

Contribution of Natural and Economic Capital to Subjective Well-Being: Empirical Evidence from a Small-Scale Society in Kodagu (Karnataka), India

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Accepted: 29 April 2015 / Published online: 7 May 2015
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Abstract Subjective well-being is determined by several types of sources of satisfaction, defined as forms of capitals. Most of research has been focused on the links between economic capital and well-being, neglecting the contribution of other forms of capital as source of satisfaction. Here, we bring natural capital into the equation and explore the relations between economic and natural capital and subjective well-being. We approach well-being as a multidimensional concept and then focus on three of its dimensions: subsistence, security, and reproduction and care. Working with tribal communities from Kodagu (Karnataka, India), we found positive associations between economic and natural capital and subjective well-being. Nevertheless, the two types of capitals differed on their relative contribution to (a) overall subjective well-being and (b) the three selected dimensions. Natural capital can be more important than economic capital in fulfilling human well-being. Findings support ongoing calls for explicitly incorporating ecological assets and ecosystem services in the design of policies oriented to measure and improve well-being.

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Keywords Ecosystem services · Life satisfaction · Dimensions of human well-being · Human scale development · Western Ghats

1 Introduction

What factors contribute to human well-being? Answering this question is of paramount importance in the design of effective public policies that improve human well-being (Costanza et al. 2007; Diener and Suh 1997; Easterlin 2001a, b, 2003; Easterlin et al. 2010; Hagerty et al. 2001; Layard 2010; Max-Neef et al. 1993; Millennium Ecosystem Assessment 2003). For the last 30 years, most efforts to improve human well-being have concentrated on economic aspects, namely increasing income and creating wealth (Dolan et al. 2008). Consequently, most indexes policy makers use to assess well-being are based on economic indicators such as income and wealth (including the Genuine Progress Index, the Human Development Index, the Index of Economic Well-Being, and the International Living Index) (Hagerty et al. 2001). Nevertheless, research shows that, over time, economic growth does not necessarily results in larger increases of subjective well-being (Easterlin et al. 2010), which suggests that well-being is also dependant on other factors.

Since subjective well-being¹ responds to the satisfaction of multiple dimensions (Costanza et al. 2007), factors not accounted for in economic indicators might potentially play a pivotal role in explaining human well-being (Easterlin 2003; Easterlin et al. 2010; Max-Neef 1995; Kamitsis and Francis 2013; Reyes-García et al. 2015). The Human Scale Development (HSD) framework (Max-Neef et al. 1993) conceptualizes well-being as a construct that comprises different dimensions covering human needs. Similarly, and building on Max-Neef's work, Costanza et al. (2007) have argued that the human needs that determine an individual's well-being include subsistence, security, reproduction and care, affection, understanding, participation, leisure, spirituality, creativity, identity, and freedom (Costanza et al. 2007; Max-Neef et al. 1993). Dimensions of well-being can be fulfilled by different material and non-material elements, called satisfiers (Cruz et al. 2009; Max-Neef et al. 1993), that in turn come from different assets, often portrayed as distinct forms of capitals. Thus, in addition to economic capital—defined here as money or manufactured goods such as tools, equipment, buildings and technology—other forms of capital, such as social capital, human capital, and natural capital, can also provide satisfiers to fulfil the different dimensions of well-being (Costanza and Daly 1992; Costanza et al. 2007; Chiesura and de Groot 2003; Dodds 1997; Fenech et al. 2003; Victor 1991).

Furthermore, according to those scholars, issues such which dimensions of well-being are prioritized and what satisfiers are available to fulfil its different dimensions depend upon particular geographical conditions, cultures, and historical periods (Max-Neef et al. 1993; Rawls 1999). Since human well-being includes multiple dimensions and since satisfiers can vary from one society to another, it is not surprising that one single type of capital—economic capital—cannot fully explain the fulfilment of human well-being.

In this paper we explore a potential source of subjective well-being: natural capital, both by itself and in relation to economic capital. We define natural capital as the stock of goods

¹ We adopt the definition of subjective well-being as respondents' own assessments of their lived experiences in the form of self-reports of satisfaction, happiness, well-being or some other near-synonym.

and services provided by ecosystems to human societies (Costanza and Daly 1992). In the last two decades, several researchers (Costanza 2006; Costanza and Daly 1992; Costanza et al. 1997, 2007; Costanza and Farley 2007; Dolan et al. 2008; Ferrer-i-Carbonell and Gowdy 2007) and policy initiatives (Millennium Ecosystem Assessment 2003; TEEB 2010) have stressed the role of natural capital on well-being. This previous work has highlighted that natural capital might contribute to all dimensions of well-being, playing a major role in the fulfilment of the subsistence dimension of rural and low income societies with limited access to technology (Costanza et al. 2007; TEEB 2010), although few empirical research has been conducted on the topic.

