Design Features and Project Age Contribute to Joint Success in Social, Ecological, and Economic Outcomes of Community-Based Conservation Projects

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Keywords
Biodiversity conservation; capacity; community conservation; conservation and development; sustainable development; synergies; tradeoffs.

Abstract
Community-based conservation (CBC) seeks to align various ecological, economic, and social goals. While a number of comparative analyses have examined the factors associated with successful outcomes in each of these domains, far fewer studies have explored joint success across domains. Understanding when and how CBC improves multiple outcomes can generate more sustainable and socially acceptable policies and programs. Here, I use a comparative database of 136 CBC projects identified from a systematic literature review to assess which aspects of national socio-economic and political context, community-characteristics, and project design features are associated with win–win outcomes. Using multivariate logistic regressions within a multilevel analysis and model-fitting framework, I show that capacity building, local participation, environmental education, and project age contribute to win–win outcomes. These results hold across various national and local contexts and resource domains and suggest that general project design features can contribute to joint success in CBC projects.

Introduction
Governments, donors, and nongovernment organizations have devoted significant resources to integrative conservation approaches. Between 1980 and 2008 nearly 75% of the $18 billion in international biodiversity aid was devoted to such projects (Miller 2014). These integrative approaches, including comanagement, ecotourism, and integrated conservation and development (hereafter referred to as community-based conservation [CBC]), typically involve some combination of devolving control over resources, engaging local communities, and linking conservation with economic development. CBC is based on the premise that socio-economic benefits and community engagement can alleviate poverty, improve social cohesion, increase support for conservation, and reduce threats to biodiversity (Borgerhoff Mulder and Coppolillo 2005). Thus, the criteria by which conservation projects are evaluated has expanded, requiring conservation planners and practitioners to be attentive to economic, social, and ecological outcomes as well as potential synergies and tradeoffs among them.

The proliferation of CBC, coupled with the set of ambitious win–win objectives outlined in the recently announced global sustainable development goals (SDGs) (United Nations General Assembly 2015), make the question of when and how win–win outcomes emerge even more critical (Adams et al. 2004). Despite the positive view portrayed in the SDGs, the consensus about CBC is that tradeoffs are more common than synergies (McShane et al. 2011). However, few studies have explicitly and systematically examined the factors associated with joint success in multiple outcomes (but see Chhatre and Agrawal 2009; Persha et al. 2010; Persha et al. 2011). This study heeds calls for quantitative, comparative analyses of CBC to provide insights into the conditions under which win–win outcomes can be achieved (e.g. Agrawal and Redford 2006; Persha et al. 2011). I use a large, comparative database of CBC projects identified from a systematic literature review to assess which
Joint success in conservation projects

J.S. Brooks

Figure 1 Coding of outcome variables and description of how they were combined for measures of synergies and tradeoffs. The combined outcome variables make up the four dependent variables for this study: ecological/economic, ecological/social, economic/social, ecological/economic/social. See supplementary material for additional details on measurement of project outcomes.

Win–Win Outcomes and Tradeoffs

While win–win outcomes have been elusive (McShane et al. 2011), there is evidence that they are possible (Chhatre and Agrawal 2009; Persha et al. 2011; Miller et al. 2012) and there is a general sense of how ecological, economic, and social outcomes are linked. For instance, economic benefits (economic) should incentivize the protection or sustainable use of species, resources, or habitats (ecological) (Abbot et al. 2001), which may be more likely with direct payments (Ferraro and Kiss 2002) or indirect use (e.g. ecotourism) (Gössling 1999), than with direct use in highly market-integrated communities with incentives for overharvesting (Brewer et al. 2012).

Similarly, protection or sustainable use of resources (ecological) should not exacerbate existing inequalities or come at the expense of equitable access (social). Positive outcomes may emerge with high levels of local participation, which can ensure that conservation rules are suited to local ecological and cultural conditions (Ostrom 1990) and enhance social capital, empower community members, and overcome existing inequalities (Campbell et al. 2010). These social benefits may further generate positive ecological outcomes and may be more likely where rights, responsibilities, and sufficient resources are devolved to local communities (Ribot et al. 2006) that face low barriers to collective action (Agrawal 2001).

