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“Why household inefficiency? An experimental approach to assess spousal resource distribution preferences in a subsistence population undergoing socioeconomic change”

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1 **Why household inefficiency? An experimental approach to assess spousal resource**  
2 **distribution preferences in a subsistence population undergoing socioeconomic change**

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51 **ABSTRACT**

52 Two disparate views of the sexual division of labour have dominated the  
53 representation of intra-household resource allocations. These *joint* and *separate* interests  
54 views differ in their interpretation of the relative roles of men and women, and make different  
55 predictions about the extent to which marriage promotes economic efficiency (i.e. maximized  
56 household production). Using an experimental “distribution task” stipulating a trade-off  
57 between household efficiency and spousal equality in allocating surpluses of meat and  
58 money, we examine factors influencing spousal distribution preferences among Tsimane  
59 forager-horticulturalists of Bolivia (n=53 couples). Our primary goal is to understand whether  
60 and how access to perfectly fungible and liquid resources – which increases with greater  
61 participation in market economies – shifts intra-household distribution preferences. We  
62 hypothesize that greater fungibility of money compared to meat results in greater squandering  
63 of money for individual fitness gain at a cost to the family. Money therefore requires costly  
64 strategies to insure against a partner’s claims for consumption. Whereas nearly all Tsimane  
65 spouses prefer efficient meat distributions, we find a substantially reduced efficiency  
66 preference for money compared to meat controlling for potential confounders (adjusted  
67 OR=0.087, 95% CI: 0.02-0.38). Reported marital conflict over paternal disinvestment is  
68 associated with a nearly 13-fold increase in odds of revealing a selfish money distribution  
69 preference. Selfish husbands are significantly more likely than other husbands to be paired  
70 with selfish wives. Lastly, Tsimane husbands and wives are more likely than Western  
71 Europeans to prefer an efficient money distribution, but Tsimane wives are more likely than  
72 Western European wives to exhibit a selfish preference. In sum, preferences for the  
73 distribution of household production surplus support joint and separate interests views of  
74 marriage; a hybrid approach best explains how ecological-, family-, and individual-level  
75 factors influence spousal preferences through their effects on perceptions of marginal gains  
76 within and outside the household.

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79 Keywords: Intra-household distribution, sexual division of labour, family, marriage,  
80 bargaining, Tsimane

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## 101 1. INTRODUCTION

102 Intra-household resource distribution determines energy budgets available for growth,  
103 reproduction and survival, and is thus central to understanding trade-offs underlying human  
104 life history allocations. The sexual division of labour and resources – perhaps the most basic  
105 form of human economic specialization and exchange (Murdock 1949) – is also a highly  
106 complex social relationship, entailing frequent cooperation and altruism but also defections  
107 and spite. Spouses face numerous barriers to generating economic surplus and allocating  
108 resources efficiently among family members, despite generally having more opportunities  
109 and willingness to share information than dyads in non-sexual relationships. Barriers include  
110 conflicting reproductive interests (Bird 1999; Borgerhoff Mulder and Rauch 2009; Gurven et  
111 al. 2009; Maynard Smith 1977; Parker et al. 1972; Smith et al. 2003; Stieglitz et al. 2012a;  
112 Stieglitz et al. 2011; Trivers 1972; Winking et al. 2007), asymmetric information and  
113 unobservable action (Ashraf 2009; Ashraf et al. 2014; Ligon 2011). These barriers can result  
114 in reduced marital quality, verbal and/or physical disputes over appropriate levels of work  
115 effort and use of time and resources (Flinn 1988; Hewlett and Hewlett 2008; Stieglitz et al.  
116 2012b), and can contribute to the development and maintenance of patriarchal social norms  
117 that reinforce and exacerbate these barriers.

118 A goal of this paper is to examine factors influencing intra-household resource  
119 distribution preferences of spouses using an experimental approach in a small-scale forager-  
120 horticultural society, the Tsimane of Bolivia. Given that Tsimane and other subsistence-level  
121 societies worldwide are witnessing rapid changes in livelihood and increasing access to cash-  
122 based economies, another goal is to examine whether and how spousal resource distribution  
123 preferences vary across populations differing in their reliance on cash and the extent to which  
124 spousal labour is more substitutable versus complementary. Despite the complexity  
125 highlighted above that emphasizes both cooperation and conflict among spouses, two  
126 disparate views of the sexual division of labour have dominated the representation of intra-  
127 household resource allocations.

128 According to a *joint interest* view, the origins of the nuclear family are rooted in a  
129 sexual division of labour where men hunt wild animals and women gather plant foods  
130 (Lovejoy 1981; Murdock and Provost 1973). The pair bond between sexes is viewed as a  
131 cooperative endeavour aimed at joint production of altricial offspring, where women “trade”  
132 paternity certainty for long-term provisioning and protection by men (Isaac 1978a; Lancaster  
133 and Lancaster 1983; Washburn and Lancaster 1968; Wood and Marlowe 2013). Marriage  
134 enables men and women to achieve fitness benefits by producing economies of scale such  
135 that the production of the pair exceeds the summed production of adults working alone  
136 (Gurven and Hill 2009; Gurven et al. 2009; Kaplan and Lancaster 2003). Spouses thus meet  
137 consumption demands by drawing from “pooled energy budgets” (Kramer and Ellison 2010;  
138 Reiche et al. 2009). This view is analogous to the “unitary” model of household decision-  
139 making in economics, where the household behaves as if it were a single unit with a single set  
140 of distribution preferences. Spouses either have identical preferences or only one spouse  
141 makes allocation decisions (Becker 1991). Because partner-specific labour proceeds are  
142 pooled in the joint budget, efficient intra-household labour allocation should be that which  
143 maximizes joint production; resource distributions should be efficient regardless of whether a  
144 husband or wife produces the resource.

145 An alternative *separate interests* view posits that fitness gains from economic  
146 efficiency alone cannot account for marriage. According to this view men’s work effort in  
147 foraging societies is not primarily motivated by a desire to provision offspring because men’s  
148 game acquisition is unpredictable or unreliable, and once acquired, game is shared widely  
149 with non-household members and not reciprocated (Hawkes 1991; Hawkes and Bliege Bird  
150 2002). This view proposes that men hunt because of the desirable social attention and mating

151 benefits that come from providing meat, which is a widely shared public good. Because  
152 hunting is difficult and requires substantial skill, strength, endurance and knowledge,  
153 successful hunting is difficult to fake and serves as an honest signal of underlying male  
154 quality to potential allies, mates and competitors (Bird et al. 2001). This signalling is  
155 effective because visibility of returning with a kill is high, and group members pay careful  
156 attention to men's hunting returns in order to obtain shares for themselves. Here men's work  
157 is viewed as a form of mating effort or status competition, rather than familial provisioning,  
158 so marriage is interpreted as a convention of publicly recognized property rights designed to  
159 reduce male mating competition, rather than a cooperative union designed to achieve  
160 economic efficiency. Women therefore choose good hunters because of their presumed  
161 genotypic or phenotypic quality, not because of their willingness to provide household  
162 resources. Intra-household distributions are thus expected to be inefficient (e.g. characterized  
163 by a spouse's selfishness) due to imperfect enforceability of marital contracts or  
164 informational asymmetries among spouses (Bloch and Rao 2002; Ligon 2011; Lundberg and  
165 Pollak 1993; Mazzocco 2007).