The few previous empirical studies about the relation between well-being and natural versus economic capital conducted with indigenous populations provide contrasting results about the relative importance of both forms of capital in explaining well-being. For example, research conducted among an indigenous society in the Bolivian Amazon suggests that, in that society, economic factors are not central in determining subjective well-being, which might imply that subjective well-being is mainly dependant on other satisfiers (Masferrer-Dodas et al. 2012). Contrarily, in research among poor indigenous farmers from Peninsular Malaysia, Howell et al. (2006) found a positive association between economic indicators and subjective well-being. A recent global study of the relations between income and subjective well-being among non-WEIRD (Western, Educated, Industrialized, Rich, and Democratic) societies, including 294 rural or forest dweller villages in 23 countries from Africa, Asia and Latin America, has found that although absolute income does help explain subjective well-being in the developing world, other aspects such as social comparison have a larger explanatory power (Reyes-García et al. 2015). The authors explain these findings in relation to the new ability to invest in technology (i.e. chainsaw, rifle, tractors) which allows for a more efficient use of ecosystem services, like provision of food, firewood, water, and so on. However, if such services are common access (i.e. forest, game, common pasture), the raise in income in one part of the group might result in decreased availability for those who are left behind (Reyes-García et al. 2015). This finding, suggests, therefore, that natural capital and the services it provides do matter for well-being and that natural and economic capital might interact in explaining well-being.

In this paper, specifically (a) we estimate the relative contribution of natural and economic capitals to subjective well-being, and (b) we compare those relative contributions across three dimensions of well-being that previous research in the area has suggested are relevant constituents of well-being: subsistence, security and reproduction and care (Zorondo-Rodríguez et al. 2014). Our case study focuses on rural and forest dwellers communities from Kodagu district of Karnataka State (India).

2 Study Site

2.1 Environment, Economy and People in Kodagu

Kodagu district is located in the south of Karnataka State, India ($75^{\circ}25'-76^{\circ}14'E$ and $12^{\circ}15'-12^{\circ}45'N$). Its landscape is composed by agroecosystems of coffee plantations (60 % of the total land surface) and remnants of the endangered evergreen and deciduous forests (Garcia et al. 2009). Kodagu is one of the major coffee-growing regions in India, contributing to nearly 2 % of the world's coffee production (Coffee Board of India 2008; Ninan and Sathyapalan 2005).

Forest dwellers, mainly *adivasi* or people from scheduled tribes, comprise a heterogeneous set of ethnic and tribal groups defined as the aboriginal population of India. According to the 2011 census, 10.5 % (or 58,054 individuals) of the total population of Kodagu belongs to Scheduled Tribes (The Registrar General & Census Commissioner 2011). The largest tribes in the district are Jenu-Kuruba, Betta-Kuruba, Soliga, and Yerava. Forest dwellers usually live in settlements established by the government during the 1960s and 1970s, locally known as colonies. Some people in *adivasi* colonies still maintain their traditional lifestyle and culture, especially those who are settled far from urban areas inside forest, in remote and inaccessible terrain largely devoid of modern amenities and technology (Demps et al. 2012b; Dowie 2009; Kshirsagar and Singh 2001). In those colonies, livelihoods are mainly based on the gathering of forest products, livestock raising, and subsistence agriculture. Households also obtain some cash from selling honey and other minor forest products to government-sponsored societies (Demps et al. 2012b). In contrast, people in other *adivasi* colonies are increasingly immersed in the market economy and in modern lifestyles, often working for wage, including in jobs provided by the Forest Department or in local farms. In 2006, the government enacted an act (Forest Right Act) to increase the rights of local people's over natural resources and ecosystem services (Macura et al. 2011), however access to lands and resources continues to be a sensitive issue between local people and government institutions (Saravanan 2009).

2.2 Human Well-Being Among *Adivasi* in Kodagu

Kodagu is one of the wealthiest districts in Karnataka. In 2005, Kodagu ranked fourth out of the 27 districts of Karnataka in the Human Development Index (Government of Karnataka 2006), a measure that only partially covers the set of factors that people consider to define their well-being (Zorondo-Rodríguez et al. 2014). The government attempts to ameliorate the well-being of *adivasi* people through the provision of social services, infrastructure, and programs aiming at poverty reduction (Government of Karnataka 2006). However, the government acknowledges that much remains to be done in order to improve the well-being of Kodagu inhabitants, especially among *adivasi* people (Government of Karnataka 2006). For example, most *adivasi* colonies do not have access to safe drinking water, electricity, toilets, or education. Moreover, Kodagu is one of the districts with lowest ratio of *adivasi* school enrolment (Government of Karnataka 2006).

3 Methods

3.1 Data Collection and Sample

We collected data between January and April 2010. Specifically, we administrated a questionnaire to capture information on (1) subjective well-being, (2) level of access to natural and economic capital, and (3) socioeconomic attributes of the respondent. We visited 16 colonies selected at random from a list of colonies in the Virajpet taluk of Kodagu (southern administrative subdivision of Kodagu). The list was provided by local official authorities. Within a colony, we proceeded systematically approaching all the houses. At the door of each house we tossed a coin to decide whether we will interview the household or not. In each selected household, we recruited among present adults one willing to participate in the survey. Data collection overlapped with the coffee harvest

season, a period during which many adults are away from home, harvesting coffee. To reduce potential bias generated from oversampling people who do not work harvesting coffee, we also visited settlements after working-hours and during holidays. Our final sample included 171 adults from different households. The sample accounts for about 25 % of all the households in visited settlements. We worked with assistance of local translators fluent in Kannada (local language) and English.