Further, equitable benefit sharing (economic and social) can empower community members, incentivize further participation, and enhance human capital, thus leading to additional economic and social benefits. This result may be more likely in nations or communities with good governance (Nelson 2010), when market access enables linkages with external decision-makers (Persha and Andersson 2014), or in smaller, homogeneous communities (Dasgupta and Beard 2007).

However, these simplified representations hide the challenges associated with aligning CBC outcomes, which include (i) potential changes in outcomes over time (e.g. if harvest rates become unsustainable or market value fluctuates), (ii) the potential value trading off ecological impacts for economic success in the short-term in order to generate the support necessary for ecological success over the long term (Miller et al. 2012), and (iii) tradeoffs among different measures within an outcome domain (Brown 2004; McShane et al. 2011). These complexities, and the limited quantitative analysis of the factors

Conservation project outcomes

- Ecological: Project outcomes with regard to condition of the habitat and/or key species
- Economic: Project outcomes with regard to economic or other development benefits
- Social: Project outcomes with regard to equitable benefit distribution, enhanced social capital, feelings of empowerment, or community cohesion

Success: most indicators showed improvement
Limited success: conflicting results for different measures of the outcome or variation in the outcome among communities, households, or individuals
Failure: most indicators for the outcome showed no change or decline

Win–Win: coded “success” for each outcome in the combination
- ecological/economic
- ecological/social
- economic/social
- ecological/economic/social

Tradeoff: all other coding combinations for the included outcomes
- success/failure
- success/limited success
- limited success/limited success
- limited success/failure
- failure/failure

aspects of national socio-economic and political context, community-characteristics, and project design features are associated with win–win outcomes, where “win–win” is defined as success in two or more of the outcomes measured (ecological, economic, social) and “tradeoffs” are defined as some combination of success, limited success, or failure (see Figure 1 and supplementary material text). The sample includes data from 136 CBC projects nested within 40 countries.
associated with win–win outcomes, have inhibited our understanding of the conditions under which such outcomes emerge.

This study builds on previous work that examined individual outcomes of CBC projects and found that participation, engagement with communities, capacity building and secure tenure were important for ecological and economic success (Brooks et al. 2012). The goal of this article is to identify the factors associated with win–win scenarios across ecological, economic and social outcomes. Following Brooks et al. (2012) I use a set of predictor variables derived from theory and observations about the conditions that support or hinder collective action and conservation behavior to provide insights into when win–win outcomes might emerge (see Tables 1 and 2 and supplementary material text for further justification of variables). These variables are grouped into the following three categories.

1. National socio-economic and political context can affect levels of corruption, trust in actors and institutions, and the functioning of economic markets (Tallis et al. 2008; Nelson 2010).

2. Community characteristics affect the likelihood of collective action and conservation behavior through mechanisms related to local economic opportunities, incentives or disincentives for behaviors, patterns of interactions among community members and stakeholders, and secure access to resources (Ostrom 1990; Agrawal 2001).

3. Project design features structure involvement in decision-making, investments in human capital, the degree of resource use permitted, and the provision and distribution of benefits.

In addition to variables in these categories, I controlled for project age, the first author’s disciplinary background, and the conservation status of the ecoregion in which the project was located (see supplementary material text for justification of these control variables).

**Methods and Analysis**

A systematic review of the CBC literature was conducted using online databases and the Advancing Conservation in a Social Context digital library (www.tradeoffs.org/app/Public/Catalog) (see supplementary material text for search details). These searches added 74 projects to an initial sample of 62 projects from previous reviews (Brooks et al. 2006; Waylen et al. 2010). Studies were included if they were published in the primary or gray literature and were the most recent of multiple sources on the same project, addressed a CBC intervention with conservation as the primary aim, measured at least two of the outcomes that were the focus of a previous study (Brooks et al. 2012), and were missing information for no more than one-third of independent variables.

Using a coding protocol modified from previous reviews (Brooks et al. 2006; Waylen et al. 2010), up to sixty-five pieces of information were collected for each project. Only data related to variables in the three aforementioned categories are presented here. Coding was done by the author and another researcher (see supplementary material for coding procedures) and coding decisions were based solely on the information presented in articles in the sample. To reduce the amount of missing information, the corresponding authors of papers in the sample were e-mailed a questionnaire containing a subset of topics in the coding protocol (for use of these data see supplementary material text).