166 Joint and separate interests views differ in their interpretation of the relative roles of  
167 men and women in the energetics of reproduction and in the life history adaptation. While it  
168 is often acknowledged that household decision-making contains elements of both joint and  
169 separate interests views, empirical studies usually conclude by supporting one view or the  
170 other. The topic has thus generated much controversy in anthropology, with much of the  
171 debate focusing on production decisions (e.g. why hunters target large vs. small game) and  
172 less emphasis on how spouses distribute production surplus. However, hybrid approaches  
173 containing elements of both joint and separate interests views have a long history in  
174 household economics (Bobonis 2009; Chiappori 1988; Manser and Brown 1980; McElroy  
175 and Horney 1981). A key tenet of a joint interest view is that a sexual division of labour and  
176 resources characteristic of marriage facilitates efficiency and maximization of household  
177 economic surplus. Yet an inefficient non-cooperative equilibrium within marriage can still be  
178 more advantageous (in terms of utility or fitness) for both spouses than divorce, as supported  
179 by experimental research indicating that spouses are willing to reject joint surplus  
180 maximization for greater personal control over resources (Ashraf 2009; Mani 2011; Munro et  
181 al. 2006), and the observation that spouses pool income for some but not all categories of  
182 consumption (Phipps and Burton 1998). But even if divergent spousal interests are explicitly  
183 acknowledged (Almas et al. 2016; Anderson and Baland 2002; Basu 2006; Duflo and Udry  
184 2004; Gurven et al. 2009; Heath and Tan Under review; Lundberg and Pollak 1993; Schaner  
185 2015), the question of whether spousal preferences yield efficient outcomes, and what factors  
186 contribute to household inefficiency remain unresolved. Answering these empirical questions  
187 is essential to advance theoretical models of household behaviour (Del Boca and Flinn 2014;  
188 Munro et al. 2006).

189 Field experiments are uniquely poised to offer insight into these questions by  
190 manipulating intra-household distribution choices to reveal spousal preferences. Experiments  
191 provide novel inferences about whether and why preferences deviate from efficiency in ways  
192 that prior observational studies cannot. Field experiments also permit more controlled  
193 comparisons of intra-household dynamics across diverse societies.

### 194 195 *1.1. The distribution task*

196 Here we assess Tsimane spousal preferences regarding intra-household allocations  
197 using a "distribution task" (Beblo et al. 2015; Cochard et al. 2014) among spouses from the  
198 same marriage. In this task spouses must decide between two allocations of a resource  
199 between themselves and their partner. Each of five decisions provides the choice between  
200 option A (equally divided between partners) and option B (unequal division between partners)

201 but always efficient in terms of maximizing joint payoffs). Spouses thus face a trade-off  
202 between equality and efficiency (see Table 1). This equality-efficiency trade-off characterizes  
203 various allocation decisions regarding food, money and other household resources (Behrman  
204 1988; Engle and Nieves 1993; Farmer and Tiefenthaler 1995). The task is not designed to  
205 examine spousal production decisions per se (e.g. who acquires what), but rather how spouses  
206 distribute production surplus. The task permits identification of spouses who maximize joint  
207 payoffs (i.e. efficient), maximize their own payoff (extreme selfish), maximize their partner's  
208 payoff (extreme altruistic), or who are concerned with partner equality (inequality averse).  
209 No communication between partners is allowed during this one-shot exercise and one cannot  
210 deduce a partner's revealed preferences. While spousal interactions are obviously repeated  
211 and communication is possible outside of the experiment, many household decisions are  
212 made independently and provide incentives to free-ride on a partner. It must also be noted  
213 that participants have the possibility to choose the unequal but efficient payoff (option B) and  
214 then pool and distribute this payoff equally with a partner after the task. Inequality aversion  
215 thus does not necessarily prevent one from choosing option B, and the number of those  
216 choosing option A is only a lower bound estimate of the number of inequality averse  
217 participants. If pooling and distribution of payoffs after the task is in fact common among  
218 spouses, then one would expect a bias toward maximizing joint payoffs.

219  
220 Insert Table 1 here  
221

222 Individual preferences elicited by this task help determine the extent to which these  
223 patterns are consistent with joint and separate interests views, or a hybrid approach. A joint  
224 interest view predicts that spouses should always prefer to maximize joint payoffs (option B)  
225 regardless of whether inequality favours a husband or wife because partner-specific incomes  
226 are pooled. A separate interests view suggests that personal gains matter more than the pair's  
227 total joint gains. A "selfish" individual should choose option A for decisions where their own  
228 payoff is smaller than their partner's (Table 1A, questions 1-2), and choose option B when  
229 inequality favours oneself (Table 1A, questions 4-5). An "altruistic" individual should do the  
230 opposite. An "inequality-averse" individual should always choose option A. Any  
231 combination of pure individual preferences is possible. Degree of selfishness is related to the  
232 number of A choices in questions 1-2; degree of altruism is related to the number of A  
233 choices in questions 4-5. A separate interests view predicts that conditions increasing spousal  
234 conflict over optimal levels of household investments should promote inefficient, particularly  
235 selfish distribution preferences. A hybrid approach predicts that evidence consistent with both  
236 joint and separate interests views will be found, and that distinct preferences may be  
237 explained by factors impacting perceptions of gains within and outside the household, and  
238 relative bargaining power (Heath and Tan Under review).

### 239 240 *1.2. Study goals and predictions*

241 We determine spousal distribution preferences for two resource types, meat and  
242 money, which have been central to economic exchange throughout human history and thus  
243 central to models of intra-household distribution in anthropology and economics. Money,  
244 unlike meat, serves as an abstract store of value, can be easily converted into other valuable  
245 goods or services, can be easily divided into small or large values, and has only recently (past  
246 few millennia) emerged in human economic exchanges (Davies 1994). The greater fungibility  
247 and liquidity of money have been linked to diminished risk-seeking behaviour than when  
248 food is used as experimental currency (Rosati and Hare 2015). Because money is more  
249 fungible, storable, and easier to conceal than meat, it can more easily be squandered (e.g. on  
250 other sexual relationships, luxury goods, recreation) by a partner at substantial cost to the

251 family, and our prior work suggests that Tsimane husbands' diversions of sporadic wages  
252 away from the family for individual fitness gain (one indicator of paternal disinvestment) are  
253 a principal cause of verbal disputes and physical violence among spouses (Stieglitz et al.  
254 2011). The Tsimane represent an informative case study, relative to fully market-integrated  
255 populations, of how reliance on a mixed economy based primarily on subsistence but with  
256 increasing market involvement and reliance on cash can influence intra-household  
257 distribution preferences. Understanding variability in these preferences informs evolutionary  
258 economic models of the family by examining their basic predictions (e.g. whether household  
259 production surplus is maximized), and builds on a growing body of psychological and  
260 experimental economic research into how different resource types influence decisions  
261 underlying production and distribution (Rosati and Hare 2015).

262 We hypothesize that greater resource fungibility increases paternal disinvestment,  
263 thus favouring strategies employed by either spouse to protect fungible resources against a  
264 partner's claims for consumption (Anderson and Baland 2002). If these strategies are  
265 internalized then we should expect revealed preferences in the distribution task for equality  
266 over efficiency for fungible resources that are most vulnerable to exploitation by either  
267 spouse. We test whether greater resource fungibility (i.e. money vs. meat) is associated with  
268 reduced preference for joint efficiency (P1). This prediction is inconsistent with a joint  
269 interest view that spouses are unequivocally motivated to maximize household production  
270 surplus.