3.1.1 *The Measure of Well-Being and its Dimensions*

We constructed a measure of overall subjective well-being and three measures of specific dimensions of well-being: (1) subsistence, (2) security, and (3) reproduction and care. There is a general consensus that the measure of subjective well-being as people's own evaluation of the quality of their lives, which includes both emotional reactions and cognitive judgments is a meaningful approach for measuring well-being as it allows comparison among individuals (Easterlin 2003). Thus, we measured subjective well-being through the standard question used in other researches (Easterlin 2003; Layard 2010; Reyes-García et al. 2015): "If you think about all the good and bad aspects of your life, how satisfied are you with your life as a whole?" We prompted individuals to provide answers in a scale from 0 to 5, where 0 referred to "very unsatisfied" and 5 to "very satisfied".

We used results from our previous research in the area (Zorondo-Rodríguez et al. 2014) to identify elements locally considered as relevant constituents of well-being. We categorized those elements in the dimensions proposed by Max-Neef et al. (1993) and Costanza et al. (2007). Since most of the reported elements corresponded to the dimensions of subsistence, security, and reproduction and care, we selected those three dimensions for further analysis. The dimension "subsistence" refers to the material and non-material elements that contribute to people's livelihood; the dimension "security" refers to elements that enable livelihood opportunities for current generations; and the dimension "reproduction and care" refers to enable future livelihoods of next generations (Costanza et al. 2007; Max-Neef et al. 1993). Since the two last dimensions emphasize opportunities for different generations (Costanza et al. 2007), our approach captures the different perceived needs for the present and near future.

Given that those dimensions are abstract constructs, we measured an individual's satisfaction in each of those dimensions by asking three specific questions using concrete examples of elements that people associate to the given dimension. The selection of the question draws in our previous work capturing the local meaning of each dimension (Zorondo-Rodríguez et al. 2014). For example, to assess satisfaction in the subsistence dimension, we asked about people's level of satisfaction with current availability of water, food, and shelter. To assess satisfaction in the security dimension, we asked about people's level of satisfaction with electric facilities, income, and transport and health facilities. To assess satisfaction in the reproduction and care dimension, we asked about satisfaction with nutrition and education of children. For each dimension, we also asked a general question using the same structure as the question on overall well-being, but using a term that represented the dimension. We used "survival", "individual security", and "security of the family" for the dimensions of subsistence, security, and reproduction and care, respectively. The suitability of our phrasing was tested through discussions with individuals and leaders of *adivasi* colonies.

3.1.2 Measures of Natural Capital

We measured natural capital using a subjective and an objective measure.

Subjective measure We asked individuals about their level of satisfaction with the local ecosystem and the services it provided. After a long discussion with individuals and leaders of *adivasi* colonies, we defined that the term nature, in the local language, was suitable to capture the essence of the concept local ecosystems. Thus, we asked “If you think about all the good and bad aspects of the nature around your village, how satisfied are you with the surrounding nature?” The answer was also given in a scale from 0 to 5 values.

Such measure captures an individual’s own evaluation of the local environment as a source of goods and services to satisfy needs.

Objective measure Our objective measure of natural capital was constructed in relation to access to and tenancy of a set of locally relevant natural assets (Zorondo-Rodríguez et al. 2014). According to previous research in the area (Zorondo-Rodríguez et al. 2014), three plausible natural assets could be used as proxies of natural capital at household level: (a) home garden diversity, or number of existing edible plants in the household’s home garden, (b) agricultural diversity, or number of different crops cultivated in the household’s lands, and (c) livestock ownership, proxied as the number of pigs, goats, and chicken in a household.

3.1.3 Economic Capital

Similar to natural capital, we assessed economic capital with subjective and objective measures.

Subjective measure Similar to natural capital, our subjective measure of economic capital considers the individual’s level of satisfaction with economic elements as a source of goods and services to satisfy the individual’s needs. We asked “If you think about all the good and bad things related to your household economy, how satisfied are you with the economy of your household?” As in previous questions, responses were given in a scale of six values.

Objective measure Our objective measure of economic capital included socially prominent assets (Zorondo-Rodríguez et al. 2014), which are usually used as standard indicators: (a) household income during the month prior to the interview, in Indian rupees (1 € = 62.5 INR, February 2010), (c) household wealth (or monetary value of a set of manufactured goods owned by the household, including cell phone, motorbike, bicycle, television, radio, table, and chairs), and (b) number of different basic facilities available for the household (e.g. drinking water, electricity, toilet, and ration card).

3.1.4 Control Variables: Socioeconomic Attributes of the Individuals

We collected information on socioeconomic attributes of informants to be used as controls in our statistical analysis. We asked individuals about their (1) level of schooling (coded as none, primary education, secondary education, incomplete or complete high school/university level), (2) age, (3) sex (male = 1), (4) health status—coded as 1 if the person declared that he/she has been unable to work during the month preceding the interview and 0 otherwise, and (5) ethnicity (schedule tribes origin codified as 1; and 0 otherwise). We also recorded village location, and generated a dummy variable that we coded as 1 when the village was located outside the forest.

