]
$D(3, 4) \geq 1$	22.0	2.86	(2.24, 3.65)	−1379.85 [1]
$D(3) = 1$	20.2	2.88	(2.25, 3.68)	−1381.26 [2]
$D(1, 3, 4) \geq 2$	5.8	3.24	(2.12, 4.97)	−1403.08 [7]
$D(1, 2, 3, 4) \geq 3$	1.6	4.18	(2.22, 7.84)	−1411.08 [8]
$D(1, 2, 3) = 3$	1.1	5.43	(2.62, 11.3)	−1411.11 [9]
Korea				
$D(1, 2, 3, 4) \geq 1$	43.1	2.60	(2.00, 3.38)	–1729.65 [6]
$D(1, 3, 4) \geq 1$	37.6	2.88	(2.20, 3.76)	–1723.27 [5]
$D(2, 3, 4) \geq 1$	34.3	2.90	(2.22, 3.79)	–1718.14 [4]
$D(2, 3) \geq 1$	30.9	3.01	(2.27, 3.98)	–1717.48 [3]
$D(3, 4) \geq 1$	27.4	3.46	(2.60, 4.61)	–1707.39 [2]
$D(3) = 1$	23.7	3.68	(2.71, 5.00)	–1706.62 [1]
$D(1, 3, 4) \geq 2$	9.0	4.14	(2.64, 6.50)	–1743.57 [7]
$D(1, 3) = 2$	6.6	4.42	(2.62, 7.37)	–1748.36 [8]
$D(1, 2, 3) = 3$	1.5	5.04	(1.74, 14.6)	–1768.99 [9]

Note: See notes in Table 4. Only the results for the effective types of poverty are reported.

Figure 4 The effective poverty curve for perceived unhappiness in Japan

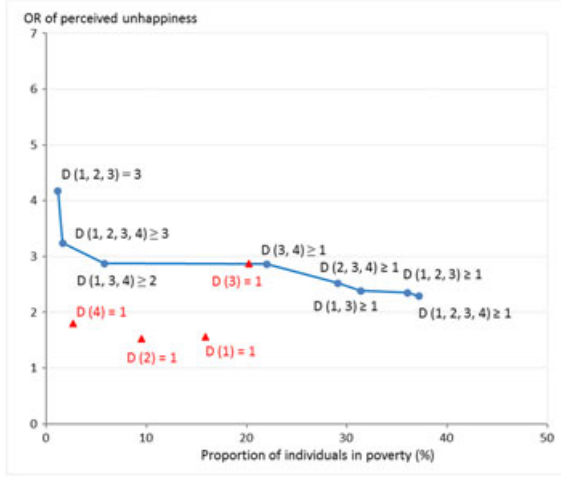
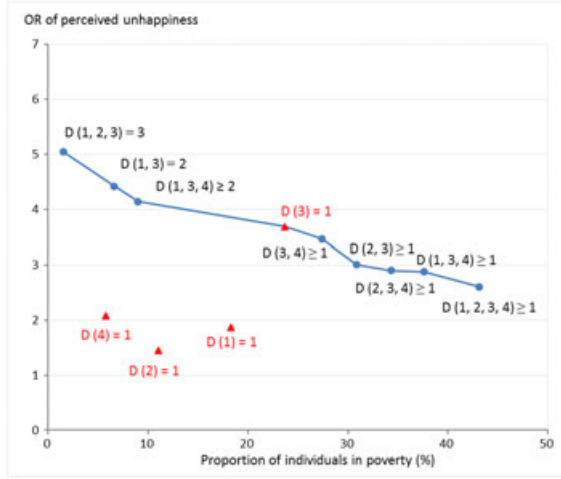


Figure 5 The effective poverty curve for perceived unhappiness in Korea



is located on the effective poverty curve. However, by considering other deprivation dimensions in conjunction with health, one can identify unhappy individuals with wider coverage and a limited loss in the OR. Meanwhile, the intersections of poverty dimensions increase the OR, but they lead to a substantial reduction in coverage; this reduces their practical utility. The intersections have both wider coverage and higher odds than the three measures of unidimensional poverty other than health deprivation.

Korea's effective poverty curve in Figure 5 has no spike in the upper left, where the intersections are located. Like in Japan, the dot for health deprivation, D (3) = 1, is located on the effective poverty curve, but its unions with other dimensions can capture unhappy individuals with a limited loss in the OR. The intersections, which are located in the upper left, have higher OR but lower coverage than unidimensional poverty; this reduces the analytical attractiveness of these types of multidimensional poverty.

V. Discussion

Thus far, we have examined multidimensional poverty and its associations with perceived happiness in China, Japan and Korea, using largely comparable nationwide survey data from these countries. To construct multidimensional poverty measures, we focused on four poverty dimensions (i.e. income, schooling, health and social protection) and utilized the dual-cutoff approach (Alkire and Foster, 2011; Alkire and Santos, 2013). Our major findings and their implications are summarized below.