Following Brooks et al. (2012), the analysis proceeded in two steps. Bivariate analyses were conducted using 2D contingency tables for categorical predictors and logistic regression for continuous predictors. The Goodman–Kruskal $\gamma$-statistic summarizes the association between predictors and outcomes and was used as a test statistic for Monte Carlo significance tests. Multiple testing was controlled for by adjusting significance levels using $q$ values (Storey 2002) to obtain approximate control of the false-discovery rate. The $P$ values obtained from the contingency tables and the regression models were supplied to the $q$ value software (available at http://www.bioconductor.org/packages/release/bioc/html/qvalue.html).

Multivariate analyses were conducted after imputing missing values (Little and Rubin 2002). Five unique datasets were created using the MICE package in R. All predictor and uncombined outcome variables were used to impute missing values (missing values were not imputed for outcomes). After imputing missing values, some predictors were combined to reduce the number of variables (see Table 1 and Table S7 for the correlation matrix for predictors). Best-fitting logistic regression models for each dependent variable (Figure 1) were selected using a forward, stepwise Akaike Information Criterion (AIC) procedure. The best-fitting model was then fit in lrm and the robcov function was used to calculate robust SEs to account for clustering of projects within countries. Estimates for the five imputed datasets were averaged and pooled SEs were calculated (Gelman and Hill 2007).

**Results**

The sample size for each combination of outcomes ranged from 64 (ecological & economic; ecological, economic & social) to 118 (economic & social) (see Figure 2). Tradeoffs were more common than synergies across all
Joint success in conservation projects

Table 1 Measurement and source of national-level predictors

| National Political Context                                                                 |
|---------------------------------------------------------------------------------------------|
| Governance                                                                                   |
| World Bank scores for quality of governance based on measures of: voice in politics,         |
| government stability, government effectiveness, regulatory quality, rule of law, and         |
| corruption. Single value obtained from the first factor score from a principal components    |
| analysis of the six measures. Data collected from [http://info.worldbank.org/governance/wgi/  |
| sc_country.asp#](http://info.worldbank.org/governance/wgi/sc_country.asp#). Scores taken      |
| from the year closest to the date of research.                                              |
| Rights                                                                                      |
| Values for political rights and civil liberties from the FreedomHouse database. Single      |
| value obtained from the first factor score from a principal components analysis of the two   |
| measures. Data collected from [http://www.freedomhouse.org/report-types/freedom-world](    |
| http://www.freedomhouse.org/report-types/freedom-world). Scores taken from the year closest |
| to the date of research.                                                                     |

| National Socio-economic Context                                                              |
| HDI                                                                                          |
| Human Development Index score from the 2009 UNDP trends dataset accessed through The United   |
| Nations Development Programme [http://hdr.undp.org/en/statistics/](http://hdr.undp.org/en/    |
| statistics/). Scores taken from the year closest to the date of research.                     |
| Gini                                                                                         |
| Gini inequality coefficient obtained ranked by country from data compiled from 2000 to 2007 |
| [http://www.wri.org/project/earthtrends](http://www.wri.org/project/earthtrends). One score  |
| for each country.                                                                            |

outcome combinations and were most common for the triad of ecological, economic, and social outcomes. Synergies were most common between ecological and economic outcomes (41% of projects) and least common between economic and social outcomes (14% of projects).

Many of the significant associations in the bivariate analysis were project design variables including local participation, engagement with local cultural traditions, investments in institutional capacity, and environmental education (see Table 3). For national context, higher HDI and good governance were associated with win–win outcomes for multiple combinations. Population size was the only community characteristic associated with win–win outcomes for more than one combination. Finally, project age was associated with win–win outcomes in all four combinations.

The multivariate analysis indicates that capacity building, project age, participation, and environmental education are particularly important for win–win outcomes (see Figures 3a–d and Table S1 for full results). The alignment of ecological and social outcomes is most likely when the project builds the capacity of individuals and institutions and with greater local participation in project design and implementation. Economic and social synergies are more likely for older projects and when the project provides environmental education. Ecological and economic synergies are more likely for older projects and when the project helps build the capacity of individuals and institutions. Finally, all three outcomes are more likely to align in older projects.

**Discussion**

Our results support the consensus that tradeoffs are more common than synergies in CBC (Brown 2004; McShane et al. 2011). Win–win results were most common for ecological and economic outcomes and least common for economic and social outcomes. Thus, economic returns do not have to come at the expense of conservation goals, but it may be difficult to distribute economic benefits equitably and manage them in a way that does not disrupt social dynamics.