3.2 Statistical Analysis

To test the association between explanatory (natural and economic capital) and outcome variables (human well-being) while controlling for the confounding effect of other individual socioeconomic attributes, we ran a series of multivariate Ordered Probit regressions. Explanatory variables included both subjective and objective measures of natural and economic capital. Outcome variables included, alternatively, the overall subjective well-being measure and the three selected dimensions. We ran a set of four different regressions for each of the four outcome variables. The four regressions differed on the set of proxies associated to natural capital and economic capital vectors: (1) only subjective measures, (2) only objective measures, (3) subjective measures of both capitals and objective measures of natural capital, and (4) subjective measures of both capitals and objective measures of economic capital. We ran all regressions using the Huber variance estimator in case our variables did not fulfil the normality assumptions (Cameron and Trivedi 2009). We also carried out a robustness analysis to assess the consistency of our results. To do that, we introduced disturbances to our models by (1) intentionally dropping some control variables, (2) running regressions with selected parts of the sample, and (3) using ordinary least square (OLS) instead of Ordered Probit regressions.

4 Results

4.1 Subjective Well-Being and its Dimensions

The descriptive analysis (Table 1) suggests that, overall, the subjective well-being of forest dwellers from Kodagu was under the mid-point (2.5) of the scale used (0–5), although variation among individuals was large (mean = 1.84, SD = 1.82). Sixty-one individuals (35.7 % of the sample) reported to be totally unsatisfied with their life, whereas 25 individuals (14.6 %) reported to be totally satisfied. The level of satisfaction differed across the

Table 1 Dimensions of subjective well-being among tribal individuals (n = 171) from Kodagu (Karnataka, India, 2010)

Variables	Definition	Mean	SD	Min-max
Subjective wellbeing	Overall individual level of satisfaction with life in a scale from 0 (totally unsatisfied) to 5 (totally satisfied)	1.84	1.82	0–5
Satisfaction with subsistence	Individual satisfaction with the fulfilment of basic material needs (i.e. house, cloths, food, and water availability) in a scale from 0 (totally unsatisfied) to 5 (totally satisfied)	2.91	1.76	0–5
Satisfaction with security	Individual satisfaction with the fulfilment of personal security (i.e. income, job opportunities, governmental ration programs, transport, electricity, and health facilities) in a scale from 0 (totally unsatisfied) to 5 (totally satisfied)	2.37	1.52	0–5
Satisfaction with reproduction and care	Individual satisfaction with the fulfilment of household wellbeing (i.e. security, education, and nutrition) in a scale from 0 (totally unsatisfied) to 5 (totally satisfied)	3.92	1.21	0–5

three dimensions of well-being. Satisfaction with reproduction and care had the highest average and the lowest variation (mean = 3.92, SD = 1.21), whereas satisfaction with security had the lowest average (mean = 2.37; SD = 1.52). Satisfaction with subsistence was 2.91 (SD = 1.76).

4.2 Natural and Economic Capital

The descriptive analysis of the subjective measures of natural and economic capital suggests high level of satisfaction with local natural capital (mean = 4.59, SD = 0.94), and medium level of satisfaction with household's economic capital (mean = 2.69, SD = 2.1) (Table 2). Most people (134 or 78.3 % of the sample) reported to be totally satisfied with local natural capital, but only 58 individuals from the sample (33.9 %) mentioned to be totally satisfied with their economic capital.

The average household owned the equivalent to 31.87 (SD = 62.16) kg of livestock meat. Informants reported that they keep, in average, 4.12 (SD = 2.56) edible plants in their gardens and that 1.52 (SD = 1.18) types of crops were cultivated in their property. Informants had received a, average of 7998 (SD = 12,318.9) INR of income during the month preceding the interview (Table 2). Thirty-five households in our sample (20.5 %) did not own any of the manufactured goods included in our list. Results on objective measures of access to both capitals suggest high variability among people in the sample.

4.3 Natural and Economic Capital Versus Overall Subjective Well-Being

In Table 3, we test the association between an individual's subjective and objective measures of natural and economic capitals and subjective well-being. Subjective measures of natural and economic capital bear a positive and statistically significant association with subjective well-being. The coefficient of the association was almost two-fold for the measure of natural capital (coefficient = 0.300, $p = 0.02$, row[a], Column [1], Table 3) than for the measure of economic capital (coefficient = 0.117, $p = 0.02$, row[e], Column [1], Table 3).

The analysis in column [2] is similar to the analysis presented in column [1] (Table 3), except that we use objective rather than subjective measures of natural and economic capitals. Only one of the objective measures of natural capital, home garden diversity, was associated in a statistically significant way with subjective well-being (coefficient = 0.062, $p = 0.08$, row [b], column [2], Table 3). Similarly, only one of our objective measures of economic capital, household income, bear a positive and statistically significant association with subjective well-being (coefficient = 0.191, $p = 0.01$, row [f], column [2] of Table 3).

We then combined both subjective and objective measures in the same regression. For the measures of natural capital, we found that only the subjective measure continues to be associated in a statistically significant way with subjective well-being (coefficient = 0.286, $p = 0.03$, row [a], column [3], Table 3). Differently, in the case of economic capital, we found that both the subjective measure (coefficient = 0.105, $p = 0.03$, row [e], column [4], Table 3) and household income (coefficient = 0.145, $p = 0.04$, row [f], column [4], Table 3) maintain their statistically significant association with subjective well-being.