271 In the distribution task distinct motivations can underlie one's preference for spousal  
272 equality (i.e. household inefficiency) including inequality aversion, selfishness (if efficiency  
273 entails less for oneself than equality), altruism (if efficiency entails less for one's spouse than  
274 equality) or irrationality (Table 1). These alternatives highlight the fact that equal but  
275 inefficient distribution preferences may still exist in harmonious marriages where spousal  
276 interests converge. To tease apart these alternatives and examine whether potentially  
277 divergent spousal interests affect revealed preferences, we test whether for a perfectly  
278 fungible resource like money, lower self-reported marital quality is associated with inefficient  
279 distribution preferences (P2). Specifically, reported marital conflict over paternal  
280 disinvestment – indicating differential consumption choices between spouses – should be  
281 associated with selfish money distribution preferences by either spouse (P2a).

282 In a stable marriage market, where spouses provide complementary investments,  
283 resource distribution preferences of spouses should be correlated (Becker 1991) such that  
284 efficient spouses are assortatively paired. This assortment may reflect either one's preference  
285 for a partner with similar characteristics, consensus preferences in the market for desired  
286 characteristics (e.g. with desirable spouses choosing each other, and less desirable spouses  
287 "settling" for each other), propinquity effects, or convergence (i.e. the tendency for spouses  
288 to become more similar over time). We thus test whether distribution preferences of spouses  
289 are correlated (P3).

290 Lastly, we hypothesize that population-level differences in economic organization and  
291 the nature and degree of spousal interdependence are associated with population-level  
292 differences in revealed distribution preferences. We test whether Tsimane exhibit a greater  
293 preference for efficiency relative to a comparative Western European sample (P4). Tsimane  
294 reliance on a mixed hunting/foraging/horticultural economy coupled with their high fertility  
295 favours greater sex-specific economic specialization, generating a complementarity where  
296 hunted foods complement gathered/farmed foods, and men's focus on hunting increases  
297 women's time spent in childcare or subsistence efforts compatible with childcare (Kaplan and  
298 Lancaster 2003). In contrast, competitive labour/consumer markets and greater labour market  
299 participation and income earned by women can reduce the value of a sexual division of  
300 labour by making men's and women's parental investments more substitutable and less

301 complementary. When investments are less complementary and more substitutable, as more  
302 commonly occurs in market-integrated Western Europe versus subsistence-level Tsimane,  
303 then spousal resource distribution preferences are expected to be less efficient (all else equal).  
304

## 305 **2. MATERIAL AND METHODS**

### 306 *2.1. Study population*

307 Tsimane are semi-sedentary forager-horticulturalists living in the Bolivian Amazon.  
308 They inhabit 90+ villages ranging in size from ~50–550 individuals. They cultivate plantains,  
309 rice, corn, sweet manioc and other crops in small swiddens, and regularly fish and hunt.  
310 These foods comprise >90% of the diet, with the remainder purchased from market stores or  
311 obtained from trade with itinerant merchants. Tsimane live in extended family clusters, where  
312 the majority of food and labour sharing occurs. Modern contraceptives are rarely used and  
313 total fertility rate is high (9 births per woman) (Kaplan et al. 2015; McAllister et al. 2012).

314 There are no formal marriage ceremonies and a couple is considered married when  
315 they sleep together in the same house. Mean±SD age at first marriage for men and women in  
316 the present sample is 20.8±2.9 and 17.4±4.0, respectively. Post-marital residence rules are  
317 flexible but emphasize matrilocality early in marriage and patrilocality thereafter. Tsimane  
318 marriages are generally stable: men and women aged 45+ report a mean of 1.3 lifetime  
319 marital partners (Stieglitz et al. 2012a). Polygyny is infrequent (<10% of married adults) and  
320 usually sororal (Winking et al. 2013). Important characteristics of long-term mates for both  
321 sexes include industriousness and a good character (Gurven et al. 2009). Despite a lack of  
322 patriarchal norms and limited residential privacy, physical wife abuse is not uncommon and  
323 when it occurs is often triggered by verbal disputes over paternal disinvestment (Stieglitz et  
324 al. 2012b; Stieglitz et al. 2011). Within marriage there is a belief that a husband's infidelity  
325 leads to his children's sickness and potentially death.

326 “Modernization”, defined here as a trend toward urban residence and participation in  
327 the market (cash) economy, takes several forms: visits to the closest market town (San Borja),  
328 sale of horticultural and other products, itinerant wage labour (e.g. with ranchers) and  
329 schooling. Most wage opportunities are only available to men, are low income and sporadic.  
330 Many villages now have elementary schools (up to 5<sup>th</sup> grade) taught by bilingual (Spanish-  
331 Tsimane) teachers, many of whom are Tsimane trained by missionaries. Secondary schools  
332 now exist in several larger villages, and young Tsimane adults are starting to become high  
333 school graduates. Generally, however, school attendance rates are low or inconsistent and  
334 adult literacy rate is low (34% in the present sample). Fluency in the Tsimane language  
335 (which is unrelated to Spanish) is universal as Tsimane remains the native language; 39% of  
336 adults (76% male) are fluent in Spanish. Mean±SD years of schooling for men and women is  
337 6.6±4.7 and 3.8±3.8, respectively.  
338

### 339 *2.2. Experimental assessment of spousal resource distribution preferences*

340 A “distribution task” consisting of 15 questions was completed by husbands and  
341 wives from the same monogamous marriage (n=53 couples). Neither literacy nor Spanish  
342 fluency was required to participate, as respondents could either state their response and/or  
343 point toward a relevant image depicted on a laminated card to respond (see Electronic  
344 Supplementary Material [ESM] for additional experimental details including examples of  
345 images presented to respondents [Figure S1]). The experiment was conducted in two villages  
346 by JS and an assistant in the Tsimane language to increase informants' comfort levels. Basic  
347 numeracy was required to participate, and all respondents possessed this ability.

348 For each question, a respondent selects one of two options specifying his/her  
349 preferred allocation of a resource between him/herself and a partner (see Table 1 and (Beblo  
350 et al. 2015; Cochard et al. 2014) for details on the original implementation of this task among



351 French and German couples). Tsimane respondents were queried about their distribution  
352 preferences for meat (dried and fresh) and money (Western Europeans were only queried  
353 about money). The task thus consisted of three rounds with five questions per round: round  
354 one choices concerned actual shares of dried meat, where responses determined participant  
355 compensation (see ESM and this section, below); round two choices concerned hypothetical  
356 shares of money (unincentivized); and round three choices concerned hypothetical shares of  
357 fresh meat (unincentivized). Round three was included to assess whether incentivizing  
358 options affects preferences for the same resource type (by comparing round three vs. round  
359 one preferences), and serves as a more natural comparison of preferences across resource  
360 types (by comparing round three vs. round two preferences, neither of which were  
361 incentivized). Across rounds, values of meat (dried or fresh) and money presented to  
362 respondents in each image are equivalent (e.g. 0.67 kg of actual dried meat = 30 Bolivianos  
363 [Bs] depicted in the image = 23.6 oz. of fresh meat depicted in the image). Any difference in  
364 preferences for meat versus money therefore cannot be attributed to a difference in value  
365 across resource types. Rounds, questions and options are presented in random order (i.e. not  
366 as shown in Table 1).

367 To recruit study participants, a radio message<sup>1</sup> was first presented in the Tsimane  
368 language that briefly introduced study objectives and logistics (e.g. participating villages,  
369 sampling restriction to married adults only, participant compensation). The following day the  
370 researchers held a village meeting, during which study objectives and protocols were  
371 explained in greater detail and any married meeting attendee was invited to participate with  
372 his/her spouse. The first village meeting was well attended since it was also held,  
373 coincidentally, to discuss plans for well construction by an independent engineering  
374 organization. High meeting attendance increased the pool of potential study participants, and  
375 limited self-selection by demographics, schooling and other factors (e.g. marital quality).