The results suggest that several project design features and project age are associated with win–win outcomes across diverse national contexts, resource domains, and project types. Importantly, these project features can be incorporated in nearly any context. Thus, while project success may be context dependent (Adams et al. 2004), these factors may provide a foundation for aligning success across outcomes.

Capacity building remained in the best-fitting model for all outcome combinations and was significantly associated with win–win outcomes for two combinations. Scholars have noted the importance of capacity building in the context of CBC (Campbell et al. 2010), and numerous reviews have emphasized the importance of individual skills development (Salafsky et al. 2001; Tallis et al. 2008) and strengthening institutional capacity (Agrawal and Benson 2011; Persha et al. 2011).

Understanding the mechanisms through which capacity building produces joint success is difficult because our combined measure includes individual-level training (e.g. biological monitoring, business skills, record keeping, equipment use) and institutional capacity (e.g. strengthening rural organizations and institutions, conflict negotiations, creating management committees). Increasing human capital through individual capacity building can increase pride, self-confidence, and a sense of belonging (Scanlon and Kull 2009) and provide skills
Table 2 Description, measurement, and coding of project design and community characteristics predictors. Some predictors used in the multivariate analysis are a combination of variables that were used in the bivariate analysis (see Table S1), as indicated in the description below.

| **Community characteristics** | **Description** | **Coding** |
|-------------------------------|-----------------|------------|
| **Market access**             | The degree communities are market integrated including wage labor, selling and purchasing goods, and remoteness, three categories: low, moderate, high. |  |
| **Threat**                    | Threats to local resources and/or the protected area (e.g., logging, hunting, land clearance). Up to three noted for each project and coded by motivation (subsistence = 1, mixed = 2, commercial = 3). Sum of the three threats divided into three categories: low (1,2), moderate (3-5), high (6-9). |  |
| **Local Institutions**        | Comprised of Supportive local culture (do local traditions and beliefs support conservation: unsupportive, mixed, supportive) and Effective local government (quality of preexisting local governance institutions: ineffective, mixed, effective). Local institutions combines variables above. Three categories: low (both ineffect./unsupp. or one ineffect./unsupp. and one mixed), moderate (one is ineffect./unsupp. and one is effect./supp.), high (both effect./supp. or one effect./supp. and one mixed). |  |
| **Pop. size**                 | Size of human population, three categories: low (<5000), moderate (5001–50000), high (>50000). Adapted from Waylen et al. (3). |  |
| **Charisma**                  | Presence of charismatic individual/group of individuals facilitating project. Coded as: no, yes. |  |
| **Pop. heterogen.**           | Ethnical/cultural diversity of community. Two categories: low (one ethnic/cultural group present, or < 33% and > 67% of one group), high (multiple ethnic groups, >33% and <67% of community of one group and/or the author notes disharmony based on caste, class, or ethnic divisions). |  |
| **Protectionism**             | IUCN ranking for protected area associated with the project. Two categories: Strict Nature Reserve/National Park, Other (national monument, habitat/species management area, protected landscape, managed resource area, no protected area). |  |
| **Resource use**              | Constraints on resource use, coded into three categories: protected, regulated, unregulated. |  |
| **Benefits provision**        | Economic/development benefits provided by project and type of resource use. Four categories: ecotourism (indirect use of targeted species/habitat), CBC (community efforts to minimize resource use), compensation/substitution (prohibition or minimized use of targeted resource but other benefits provided), enhancement (increasing marketable use of the targeted resource). |  |
| **Capacity**                  | Comprised of Capacity skills (did project build skills intended to aid development or conservation efforts), and Capacity institutions (were local institutions relating to environmental management reinforced or built as a result of the project). Coded as: yes, no. Capacity combines variables above. Two categories: no (neither skills nor institutions), yes (skills, institutions or both). |  |
| **Envt. education**           | Whether environmental education was a component of the project. Coded as: no, yes. |  |
| **Project Design Features**   | Comprised of Impetus (whether impetus for project came from the community), Establishment (level of community involvement in project establishment), and Daily management (level of community involvement in daily project management. Coded as: no or low =1, some =2, joint or complete involvement =3. Participation combines variables above. Three categories: no/low (3,4), moderate (5,6), high (7-9). |  |
| **Engagement**                | Comprised of Approach local culture (whether project engaged with local cultural traditions and beliefs), and Approach local institutions (whether the project engaged with local institutions and/or leaders). Each coded as: no engagement/conflict=1, mixed=2, engaged=3. Engagement combines variables above. Three categories: no/low (2,3), moderate (4), high (5,6). |  |
| **Project Age**               | Number of years the project has been running. |  |
| **Author discipline**         | Affiliation of first author, four categories: biological sciences, social sciences, interdisciplinary science or department, employed by an NGO. |  |
| **Ecoregion status**          | Conservation status of ecoregion(s) in project area. When multiple exist only lowest status value is coded, three categories: critically endangered, vulnerable, relatively stable. |  |