4.4 Natural and Economic Capital Versus Selected Dimensions of Well-Being

We emphasize three noteworthy results from the models using the three selected dimensions of well-being as outcome variables (Table 4). First, subjective measures of natural

Table 2 Descriptive statistics of subjective and objective measures of natural and economic capital and of control variables used in regression analyses

Variables	Definition	Mean	SD	Min-max
<i>Natural capital</i>				
Subjective measure				
Satisfaction with local ecosystems	Individual satisfaction with surrounding ecosystems in a scale from 0 (totally unsatisfied) to 5 (totally satisfied)	4.59	0.94	0–5
Objective measures				
Home garden diversity	Number of edible species (fruits and vegetables) in the home garden	4.12	2.56	0–13
Agricultural diversity	Number of types of crops cultivated in the property	1.52	1.18	0–5
Household livestock ownership	Estimated kilograms of livestock (pig, goats and chicken) own by the household	31.87	62.16	0–477.6
<i>Economic capital</i>				
Subjective measure				
Satisfaction with household economy	Individual satisfaction with household economy. Answer in a scale from 0 (totally unsatisfied) to 5 (totally satisfied)	2.69	2.10	0–5
Objective measures				
Household income	Rupees earned through wage labor or the sale of products by members of the household during the month previous to the interview (in thousands of Indian Rupees; 1 € = 62.5 INR, February 2010)	7.99	12.31	0–150
Basic facilities	Dummy variable that captures the presence in the household of electricity or toilet facilities (= 1), or the absence of both (= 0)	36 %		
Household wealth	Monetary value of manufactured goods (such as chairs, tables, televisions, bicycles, and motorbikes) in the household (in thousands of Indian Rupees). We used the natural logarithm in the analysis	4.19	5.93	0–34.33
<i>Control</i>				
Schooling	Level of schooling of the individual. 0 = none, 1 = primary education, 2 = secondary education, and 3 = incomplete or 4 = complete high school/university level	0.92	1.18	0–4
Age	Age of Individual (in years)	38.57	15.66	16–85
Male	Gender of the individual (1 = male).	43 %		

Table 2 continued

Variables	Definition	Mean	SD	Min-max
Illness	Individual reported having been ill in bed, unable to work, during last month (1 = yes)	33 %		
Scheduled tribes	Individual belongs to schedule tribes group (1 = yes)	83 %		
Outside the forest	Percentage of Individuals living outside reserve forest and protected areas (1 = yes)	8 %		

Table 3 Associations of subjective wellbeing and its dimensions against subjective measures of capital types among tribal individuals (n = 171) from Kodagu (Karnataka, India, 2010)

Explanatory variables	Outcome variable				
	Overall subjective well-being				
	[1]	[2]	[3]	[4]	
<i>Natural capital</i>					
Subjective measure					
Satisfaction with local ecosystems	[a]	0.300 (0.126) ^b	^	0.286 (0.126) ^b	0.310 (0.128) ^b
Objective measures					
Home garden diversity	[b]	^	0.062 (0.038) ^c	0.053 (0.039)	^
Agricultural diversity	[c]	^	-0.100 (0.076)	-0.090 (0.073)	^
Household livestock ownership, in logarithm	[d]	^	0.004 (0.047)	-0.006 (0.046)	^
<i>Economic capital</i>					
Subjective measure					
Satisfaction with household economy	[e]	0.117 (0.048) ^b	^	0.120 (0.048) ^b	0.105 (0.049) ^b
Objective measures					
Household income, in logarithm	[f]	^	0.191 (0.080) ^b	^	0.145 (0.072) ^b
Basic facilities	[g]	^	0.042 (0.125)	^	0.018 (0.119)
Household wealth, in logarithm	[h]	^	-0.016 (0.035)	^	-0.019 (0.033)
<i>Control variables</i>					
Schooling	[i]	0.050 (0.081)	0.053 (0.088)	0.038 (0.087)	0.070 (0.082)
Age	[j]	-0.009 (0.007)	-0.015 (0.007) ^b	-0.010 (0.007)	-0.008 (0.007)
Male	[k]	0.292 (0.178) ^c	0.189 (0.180)	0.308 (0.177) ^c	0.252 (0.184)
Illness	[l]	-0.501 (0.212) ^b	-0.477 (0.209) ^b	-0.519 (0.211) ^b	-0.466 (0.214) ^b
Scheduled tribes	[m]	0.478 (0.187) ^b	0.466 (0.220) ^b	0.510 (0.193) ^a	0.440 (0.206) ^b
Outside the forest	[n]	0.429 (0.192) ^b	0.417 (0.201) ^b	0.489 (0.186) ^a	0.453 (0.207) ^b

Cells show coefficient estimates of ordered probit regressions and, in parenthesis, the standard errors. Models were run with robust estimator of variance. ^a, ^b, ^c refer to significant levels at 1, 5, and 10 % respectively. ^ indicates variable excluded from model. For definition of variables see Tables 1 and 2

and economic capital display a positive and statistically significant association with individual satisfaction in each of the three dimensions (rows [a] and [e], columns [1]–[12], Table 4). Second, in terms of magnitude and statistical significance, the subjective measure