376 During both village meetings and individual trials we explained to participants that  
377 they would receive two pay-outs of dried meat: 1) a show-up gift of 0.67 kg for each  
378 participant (worth 30 Bs or \$4.30 USD), and 2) up to another 0.67 kg (but as little as 0 kg)  
379 based on their distribution task responses in round one. We explained that compensation  
380 would be provided after all couples in the village participated. We selected dried meat as  
381 compensation because meat is always in high demand, regardless of market involvement, and  
382 because it is storable (~1 month). Participants thus did not feel pressure to consume the meat  
383 immediately and could freely choose whether and how to distribute it. Money was not used as  
384 compensation to avoid commodification and to minimize sample bias (e.g. money may  
385 appeal more to individuals with greater market involvement, thus potentially biasing  
386 participation rates). The total value of compensation per respondent was equivalent to one-  
387 half to one day's worth of wage labour, as has been used in economic experiments worldwide  
388 (Henrich et al. 2005). To incentivize decisions and ensure anonymity, one response in round  
389 one for each couple was randomly selected for the second pay-out. This pay-out was  
390 determined by two dice rolls: one to select whether the husband's or wife's round one  
391 response would be used, and another to choose the response. We repeatedly emphasized that  
392 responses were private and that a spouse would have no opportunity to discover one's own  
393 responses even after receiving compensation. Each participant received both pay-outs of  
394 dried meat simultaneously (i.e. in the same plastic bag), and could not deduce a partner's  
395 responses from the weight of the bag. During the experiment participants could not  
396 communicate with others, including spouses.

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<sup>1</sup>A former Protestant Mission maintains a radio station in San Borja which communicates messages to listeners at fixed hours each day. Most Tsimane hear these messages (or have a neighbour who hears messages and then informs non-listeners) on their personal home radios.

397 Distribution task instructions were translated into Spanish and then Tsimane by a  
398 bilingual Tsimane research assistant and JS. To test translation accuracy the Tsimane  
399 instructions were then back-translated into Spanish by a different Tsimane researcher, and  
400 discussions among the two Tsimane and JS ensued until an effective translation was found.  
401 Considerable care was taken to explain the instructions simply, both verbally and using the  
402 laminated cards (see ESM). After explaining instructions to each respondent in private, the  
403 respondent was asked two questions to test their comprehension. All respondents correctly  
404 answered both questions before beginning the study. Respondents were informed that there  
405 was no right or wrong way to complete the task, and were repeatedly encouraged to ask  
406 questions if anything was unclear. To further ensure comprehension we explained to  
407 participants how a given resource was actually distributed between spouses while the  
408 participant was presented with each question (15 questions\*2 options/question\*2  
409 partners/option=60 explanations/respondent). This combination of simultaneous visual  
410 presentation and verbal explanation ruled out the possibility that individuals were responding  
411 by rote without actually considering the efficiency-equality trade-off. Indeed, for each  
412 question most participants were observed to be correctly “doing the math” prior to  
413 responding. Participants were encouraged to carefully consider each option before  
414 responding, and to use as much time as needed. Once a response was provided the participant  
415 was asked if he/she was certain, while also being reminded of the implications for not having  
416 chosen the alternative. Participants were also asked to explain their responses using an open-  
417 ended format (i.e. “Why did you choose option A and not B?”). From these open-ended  
418 questions it was clear that respondents understood the task and actively considered the  
419 alternative on a question-by-question basis. The experimenter looked only at the laminated  
420 card (or bowls of dried meat) when participants responded to avoid inadvertent social cuing.

421 To gain insight into respondents’ task perception, respondents were asked post-  
422 experiment whether task decisions resembled those encountered in daily life (unrealistic=0,  
423 slightly realistic=1, realistic=2) and whether decisions were difficult (easy=0, slightly  
424 difficult=1, difficult=2). Over half of respondents (62% men, 55% women) perceived  
425 decisions as realistic; 68% of men and 66% of women perceived decisions as easy.

### 426 427 *2.3. Self-reported marital quality and socio-demographics*

428 After the experiment, participants were queried about the frequency of serious verbal  
429 disputes with their spouse in the past three months (0=none, 1=once per month, 2=once per  
430 week, 3=several per week, 4=daily). Participants then reported, without prompts, the cause of  
431 their most frequent serious verbal disputes in the past three months. This open-ended, free-  
432 listing technique was used because it does not force respondents into selecting preconceived  
433 categories and allows for a more thorough account than otherwise possible. We focused on  
434 the most serious disputes because we reasoned that they would provide the most accurate  
435 recall. No restriction was placed on the number of disputes that one could mention. After  
436 each dispute was reported, we systematically queried participants about the relevance of other  
437 potential causes (Stieglitz et al. 2012b; Stieglitz et al. 2011). For example, if a wife reported a  
438 dispute over a husband’s excessive alcohol consumption (one indicator of paternal  
439 disinvestment), we then asked the wife whether this dispute was also caused by the husband’s  
440 neglect of particular subsistence tasks, childcare or domestic tasks, the husband’s excessive  
441 social visitation, or other causes (see ESM for additional details).

442 Age and marital duration were estimated based on a combination of methods  
443 described elsewhere (Winking et al. 2013). Parity, schooling, Spanish fluency and literacy  
444 were assessed during annual census updates conducted by the Tsimane Health and Life  
445 History Project. After the experiment husbands were asked about their wage labour

446 involvement (i.e. time elapsed since the last wage opportunity, and daily earnings from this  
447 opportunity) to gain further insight into market participation.

448 Mean $\pm$ SD age of husbands and wives is 34.8 $\pm$ 12.2 and 30.9 $\pm$ 12.0, respectively.  
449 Mean $\pm$ SD marital duration is 12.4 $\pm$ 10.5 years (range: 1 month-46 years), and mean $\pm$ SD  
450 number of joint children is 3.2 $\pm$ 3.5 (range: 0-13).

451 Procedures for all methods were approved by the UNM Human Subjects Review  
452 Board, Tsimane government, village leaders and study participants.

453

#### 454 *2.4. Data analysis*

455 Outcomes include responses to individual distribution task questions, and aggregate  
456 responses in a given round (see electronic appendix). The latter are used to classify  
457 respondents as follows: always maximize joint payoffs (efficient), always maximize a  
458 partner's payoff (extreme altruist), or always maximize own payoff (extreme selfish). To  
459 classify other respondents whose aggregate preferences are not represented, we calculate a  
460 ratio of "own payoff" to "couple payoff" summed over the five questions in a round. We  
461 calculate for the five questions the sum of own payoff divided by the sum of couple payoffs,  
462 which corresponds to the share of the total payoff retained by the respondent. If this share  
463 equals 0.5 then respondents are classified as "symmetric-inequality averse" (i.e. their  
464 preference is symmetric around question #3); if this share is greater (or lower) than 0.5  
465 respondents are classified as "asymmetric selfish" (or "asymmetric altruist"). Respondents  
466 who did not select option B for question #3 are classified as "irrational".