We collapsed Waylen et al.’s (2010) seven-level variable to three categories to reduce the number of predictors in the models. It was important to avoid categories with low representation in the analysis, so, we considered the structure of the data while constructing the three categories.

Modified from: Oldekop JA, Bebbington AJ, Brockington D, & Prieziosi RF (2010) Understanding the lessons and limitations of conservation and development. Conserv Biol 24(2):461-469.

Year of project initiation was subtracted from the year research for the project was conducted. When the year in which research was initiated was not reported, we subtracted from the publication year the mean number of years between the initiation of research and the publication year for all other studies in the sample.

See: Olson DM & Dinerstein E (1998) The global 200: A representation approach to conserving the Earth’s most biologically valuable ecoregions. Conserv Biol 12(3):502-515.
that facilitate participation and help individuals harness economic opportunities. Thus, individual capacity building can be a component of more holistic approaches to poverty reduction (Agrawal and Redford 2006) that go beyond income generation by strengthening human capital and improving human capabilities (Sen 1999). If the human capital generated by capacity building is applied across social, ecological, and economic components of the project, then it may provide a foundation for synergies and long-term CBC success.

The results of the bivariate analysis suggest, however, that institutional capacity building is a better predictor of win–win outcomes. Strengthening institutional capacity may help foster interactions among community members that are important for multiple outcomes. For instance, informal institutions to improve communication and mobilize community members were needed in one community in Taiwan to support voluntary patrolling efforts (Tai 2007). These informal communication networks strengthened social capital (social outcome) and lead to more formal institutions that protected wildlife habitat (ecological outcome) that was also a prime tourist destination (economic outcome).

Local participation and environmental education were also important, albeit to a lesser degree. Several reviews have found local participation and autonomy to be crucial for independent CBC outcomes (Padge et al. 2006; Brooks et al. 2012), as well as for synergies between outcomes (Chhatre and Agrawal 2009; Persha et al. 2011). Locally derived management decisions are thought to be better suited to local ecological dynamics and to lead to better compliance (Ostrom 1990). In addition, social outcomes may be enhanced when participation can lead to feelings of empowerment, pride, and buy-in from community members (Campbell et al. 2010). Further, locally crafted rules about benefits distribution may be better adapted to local socio-economic and cultural conditions. Thus participation may enhance ecological and social outcomes in distinct ways, or indirectly improve ecological conditions through improved social dynamics (Miller et al. 2012). For instance, Scanlon and Kull (2009) provide evidence that CBC helped create a shared identity among communities in Namibia, which played a role in reducing hunting.

Environmental education was associated with joint economic and social success, but the lack of detailed descriptions of environmental education makes it difficult to determine how. Educational programs may be structured as forums that bring community members together, thereby contributing to social gains. These

Figure 2: Percentage of synergies (light grey), tradeoffs (dark grey) and dual failures (black) for each combination of outcomes. Dual failures where included as tradeoffs for the analyses.
educational programs may inform communities about important ecosystem services as well as the potential economic value of conservation, which could contribute to positive economic outcomes. For instance, Becker et al. (2005) describe efforts to inform communities about the ecological and economic value of premontane moist forests in Ecuador. Education programs increased awareness of ecological importance and economic value, and also lead to involvement in environmental monitoring efforts, which enhanced community relationships.