Table 4 Associations of subjective well-being and its dimensions against objective measures of capitals among tribal individuals (n = 171) from Kodagu (Karnataka, India, 2010)

Explanatory	Outcome variables: dimensions of well-being																	
	Subsistence						Security						Reproduction and care					
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]						
<i>Natural capital</i>																		
Subjective measure																		
Satisfaction with local ecosystems	[a]	0.298 (0.09) ^a	^	0.278 (0.09) ^a	0.287 (0.09) ^a	0.245 (0.09) ^a	^	0.238 (0.10) ^b	0.208 (0.09) ^b	0.238 (0.1) ^b	^	0.233 (0.09) ^b	0.234 (0.10) ^b					
Objective measures																		
Home garden diversity	[b]	^	0.069 (0.04) ^c	0.085 (0.04) ^b	^	^	0.026 (0.04)	0.036 (0.04)	^	^	0.043 (0.04)	^	^					
Agricultural diversity	[c]	^	-0.086 (0.08)	-0.102 (0.08)	^	0.072 (0.07)	0.079 (0.07)	^	^	0.134 (0.08) ^c	0.133 (0.07) ^c	^	^					
Household livestock ownership (in ln)	[d]	^	0.054 (0.04)	0.059 (0.04)	^	-0.011 (0.05)	-0.011 (0.05)	^	^	-0.018 (0.05)	-0.029 (0.05)	^	^					
<i>Economic capital</i>																		
Subjective measure																		
Satisfaction with household economy	[e]	0.298 (0.04) ^a	^	0.301 (0.04) ^a	0.295 (0.04) ^a	0.161 (0.04) ^a	^	0.156 (0.04) ^a	0.160 (0.04) ^a	0.122 (0.04) ^a	^	0.113 (0.04) ^a	0.123 (0.04) ^a					
Objective measures																		
Household income (in ln)	[f]	^	0.198 (0.07) ^a	0.129 (0.07) ^c	^	0.025 (0.05)	^	0.025 (0.05)	-0.009 (0.05)	^	0.001 (0.08)	^	-0.009 (0.08)					
Basic facilities	[g]	^	0.497 (0.15) ^a	0.537 (0.14) ^a	^	0.357 (0.12) ^a	^	0.357 (0.12) ^a	0.332 (0.12) ^a	^	-0.068 (0.12)	^	-0.092 (0.11)					
Household wealth (in ln)	[h]	^	-0.006 (0.03)	-0.004 (0.03)	^	0.031 (0.03)	^	0.031 (0.03)	0.037 (0.03)	^	0.031 (0.03)	^	0.042 (0.03)					

Table 4 continued

Explanatory variables	Outcome variables: dimensions of well-being														
	Subsistence						Security						Reproduction and care		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]			
<i>Control variables</i>															
Schooling	[i] 0.144 (0.08) ^c	0.088 (0.09)	0.091 (0.09)	0.157 (0.09) ^c	0.022 (0.08)	-0.017 (0.09)	0.003 (0.08)	-0.009 (0.08)	0.203 (0.08) ^b	0.172 (0.09) ^b	0.193 (0.09) ^b	0.187 (0.08) ^b			
Age	[j] 0.001 (0.01)	-0.008 (0.01)	-0.002 (0.01)	0.001 (0.01)	-0.002 (0.01)	-0.008 (0.01)	-0.003 (0.01)	-0.003 (0.01)	0.001 (0.01)	-0.004 (0.01)	0.001 (0.01)	0.001 (0.01)			
Male	[k] 0.057 (0.16)	-0.088 (0.17)	0.055 (0.16)	0.004 (0.16)	0.123 (0.16)	0.046 (0.17)	0.103 (0.16)	0.107 (0.17)	0.105 (0.18)	0.049 (0.17)	0.084 (0.18)	0.100 (0.18)			
Illness	[l] -0.302 (0.19)	-0.367 (0.19) ^c	-0.352 (0.19) ^c	-0.237 (0.20)	-0.433 (0.19) ^b	-0.458 (0.18) ^b	-0.449 (0.19) ^b	-0.413 (0.19) ^b	0.014 (0.19)	-0.029 (0.19)	-0.002 (0.19)	0.018 (0.19)			
Scheduled tribes	[m] 0.041 (0.22)	0.388 (0.27)	-0.007 (0.23)	0.390 (0.25)	-0.272 (0.22)	0.018 (0.23)	-0.338 (0.23)	0.010 (0.25)	0.228 (0.22)	0.219 (0.27)	0.160 (0.22)	0.257 (0.24)			
Outside the forest	[n] 0.215 (0.20)	-0.216 (0.23)	0.241 (0.21)	-0.175 (0.23)	0.722 (0.19) ^a	0.305 (0.21)	0.687 (0.20) ^a	0.436 (0.21) ^b	0.075 (0.19)	-0.010 (0.21)	0.014 (0.21)	0.102 (0.21)			

Cells show coefficient estimates of ordered probit regressions and, in parenthesis, the standard errors. Models were run with robust estimator of variance. ^a, ^b, ^c refer to significant levels at 1, 5, and 10 %, respectively. [^] indicates variable excluded from model. For definition of variables see Tables 1 and 2

of natural capital bears a similar association with the three dimensions of well-being (row [a], columns [1]–[12], Table 4), whereas the subjective measure of economic capital bears a stronger association with the subsistence (row [e], column [1], [3], and [4], Table 4) than with the other two dimensions (row [e], column [5]–[12], Table 4).