467 We utilize both within- (P1) and between-subjects (P2-P4) comparisons to test  
468 predictions. Chi-square and Mann-Whitney *U* tests are used for descriptive analyses.  
469 Generalized estimating equations (GEE) analyses are used to model effects of resource type  
470 on the probability of choosing an efficient distribution. This method accounts for the  
471 correlated structure of a dependent variable arising from repeated measures on the same  
472 individual (Liang and Zeger 1986). There is no standard absolute goodness-of-fit measure  
473 with the GEE method (Pan 2001), which does not make distributional assumptions and uses a  
474 quasi-likelihood rather than full likelihood estimation approach (see Pan 2001 for a general  
475 formulation). Logistic regression is used for between-subjects analyses to model the  
476 probability of being classified as efficient (or selfish, etc.) based on aggregate preferences. A  
477 stepwise approach is used to fit regression models. Parameter estimates are reported as odds  
478 ratios (ORs) or predicted probabilities. GEE and logistic regressions assume that between-  
479 subjects measurements are independent, which may not be realistic if spousal distribution  
480 preferences are correlated (P3). We therefore repeated analyses after including a random  
481 intercept for couple ID in mixed effects logistic regressions, although couple ID did not yield  
482 a significant variance estimate or affect results. Fixed effects of village ID and distribution  
483 task question number (indicating degree and direction of inequality) were also not significant  
484 and omitted. For all continuous predictors we tested for non-linear associations using  
485 quadratic or cubic terms. To test for population-level differences in money distribution  
486 preferences we merged French and German samples into one "Western European" sample;  
487 differences between French and Germans have been reported elsewhere (Beblo et al. 2015)  
488 and are not of primary interest here.

489

### 490 **3. RESULTS**

#### 491 *3.1. Classification of Tsimane spouses based on aggregate distribution task preferences*

492 No respondent is classified as "extreme selfish" or "irrational" for either resource type  
493 (meat [dried or fresh] or money). When meat distribution options are incentivized (dried  
494 meat), all respondents choose efficiency (Figure 1). When meat distribution options are not  
495 incentivized (fresh meat), all husbands and nearly all wives (96%) still choose efficiency,

496 indicating that incentivizing options does not strongly affect preferences for the same general  
497 resource type.

498 For money, most husbands (87%) and wives (70%) choose efficiency. Wives not  
499 consistently preferring efficiency are either asymmetric selfish (hereafter “selfish” unless  
500 otherwise noted, 13%), asymmetric altruistic (8%), symmetric-inequality averse (hereafter  
501 “symmetric”, 6%) or extreme altruistic (4%). Selfish wives are more likely than other wives  
502 to report a spousal dispute over paternal disinvestment (86% vs. 17%, Fisher’s Exact  
503  $p=0.001$ ) (Table S1), but do not differ from other wives in terms of demographics, indicators  
504 of modernization or task perception. Husbands not consistently preferring efficiency are  
505 either selfish (6%), symmetric (6%) or extreme altruistic (2%)<sup>2</sup> (Figure 1). Efficient husbands  
506 are more likely than other husbands to be fluent in Spanish (63% vs. 29%, Fisher’s Exact  
507  $p=0.096$ ) and earn more per day from their last wage opportunity (mean=68 vs. 57 Bs, Mann-  
508 Whitney U  $p=0.081$ ) (Table S2). Wives are less likely than husbands to choose efficiency  
509 ( $\chi^2=4.50$ ,  $p=0.034$ , 106 individuals), are more likely to be asymmetric altruistic (Fisher’s  
510 Exact  $p=0.059$ ), but are not more likely to be selfish ( $\chi^2=1.77$ ,  $p=0.184$ ).

511

512

Insert Figure 1 here

513

514 *3.2. Is greater resource fungibility (i.e. money vs. meat) associated with reduced preference*  
515 *for joint efficiency (P1)? Yes.*

516 Tsimane respondents selected the inefficient option for 6.1% of observations<sup>3</sup>, and  
517 90.4% (47/52) of inefficient responses occur with money as the resource type. Probability of  
518 choosing efficiency is much lower for money (adjusted  $OR_{Money}=0.087$ , 95% CI: 0.02-0.38,  
519  $p=0.001$ ) after controlling for potential confounders including demographics and indicators of  
520 marital quality, modernization and task perception (Table S3). Holding significant  
521 confounders constant (at the sample mean), the predicted probability of choosing efficiency is  
522 0.99 for meat and 0.92 for money; these probabilities do not change after including fixed  
523 effects of village ID and distribution task question number (indicating degree and direction of  
524 inequality), which are not significant. Across resource types, inefficient responses of both  
525 husbands and wives are equally prevalent based on whether a husband or wife receives the  
526 greater resource share (i.e. half of inefficient responses [husbands: 8/16, wives: 18/36] occur  
527 when a wife receives the greater share, and half occur when a husband receives the greater  
528 share) (Figure S2). Resource type effect size is therefore similar if regressions are restricted  
529 to question #'s 1-2 (inequality favours wife) or to question #'s 4-5 (inequality favours  
530 husband). Inclusion of separate interaction terms between resource type and either age, sex or  
531 number of joint children does not yield significant parameter estimates.

532

533 *3.3. Is lower self-reported marital quality associated with inefficient – particularly selfish –*  
534 *money distribution preferences (P2)? Yes.*

535 Inefficient preferences can result from selfishness, altruism or inequality aversion, but  
536 analyses in section 3.2 do not distinguish between these alternatives. To test P2 it is therefore  
537 necessary to conduct between-subjects analyses using aggregate responses.

---

<sup>2</sup>Total≠100 due to rounding.

<sup>3</sup>For consistency the sample is restricted to distribution preferences for fresh meat and money (both of which are unincentivized and elicited using hypothetical resources); preferences for dried meat (which are incentivized and elicited using the actual resource) are omitted from analyses. Moreover, for each resource type responses to question #3 (where there is no efficiency-equality trade-off) are omitted because no respondent selected the irrational option A. The analysis sample is thus 848 observations (2 resource types [fresh meat and money]\*4 questions/type\*106 respondents).

538 Sixty-nine percent of respondents (66% husbands, 72% wives,  $\chi^2=0.396$ ,  $p=0.529$ )  
539 reported having a serious verbal dispute with a partner in the past three months. Respondents  
540 who reported having a dispute are more likely paired with someone who likewise reported a  
541 dispute ( $\chi^2=6.324$ ,  $p=0.012$ ), indicating spousal consistency in reporting. Further, respondents  
542 who reported having a dispute over paternal disinvestment (15% husbands, 26% wives,  
543  $\chi^2=2.065$ ,  $p=0.151$ ) are more likely paired with someone who also reported this same type of  
544 dispute (Fisher's Exact  $p=0.023$ ). Disputes over paternal disinvestment are among the most  
545 commonly free-listed disputes by both sexes (Figure S3).

546 As predicted, those reporting paternal disinvestment disputes are more likely to be  
547 selfish ( $OR_{Disinvestment}=12.6$ , 95% CI: 2.93-54.28,  $p=0.001$ ). Respondents reporting any  
548 disinvestment dispute trend toward being less efficient ( $OR_{Disinvestment}=0.38$ , 95% CI: 0.14-  
549 1.07,  $p=0.067$ ), but this negative effect weakens slightly after including demographic controls  
550 ( $OR_{Disinvestment}=0.47$ , 95% CI: 0.16-1.39,  $p=0.172$ , controlling for age, age<sup>2</sup> and sex).  
551 However, respondents reporting any recent dispute are not less likely than other respondents  
552 to choose efficiency, but trend toward being less altruistic after controlling for potential  
553 confounders (adjusted  $OR_{Dispute\ Reported}=0.258$ , 95% CI: <0.01-2.02,  $p=0.1$ ) (Table 2). No  
554 indicator of modernization or task perception is significantly associated with aggregate  
555 distribution task preferences in bivariate or stepwise regressions, thus ruling out these  
556 potential confounders. The fact that preferences for inefficiency and greater selfishness are  
557 associated with paternal disinvestment disputes – but not any dispute (Table 2) – reduces the  
558 possibility that other types of marital conflicts influence this association. Indeed, in separate  
559 analyses (not shown) aggregate distribution task preferences among respondents reporting  
560 disputes other than paternal disinvestment (e.g. over a wife's "neglect" of domestic work, see  
561 Figure S3) are not significantly different from respondents reporting no such disputes. We  
562 find no significant interaction effect of sex and dispute reports (over paternal disinvestment  
563 or other causes) on preferences. Similarly, no indicator of modernization interacts with  
564 dispute reports to affect preferences.