Finally, project age was associated with win–win outcomes for all combinations in the bivariate analysis, and three of the combinations in the multivariate analysis. Previous studies have noted that success in CBC projects and conservation enterprises may take years to emerge (Salafsky et al. 2001), which may be a function of the complex nature of social-ecological systems and the trial-and-error process through which institutions co-evolve with local conditions (Rammel et al. 2007). Interestingly, projects older than twelve years had a significantly greater proportion of synergies than younger projects, although this association may be due to the small sample size for projects of that age and could be a function of publication bias (see supplementary material text).

Importantly, the causal link between project age and win–win outcomes is unclear. While win–win outcomes may result from projects being given sufficient time to mature, it is plausible that projects that show early signs of success across multiple outcomes receive more financial and/or community support and are thus more likely to persist.
Joint success in conservation projects

The importance of project age and design features does not mean that community characteristics and national context are unimportant. It is well established that particular community characteristics can contribute to sustainable resource management (Agrawal 2001), and Tallis et al. (2008) present evidence that leads them to hypothesize that strong governance is important for win–win outcomes. Further, our bivariate analysis suggests that governance and HDI may contribute to win–win outcomes. However, the effect of national context may be mediated by project design or community characteristics in ways that we cannot discern through the exploratory analyses conducted here. A larger dataset and/or specific hypotheses for a smaller number of predictors would be needed to explore interactions with national context variables (e.g. Miller et al. 2015).

In addition, with this analysis I cannot make claims about direct synergies or tradeoffs between outcomes (Agrawal and Benson 2011). Joint success indicates neither a causal relationship between outcomes nor that the same underlying factor contributed to success in multiple outcomes. Similarly, the absence of win–win outcomes does not necessarily indicate direct tradeoffs whereby an increase in one outcome leads to a decline in another outcome. Instead outcomes may be related through complex feedbacks (Miller et al. 2012) or may be affected by independent factors. Longitudinal studies that indicate whether and how outcomes change over time and provide information on mechanisms underlying those changes are important for understanding causal relationships between outcomes. In addition, quasi-experimental designs (Ferraro and Hannauer 2014) and

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Figure 3 (a)–(d) Plots of the pooled coefficients (dots) and 95% confidence intervals (bars) (X-axis) for variables in the reduced-fit model for each outcome combination as selected by forward, stepwise AIC. Asterisks denote variables that are significantly associated with win–win outcomes for that combination. See supplementary material text for a discussion of the interpretation of the values for the pooled coefficients that are provided in Table S1 and are represented by the dots above.
quality reviews that examine linkages between key variables and outcomes across scales can also provide important insights (Robbins et al. 2015).

Finally, several potentially important predictors, such as local ecological conditions, supportive national policies, and economic heterogeneity, were excluded from the analysis due to insufficient information in the papers in our sample (see supplementary material text for additional omitted variables). These variables and others could also explain conservation success or failure and should be included in future work.

Conclusion

This study suggests that capacity building, local participation, environmental education, and project age are associated with joint success in CBC. These features may strengthen a community’s ability to participate in project management, capitalize on opportunities, respond to change, and adapt over time. While win–win outcomes are possible and it is important to explore when, where, and why they emerge, it is evident that tradeoffs are more common across all pairing examined here. Therefore, I reiterate calls (McShane et al. 2011) for project organizers to explicitly discuss the potential for tradeoffs in order to temper expectations and prepare communities to anticipate and manage conflicts that arise in the course of a CBC project.

Acknowledgments

This project was funded by the Beckman Institute, University of Illinois, Urbana-Champaign and the Ohio Agricultural Research and Development Center. I thank Kerry Waylen for her efforts with research design and coding, Monique Borgerhoff Mulder for guidance and feedback on early drafts, Peter Brosius at the Center for Integrative Conservation Research, University of Georgia for facilitating the initial research, Mark Grote for statistics advice, Shandell Brown, Lauren Weisenfluh, and David Kim for assistance with research, and two anonymous reviewers for very helpful suggestions.

Supporting Information

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

Table S1a-d. Results of logistic regression after step-wise, forward AIC model selection for each of the four combinations of outcome variables.

Table S2. Projects and associated publications included in the study.

Table S3. Summary statistics for all independent and dependent variables for raw data before imputing missing values.

Table S4. Correlation matrix of Spearman’s r values for independent variables used in the multivariate analysis for all five imputed datasets.

Figure S1. Proportion of win-win outcomes by project age for each combination. The sample size for each age grouping in each combination of outcomes is provided within the bars.

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