Third, in regressions using objective measures of natural and economic capital (Table 4), we found different and non-consistent, associations with the three dimensions of well-being. For instance, we found that home garden diversity (row [b]) was associated in a positive and statistically significant way with the subsistence, but not with the security and the reproduction and care dimensions. We also found that agricultural diversity was positively associated with satisfaction in the reproduction and care dimension, but not with satisfaction in the subsistence and the security dimensions (row [c]). We also found dissimilar associations of the objective measures of economic capital with the three dimensions of well-being measured (Table 4). Higher household income was associated with higher satisfaction in the subsistence dimension (row [f], columns [1]–[4]), but not in the security (columns [5]–[8]) nor in the reproduction and care dimensions (columns [9]–[12]). We also found that the larger the number of facilities available to the household, the larger the level of satisfaction with the subsistence (row [g] of columns [1]–[4]) and the security (row [g] of columns [5]–[8]) dimensions. Household wealth was not associated in a statistically significant way with any dimension of well-being.

Finally, results of the robustness analysis showed that the sign, magnitude, and statistical significance of the coefficients of almost all associations explored in Table 3 did not change, or slightly changed (data not shown). Coefficients only changed substantially when we ran the models with the subsamples of men and women separately. For men, the subjective measure of natural (coefficient = 0.433, $p = 0.004$) and economic (coefficient = 0.162, $p = 0.021$) capitals were associated to subjective well-being in a positive and statistically significant way, whereas the association was not significant among women.

5 Discussion

Our study contributes to the understanding of the role of natural capital as a source of satisfiers for human well-being. The main finding of this work is that, for the forest dwelling society studied, both natural and economic capitals contribute to well-being. After presenting some potential biases and caveats of our study, we discuss two main results: the overall levels of subjective well-being among the study population and the relation of natural and economic capital to well-being and the three selected dimensions.

5.1 Caveats and Limitations

Results from this study might suffer from measurement errors in the outcome and the explanatory variables. Measurement errors in the indicators of well-being might arise from a plausible overlap among the three dimensions of well-being included (Costanza et al. 2007). We are aware that our proxy measures did not avoid this overlap and, hence, that we cannot evaluate the three dimensions independently one from each other. Measurement errors might also arise in the objective measures, as people might have not remembered or may have not provided accurate information on economic issues and use of natural resources. This might be especially true for some of the proxies of natural capital, since

growing gardens into forest is highly regulated in the area. We also might have some double counting, as some assets included as natural capital (e.g. natural resources) might have been included into the values of economic capital (e.g. household income). For instance, we used livestock and crops as proxies of natural capital, but both variables might also generate economic capital if milk, animals, or agricultural products are commercialized. In this respect, double counting will depend on how different assets from capitals are considered—as either intermediate or final services—in relation to their degree of connection to human well-being. Measurement errors in the explanatory variables might produce an attenuation bias and make the estimates more conservative.

Another source of bias in our estimations might come from omitted variables. For instance, we found that—among the three objective variables of natural capital—only home garden diversity was associated with subjective well-being. It is possible that other proxies of natural capital, not measured in this work, might have a more direct relation to well-being than the proxy variables selected. We tried to collect direct information on extraction of natural resources from the forests and surface of land cultivated, but those questions raised sensitive issues among informants and authorities (Macura et al. 2011; Saravanan 2009), so we discontinued the collection of these data. Our analysis also omitted non-material uses of nature (e.g. religious or spiritual uses) which are locally important (Demps et al. 2012a). We tried to tackle the effects of omitted variables by introducing modifications to the core model in our robustness analysis. Results suggested that our estimates were consistent and robust despite several disturbances included in the models.

Last, our study might suffer a caveat related to the use of cross-sectional data. Because we only have one data point for each individual, we could not control for individual fixed-effects that might affect reports of well-being (Godoy et al. 2009; Ferrer-i-Carbonell and Frijters 2004). Researchers have pointed out that the control for fixed-effects might affect the estimated associations of well-being with some particular variables, such as income (Easterlin 2003; Ferrer-i-Carbonell and Frijters 2004).

5.2 Human Well-Being in Kodagu

“I am totally unsatisfied with my life. I do not have an appropriate house or job, neither there are basic facilities in the community. The government does not support us enough to improve our living standard, not even regarding the most basic services” told us a 35-year-old lady. Thus, although Kodagu is often described as one of the districts with highest levels of well-being in India (Government of Karnataka 2006), subjective well-being scores recorded in our study are lower than scores obtained in national level surveys (Veenhoven 2012). This finding could be explained by the fact that our sample is not representative of all social groups of Kodagu. Rather, our sample consisted of *adivasi* and forest dwellers informants, a population that has historically suffered marginalization in India, and might therefore display lower levels of well-being than the average. Our first result, then, highlights that aggregated measures of well-being hide important internal differences between different sectors of the society.