565

566

Insert Table 2 here

567

568 *3.4. Are distribution preferences of spouses correlated (P3)? Partially.*

569

To test P3 we restrict analyses to money distribution preferences given limited  
570 variance in meat distribution preferences. Seventy-four percent of efficient husbands ( $n=46$ )  
571 are paired with efficient wives, compared to 33% of selfish ( $n=3$ ), 0% of altruistic ( $n=1$ ) and  
572 67% of symmetric husbands ( $n=3$ ) (Figure 2). Efficient husbands are less likely than other  
573 husbands to be paired with selfish wives ( $OR_{Husband\ efficient}=0.127$ , 95% CI: 0.02-0.78,  
574  $p=0.026$ ,  $n=53$ ), and efficient husbands are more likely (albeit not significantly) paired with  
575 efficient wives ( $OR_{Husband\ efficient}=3.778$ , 95% CI: 0.74-19.38,  $p=0.11$ ). Sixty-seven percent of  
576 selfish husbands are paired with selfish wives, compared to 9% of efficient, 0% of altruistic  
577 and 33% of symmetric husbands (Figure 2). Selfish husbands are more likely paired with  
578 selfish wives ( $OR_{Husband\ selfish}=18.000$ , 95% CI: 1.38-235.69,  $p=0.028$ ). These results – while  
579 based on a small sample size – do not change controlling for schooling of each spouse, which  
580 is moderately positively correlated (Pearson  $r=0.37$ ,  $p=0.006$ ). Results also do not change  
581 controlling for task perception of each spouse, which is positively correlated for one but not  
582 both indicators (agree task easy:  $\chi^2=4.02$ ,  $p=0.045$ ; agree task realistic:  $\chi^2=0.29$ ,  $p=0.591$ ).  
583 Spousal distribution preferences are not more strongly correlated with increasing marital  
584 duration, suggesting minimal/no convergence in preferences over time.

585

586

Insert Figure 2 here

587 3.5. Are efficient money distribution preferences more common among Tsimane than Western  
588 Europeans (P4)? Yes.

589 We restrict analyses of P4 to money distribution preferences since Western Europeans  
590 were not queried about preferences for other resource types. Tsimane husbands and wives are  
591 more likely than Western Europeans to choose efficiency (husbands: 87% vs. 56%,  $\chi^2=15.87$ ,  
592  $p<0.001$ ,  $n=209$ ; wives: 70% vs. 53%,  $\chi^2=4.80$ ,  $p=0.028$ ,  $n=209$ ) (Figure 3; Table S4). The  
593 group-level difference is significant controlling for age and sex (adjusted  $OR_{Tsimane}=2.631$ ,  
594 95% CI: 1.56-4.45,  $p<0.001$ ,  $n=418$ ), and is not attenuated after including other demographic  
595 covariates (marital duration, spousal age difference or number of co-resident children).  
596 Inclusion of a group-by-age interaction term yields a significant parameter estimate  
597 (interaction  $p=0.01$ , controlling for sex), indicating that Western Europeans but not Tsimane  
598 are less likely to choose efficiency with age (Figure S4). Inclusion of additional interaction  
599 terms between group and other demographic predictors does not yield significant parameter  
600 estimates.

601 Despite no Tsimane being classified as “extreme selfish”, Tsimane wives are more  
602 likely than Western Europeans to exhibit selfish preferences (asymmetric selfish or extreme  
603 selfish) (wives: 13% vs. 3%, Fisher’s Exact  $p=0.007$ ; husbands: 6% vs. 7%, Fisher’s Exact  
604  $p=0.506$ ). There is a significant group-by-sex interaction effect on the probability of  
605 exhibiting any selfish preference (interaction  $p=0.033$ , controlling for age) (Figure S5).  
606 Inclusion of other demographic predictors as either main effects or interacting with group  
607 does not yield significant parameter estimates.

608 There are no group-level differences in the probability of exhibiting altruistic  
609 preferences (asymmetric altruist or extreme altruist) (Figure 3; Table S4). Tsimane husbands  
610 and wives are less likely than Western Europeans to prefer a symmetrical distribution  
611 (husbands: 6% vs. 20%,  $\chi^2=5.87$ ,  $p=0.015$ ; wives: 6% vs. 30%,  $\chi^2=12.51$ ,  $p<0.001$ ). These  
612 group-level differences are significant controlling for age and sex (not shown); inclusion of  
613 other demographic predictors as either main effects or interacting with group does not yield  
614 significant parameter estimates.

615

616 Insert Figure 3 here

617

#### 618 4. DISCUSSION

619 Using an experimental approach stipulating a trade-off between household efficiency  
620 and spousal equality in distributing production surplus, we find that Tsimane spouses  
621 strongly prefer efficient meat distributions. Meat distribution preferences are similar for  
622 unincentivized responses (Figure 1), and are consistent with a joint interest view that  
623 marriage in small-scale societies achieves economic efficiency and maximization of  
624 household production surplus (Isaac 1978b; Kaplan and Lancaster 2003; Lancaster and  
625 Lancaster 1983; Lovejoy 1981; Murdock and Provost 1973). The efficiency preference is  
626 apparent even though our distribution task does not specify who acquired the resource, which  
627 could in principle minimize salience of the perceived benefits provided by sex-specific  
628 economic specialization and complementarities between spouses’ distinct productive efforts.  
629 The fact that Tsimane women in particular prefer household efficiency – regardless of  
630 whether a wife or husband possesses meat – is not compatible with a separate interests view  
631 that women’s mate choice is indifferent to men’s willingness to provide acquired game for  
632 household consumption.

633 Consistent with P1 we find a much stronger efficiency preference for meat compared  
634 to money, despite the fact that both resources are almost exclusively acquired by men in this  
635 socioecological context. Including numerous potential confounders does not influence the  
636 strong effect size of resource type, equivalent to an 11-fold increase in odds of choosing

637 efficiency for meat compared to money. While most spouses prefer efficiency over other  
638 distributions (Figure 1), inefficient preferences result from a combination of selfishness,  
639 altruism and inequality aversion. This variability in preferences is consistent with a hybrid  
640 approach containing elements of both joint and separate interests views of marriage (Table  
641 1B) (Gurven et al. 2009). The preference for household inefficiency may be related to intra-  
642 household inequality aversion since no Tsimane prefers to maximize his/her own monetary  
643 payoff (extreme selfishness) and only 3% prefer to maximize a partner's payoff (extreme  
644 altruism). Despite the possibility of post-experiment payoff pooling resulting in an equal  
645 distribution regardless of revealed preferences, 22% of Tsimane (13% men, 30% women)  
646 prefer the inefficient but equal money distribution option at least once (47/530 round two  
647 observations [8.9%]), providing a lower bound prevalence of inequality aversion.