First, the results of our descriptive analysis demonstrate the similarities and differences in multidimensional poverty across the three countries studied. With an

increase in the cutoff point at the aggregate level (in other words, at a higher level of intersection of poverty dimensions) the headcount rates decline sharply; this is a pattern commonly observed across all three countries. This suggests that an overly high intersection of poverty dimensions may reduce the analytical validity of multidimensional poverty.

Regarding transnational differences, we find that the headcount ratios (both unadjusted and adjusted for the intensity of deprivation) are highest in China, followed by Korea and then Japan; this reflects Japan's relatively low levels of deprivation among the various poverty dimensions. By decomposing multidimensional poverty into a variety of dimensions, we find that deprivations in income and health are two dominant contributors to multidimensional poverty in all three countries. Meanwhile, deprivations in social protection make a greater contribution to poverty in China than in Japan or Korea; this probably reflects differences in social insurance systems among the three countries.

The results of our analysis also reveal transnational differences in sex and age-based patterns of multidimensional poverty. Women face multidimensional poverty much more than men do in Korea and China, but this trend does not hold in Japan. Meanwhile, the relative seriousness of poverty among older compared to younger individuals is more prominent in Korea and Japan than in China. These results suggest that the demographic characteristics of multidimensional poverty differ across countries, thus reflecting their respective socioeconomic and institutional contexts. Indeed, this is an issue that should be investigated in depth in future research.

Another novelty of the current study is that it examined the association between multidimensional poverty and perceived happiness. We explored what types of multidimensional poverty were effective in identifying individuals who felt unhappy, rather than allocating arbitrary weights to poverty dimensions. For all three countries, we first noticed that multidimensional poverty in the form of unions of poverty dimensions was generally more effective in identifying unhappiness than any unidimensional poverty, as multidimensional poverty identifies unhappy individuals with a wider coverage and at higher odds. These findings underscore the validity of multidimensional poverty as a predictor of perceived happiness: a reasonable result, given that perceived happiness (or subjective well-being, in general) also has multidimensional aspects.

Furthermore, the current study highlighted a tradeoff between the coverage of individuals in multidimensional poverty and the odds of perceived unhappiness. A higher cutoff point level at the aggregate level increases the odds of perceived unhappiness, but substantially reduces the coverage of individuals in multidimensional poverty. This reduces the practical utility of multidimensional poverty; it also makes its analytical effectiveness relative to that of unidimensional poverty less clear. These results imply that compared to unidimensional measures of poverty, unions rather than intersections of poverty dimensions can increase the relative analytical effectiveness of multidimensional poverty.

Despite these significant findings, the study has several limitations, in addition to the potential biases in the study samples of each country's survey. First, we

could not establish any causal relationships among the variables, as our analysis is based on cross-sectional data. It is reasonable to argue that poverty has a negative impact on subjective well-being, but we cannot overlook the fact that lower subjective well-being often leads to lower income and poorer health. Interactions among poverty variables should also be examined, although in our regression analysis they were exogenously given.

Second, in this study, we used only binary variables for all poverty dimensions; as such, they do not capture depth of poverty. For example, we defined an individual as being 'low income' if his or her household income was below the poverty line. This definition disregards differences in the degree of poverty among individuals whose incomes are below the poverty line (Alkire and Foster, 2011). The same problem applies for the dependent variable: we constructed binary variables for perceived unhappiness, to facilitate ease of interpretation of the results; however, their associations with multidimensional poverty would likely differ if we were to use different cutoff points or their original ordinal values.

Third, the mechanism that links multidimensional poverty and subjective well-being remains unknown. In line with Sen's (1999) capabilities theory, we focused on four poverty dimensions that, when they are in an adverse state, are expected to prevent an individual from enhancing his or her subjective well-being. However, we did not discuss the pathway between multidimensional poverty and subjective well-being. The observed differences in multidimensional poverty and its associations with perceived unhappiness across the study countries suggest that more detailed transnational comparisons could help us better understand the mechanism that links multidimensional poverty and subjective well-being.

VI. Conclusion

In all, the results of the current study indicate that investigations of multidimensional poverty can provide us with comprehensive information vis-à-vis poverty and its associations with perceived happiness. Notably, we found that, in most cases, unions of multiple poverty dimensions could pinpoint those individuals who felt unhappy, with both wider coverage and at higher odds than those available using unidimensional poverty dimensions. These findings are reasonable in general, given that this approach has its origins in Sen's (1999) capabilities theory. However, we should further refine the conceptual and methodological aspects of multidimensional poverty, in order to enhance its applicability to social and economic policies.

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