Despite the low overall level of well-being, we also found levels of satisfaction higher than mid-point for the dimensions of subsistence and reproduction and care. Some locally successful governmental programs seem to account for the high levels of satisfaction reported. People explained that they are relatively satisfied with the public systems of education and food distribution. Particularly, where children can get scholarships to attend school, informants reported high levels of satisfaction with children education. Previous

ethnographic information evidenced that Kodagu's network of primary schools covers a large number of *adivasi* colonies (Demps et al. 2012b). Nevertheless, our results still suggest that there is a lack of association between level of overall well-being and the level of satisfaction for the three dimensions. We argue that, since well-being is a multidimensional construct, there might be dimensions not included in our study that could explain the mismatch between the overall measure of well-being and the specific measure of its dimensions. Our findings invite researchers and policy-makers to continue assessing the relation between well-being and its different dimensions, in an attempt to untangle which of the dimensions might have a larger explanatory power on overall well-being.

5.3 The Association Between Natural Capital and Subjective Well-Being

Both subjective and objective measures of natural capital are associated to subjective well-being, but the subjective measure of natural capital displays a stronger association than the subjective measure of economic capital. Although all human societies ultimately depend on natural systems for their subsistence (Gómez-Baggethun and de Groot 2010), the link is more evident for societies—like the one studied here—with an economy based on the direct use of natural resources. Thus, natural capital might display a stronger association with subjective well-being than economic capital because of the direct dependence on local ecosystems of the studied population.

It is interesting to notice that people emphasized the importance of land ownership for well-being. “We have land, but it is not enough to satisfy all our food requirements” argued a woman living in a colony inside the forest and who reported a mid-point level of subjective well-being. Land ownership, however, is not the only aspect valued. The surrounding environments also “offer calm and peace to us, so I prefer to live close to the forest,” emphasized a 27-years-old man. Furthermore, local ecosystems also have religious values for local people, as suggested by the presence of several sacred forests around Kodagu (Bhagwat and Rutte 2006; Ormsby 2011; Bhagwat et al. 2005).

Another noteworthy finding relates to the different associations of natural and economic capital with the three dimensions of well-being. For instance, we found that both subjective and objective measures of natural and economic capitals were associated with the subsistence dimension, which suggests that both capitals complement one to each other in fulfilling it. Differently, the two forms of capitals differed on their association with the security and reproduction and care dimensions: natural capital is a more important satisfier of both dimensions than economic capital. This finding suggests that people could rely on local ecosystems to cope with their livelihood insecurity (i.e. temporary and uncertain wages, inability to save money, and lack of cash). Nevertheless, we did not find any association between our objective measures of natural capital and satisfaction with the security dimension. Instead, the variables used in the model suggest the importance of the set of basic facilities available for the household.

For the dimension of reproduction and care, we found that subjective measures of natural capital displayed a larger association than subjective measures of economic capital. We also found that the number of cultivated crops is associated with the satisfaction of reproduction and care. Altogether, those associations suggest that local ecosystems are perceived as a main source of a present and a future well-being. As a 22-year-old woman said: “Forest allows not only the satisfaction of our needs, but also of the needs of next generations.” Last, our results also suggest that income, one of the assumed main determinants of well-being, is not necessarily associated to all its dimensions.

6 Conclusion

Our study supports previous evidence suggesting that economic indicators alone can not explain subjective well-being (Easterlin 2003; Easterlin et al. 2010; Masferrer-Dodas et al. 2012; Reyes-García et al. 2015). Furthermore, our results suggest that natural capital may be more important than economic capital in satisfying particular well-being dimensions, at least among rural and indigenous societies. Our research also calls for attention on the low levels of well-being reported by forest dwellers from Kodagu.

Overall, the results of this work could help in the design of local policies related to well-being in two different ways. First, our results highlight that considerations regarding access and control of natural capital should be included in policies related to well-being, as natural capital is a determining factor and main source of satisfiers for local well-being. In previous work examining locally defined satisfiers (Zorondo-Rodríguez et al. 2014), we found that local communities consider access to natural resources as an important satisfier. Policy-makers could, therefore, allocate more resources to local ecosystem management or enhance forms of community natural resource management in order to ensure local provision of ecosystem services. The importance to access to land and resources has been partially recognized in recent policies, such as the Scheduled Tribes and Other Traditional Forest Dweller Act, a forest right act recently established in India (Government of India 2007; Sathyapalan 2010; Macura et al. 2011). But, whether such policies will increase *adivasi* access to natural capital, and thus increase their well-being, is an open question, and an important issue to keep in mind when designing well-being policies in the study area. Second, associations of both types of capitals with dimensions of well-being offer plausible ways to satisfy specific dimensions of well-being, as there might be synergies between both natural and economic capital. Results give insights to design specific strategies of resources allocation to improve satisfaction of concrete dimensions of well-being.

Acknowledgments Research was funded by NSF—Cultural Anthropology Program (BSC-0726612) and ANR—French National Research Agency Project (ANR-05-PADD-0XX Public Policies and Traditional Management of Trees and Forests—POPULAR). We greatly appreciate the hospitality, kindness, and friendship of people from Kodagu. We are also grateful to P. Vaast and C.G. Kushalappa. We thank the comments and suggestions by S. Crespín, A. Fernández-Llamazares, A. Pyhälä. F. Zorondo-Rodríguez thanks the economic support provided by the “Presidente de la República” scholarship (CONICYT, Chile).

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