648 Our finding that meat and money elicit different preferences is broadly consistent with  
649 prior experimental and neuroimaging research indicating that people make value-based  
650 decisions differently when faced with decisions about money versus either food or other  
651 concrete inedible payoffs (Rosati and Hare 2015). People exhibit fewer risk-seeking  
652 preferences and reduced reward discounting for money, even in small amounts, compared to  
653 desirable food or inedible prizes. Distinct brain regions also appear to underlie value-based  
654 decisions based on whether payoffs are monetary or not (Clithero and Rangel 2014). It has  
655 thus been suggested that different psychological processes motivate decisions about abstract  
656 compared to concrete payoffs of similar value. Money may uniquely influence decision-  
657 making because of its fungibility and liquidity, as people exhibit fewer risk-seeking  
658 preferences in experiments when money can be freely exchanged for other payoffs compared  
659 to when this ability is constrained (Rosati and Hare 2015). Taken together, this prior research  
660 – usually conducted in Western populations and in contexts where payoffs are not divided  
661 with others – suggests that expectations about resource fungibility and liquidity directly affect  
662 consumption decisions. The present study generalizes to a non-Western subsistence-level  
663 population the finding that money elicits different preferences for use compared to food, and  
664 provides an ultimate explanation for why resource fungibility and liquidity is central to  
665 understanding consumption and distribution preferences within households.

666 We hypothesized that the greater fungibility of money compared to meat, and as a  
667 result the greater potential to squander money for individual fitness gain at a cost to the  
668 family (Stieglitz et al. 2012a), favours unique individual strategies to protect money against a  
669 partner's claims for consumption (Anderson and Baland 2002). As expected if these  
670 strategies are internalized, we find that spouses are more likely to reject household efficiency  
671 for an equal distribution of the highly fungible resource most vulnerable to exploitation by a  
672 partner. This finding is not compatible with a joint interest view that spouses are  
673 unequivocally motivated to maximize household production regardless of resource type.  
674 Resource fungibility may be one of several resource characteristics (e.g. in addition to  
675 variance in daily acquisition, degree of complementarity with other household investments)  
676 that influence perceptions of the marginal gains from individual consumption and distribution  
677 (Kaplan and Gurven 2005).

678 Consistent with P2 we find that reported marital conflict over paternal disinvestment  
679 is associated with a nearly 13-fold increase in odds of revealing a selfish money distribution  
680 preference (Table 2). Greater preference for costly selfishness is uniquely associated with  
681 recent paternal disinvestment disputes, but not any other recent marital disputes, which is  
682 broadly consistent with prior research indicating that paternal disinvestment is the principal  
683 cause of intense verbal and physical conflict among Tsimane spouses (Stieglitz et al. 2012b).  
684 Paternal disinvestment thus presents a principal barrier to allocating household resources  
685 efficiently, as suggested by a separate interests view that spousal disagreement over  
686 appropriate use of household resources leads to costly selfish actions (Bloch and Rao 2002;

687 Borgerhoff Mulder and Rauch 2009; Mani 2011; Munro et al. 2006). Experimental research  
688 in rural Kenya demonstrates that greater spousal heterogeneity in discounting preferences –  
689 similarly indicating differential consumption choices – leads to inefficient and selfish savings  
690 behaviour, whereas greater spousal homogeneity in preferences facilitates household  
691 efficiency in savings (Schaner 2015). Our results suggest that greater resource fungibility per  
692 se can promote costly selfish actions even among spouses with homogenous allocation  
693 preferences, and that actions are explained by factors impacting perceptions of individual  
694 fitness gains within and outside of marriage.

695 Despite a small sample size, we find partial support for P3, as selfish husbands are  
696 significantly more likely than other husbands to be paired with selfish wives. Marital  
697 assortment may result from “market forces”, i.e., consensus in the marriage market regarding  
698 desirable partner characteristics. If selfishness is a characteristic that most find undesirable in  
699 a partner, then selfish individuals should attract fewer partners and thus pair with the less  
700 desirable (in this case, other selfish individuals). Similar logic may explain why efficient  
701 husbands are less likely paired with selfish wives, although we cannot rule out alternative  
702 explanations (e.g. propinquity effects, preference for a partner with similar characteristics as  
703 oneself). Among Tsimane, work effort and productivity are important mate choice criteria for  
704 both sexes, spouses engage in similar levels of work effort, and time allocation to work for  
705 each spouse is positively associated with fertility (Gurven et al. 2009). Positive assortment by  
706 personality is also evident for traits such as agreeableness and conscientiousness  
707 (unpublished data), which may facilitate household coordination and efficiency. Spousal  
708 distribution preferences are not more strongly correlated with increasing marital duration,  
709 which ranges from one month to 46 years in the present sample. Assortment may therefore be  
710 due to initial preferences upon union formation rather than preference convergence over time.  
711 Odds of being paired with an efficient wife are nearly four-fold higher for efficient versus  
712 inefficient husbands, although the effect is not significant because of the small sample size of  
713 inefficient husbands ( $n=7$ , see Figure 2). Given the percentage of efficient and inefficient  
714 husbands paired with efficient wives (74% and 43%, respectively), a post-hoc power analysis  
715 indicates that a sample size of 125 husbands (a 136% increase from the current sample size)  
716 would be required to attain 80% power at an alpha of 0.05 with an identical unbalanced  
717 design. Obtaining this larger sample would have entailed visiting multiple additional Tsimane  
718 villages, which was not possible given various constraints. Nevertheless, prior experimental  
719 studies with larger sample sizes in rural Africa find that spouses with similar characteristics  
720 (e.g. level of schooling) generate greater household surplus (Munro et al. 2006; Schaner  
721 2015), which is broadly consistent with the findings reported here.

722 Consistent with P4, we find that Tsimane are more likely than Western Europeans to  
723 choose efficiency (Figure 3). We suggest that group-level differences in economic  
724 organization and degree of complementarity in parental investments motivate the observed  
725 differences in distribution preferences. Multiple lines of evidence (Henrich et al. 2005)  
726 indicate that common economic tasks affect basic values underlying preference formation,  
727 and that these values in turn affect temperament and behaviour. If these values are  
728 internalized, generalized and expressed, and if learning processes are adaptive and flexible,  
729 then the greater preference for monetary efficiency among Tsimane in a novel experimental  
730 situation may not be so surprising in light of their comparatively limited market exposure.  
731 Specialization in household production by sex that is characteristic of forager-horticulturalists  
732 can inform one’s expectations of a spouse’s preferences, such that even in an experiment  
733 Tsimane may expect a partner to behave in a similarly efficient manner. These expectations  
734 can sustain a high degree of cooperation throughout marriage, which may help explain why  
735 Tsimane efficiency preferences vary little with age (unlike for Western Europeans, see Figure  
736 S4). At the same time, a greater preference for selfishness among Tsimane women compared



737 to Western European women (Figure S5) suggests a willingness to sacrifice household  
738 efficiency for greater personal control of fungible and liquid resources. This preference can  
739 indicate a broader adaptive strategy employed by Tsimane women to protect money against a  
740 husband's claims for consumption, especially because monetary access is often male-  
741 dominated and can result in costly paternal disinvestment.

742

#### 743 *4.1. Strengths and limitations*

744 The research design minimizes response and sampling biases. Data are obtained  
745 independently from both spouses instead of only one spouse, permitting assessment of  
746 spousal consistency in reporting. Indeed, we find consistency in reporting recent verbal  
747 disputes in marriage (section 3.3). Study recruitment and participant compensation (section  
748 2.2) also limited self-selection by demographics, degree of modernization and marital quality.  
749 Moreover we can rule out potential "contamination effects", which are expected if Tsimane  
750 participants, after completing the study, informed others of what to expect and thus biased  
751 others' distribution task responses. To test for such effects we examined whether distribution  
752 preferences within a village changed over time but found no such evidence. Regarding  
753 external validity, a majority of respondents indicated that distribution task questions  
754 resembled the types of decisions encountered in daily life (section 2.2). Variability in task  
755 perception did not significantly affect any outcome or modify effect sizes of primary  
756 predictors. The fact that no Tsimane exhibited an irrational distribution preference and the  
757 fact that all Tsimane correctly answered both pre-task comprehension questions suggests that  
758 Tsimane understood the task. Results of cross-population analyses (section 3.5) are not  
759 affected if irrational Western Europeans are omitted from analyses. Our study is the first to  
760 our knowledge to systematically compare resource distribution preferences among couples in  
761 subsistence-level and fully market-integrated populations using a common experimental  
762 framework.

763 Nevertheless, resource transfers outside of the "laboratory" obviously cannot be  
764 prevented in experiments among spouses. If post-experiment transfers are indeed common  
765 then this affects our ability to correctly classify spouses based on their aggregate preferences  
766 (e.g. an "asymmetric-selfish" wife may transfer half of her resources to a husband post-  
767 experiment and thus prefer inequality aversion to selfishness). Relatedly, there are other  
768 possible explanations of altruistic preferences; altruistic spouses may allow or expect a  
769 partner to divide a resource equally among co-resident kin, and thus altruism could be a sign  
770 of partner respect even at the expense of household efficiency. Perhaps this helps explain  
771 why degree of offspring dependency is associated with inefficient distributions (see Table S3,  
772 Table 2). Alternatively, altruism could be a form of extra-pair mating effort, as predicted by a  
773 separate interests view of marriage, if reputational benefits of altruism entail extra-pair  
774 mating opportunities or other social benefits. Our inability to validate revealed preferences  
775 with subsequent behavioural measures represents a significant study limitation that hinders  
776 stronger interpretation of observed empirical patterns. Another study limitation is the small  
777 sample size, especially for testing P3.

778

#### 779 *4.2. Conclusion*

780 Examination of spousal preferences for distributing household production surplus  
781 reveals evidence for both joint and separate interests views of marriage (Anderson et al.  
782 1999). Shared and distinct spousal preferences are explained by ecological-, family-, and  
783 individual-level factors impacting perceptions of marginal gains within and outside the  
784 household. A hybrid approach explains intra- and inter-population variation in distribution  
785 preferences. Determining whether such preferences predict marital behaviour and outcomes  
786 should be a focus of future research.

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796

797 **CONFLICT OF INTEREST**

798 None reported.

799

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803

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## TABLES AND FIGURES

Table 1. A) Distribution task design. The task consists of three rounds and five questions/round. Respondents choose option A or B for each question. Spouses face a trade-off between equality and efficiency for every question except #3, where options A and B both offer equal divisions but B is also efficient. In round one respondents indicate their preferences for actual shares of dried meat ( $X=0.67$  kilograms), and responses determine compensation. Round two choices concern hypothetical shares of money (unincentivized;  $X=30$  Bolivianos). Round three choices concern hypothetical shares of fresh meat (unincentivized;  $X=0.67$  kilograms). Rounds, questions and options are presented in random order (not as shown here). B) Classification of individuals based on their aggregate preferences. Efficient individuals maximize joint payoffs. Selfish individuals retain a disproportionate share ( $>0.5$ ) of joint payoffs for themselves, whereas altruists retain  $<0.5$  for themselves. Symmetric individuals choose equality instead of efficiency at least once, retaining an equal share ( $0.5$ ) of joint payoffs as a partner.

A) Question # in a given round	Option A		Option B	
	Payoff for self	Payoff for partner	Payoff for self	Payoff for partner
1	$X*0.33$	$X*0.33$	0	X
2	$X*0.33$	$X*0.33$	$X*0.25$	$X*0.75$
3	$X*0.33$	$X*0.33$	$X*0.5$	$X*0.5$
4	$X*0.33$	$X*0.33$	$X*0.75$	$X*0.25$
5	$X*0.33$	$X*0.33$	X	0

B) Classification of individuals based on aggregate preferences	Preference (#'s below indicate question #'s above)		Consistent with which view of marriage?
	Option A	Option B	
EFFICIENT (maximize joint payoff)		1-5	Joint interest
EXTREME ALTRUISTIC (max. spouse's payoff)	4-5	1-3	Hybrid
EXTREME SELFISH (max. own payoff)	1-2	3-5	Separate interests
ASYMMETRIC- ALTRUISTIC		Multiple possibilities	Hybrid
ASYMMETRIC - SELFISH		Multiple possibilities	Hybrid
SYMMETRIC-INEQUALITY AVERSE		Multiple possibilities	Hybrid
IRRATIONAL	3		Neither

Table 2. Determinants of being classified as efficient, selfish, altruistic, or symmetric-inequality averse based on aggregate money distribution preferences (n=53 husbands and wives from the same marriage). Logistic regression coefficients are presented as odds ratios.

Predictor	Bivariate models				Stepwise models			
	Efficient	Selfish	Altruistic <sup>h</sup>	Symmetric	Efficient	Selfish	Altruistic <sup>h</sup>	Symmetric
<i>Indicator of reduced marital quality</i>								
Any dispute reported <sup>a</sup> (vs. not reported)	1.237	1.061	0.311 <sup>*</sup>	2.353	-----	-----	0.258 <sup>*</sup>	-----
Any dispute over paternal disinvestment <sup>b</sup> (vs. not reported)	0.380 <sup>*</sup>	12.600 <sup>***</sup>	----- <sup>i</sup>	0.752	-----	12.600 <sup>***</sup>	----- <sup>i</sup>	-----
<i>Demographic</i>								
Age <sup>c</sup> (years)	0.806	0.982	5.928 <sup>*</sup>	1.009	0.743 <sup>*</sup>	-----	-----	-----
Age <sup>2</sup> (years)	1.003 <sup>*</sup>	-----	0.969 <sup>*</sup>	-----	1.004 <sup>*</sup>	-----	-----	-----
Sex=male	2.842 <sup>**</sup>	0.394	0.151 <sup>*</sup>	1.000	3.314 <sup>**</sup>	-----	0.108 <sup>*</sup>	-----
# joint children < age 10 <sup>d</sup>	0.669 <sup>**</sup>	1.184	2.122 <sup>**</sup>	1.146	-----	-----	2.148 <sup>**</sup>	-----
<i>Indicator of modernization</i>								
Schooling <sup>e</sup> (years)	1.012	1.063	0.666 <sup>*</sup>	1.057	-----	-----	-----	-----
Fluent in Spanish (vs. not or partially)	2.066	0.654	0.246	0.782	-----	-----	-----	-----
Partner schooling <sup>f</sup> (years)	0.916 <sup>*</sup>	1.113 <sup>*</sup>	1.013	1.080	-----	-----	-----	-----
Time since H's last wage opportunity <sup>g</sup> (months)	1.033	0.973	0.993	0.905	-----	-----	-----	-----
H's daily wage from last opportunity <sup>g</sup> (2014 Bs)	1.012	0.984	0.994	0.992	-----	-----	-----	-----
<i>Task perception</i>								
Realistic (vs. not)	1.739	0.437	0.943	0.695	-----	-----	-----	-----
Easy (vs. not)	2.253 <sup>*</sup>	0.289 <sup>*</sup>	1.250	0.471	-----	-----	-----	-----

<sup>a</sup>Refers to serious verbal disputes with a partner in the past three months. <sup>b</sup>Dispute causes were free-listed by respondents without prompts. Paternal disinvestment includes excessive alcohol consumption, infidelity (perceived or real) or irresponsible use of money (see Stieglitz et al. 2011, 2012). <sup>c</sup>Marital duration is strongly correlated with age (Pearson  $r=0.83$ ,  $p<0.001$ ) and is not a significant predictor in univariate models; marital duration is thus omitted. Spousal age difference (H-W, years) is also not a significant predictor and is omitted. <sup>d</sup>Whether a respondent has any living children from prior unions (vs. none) is not a significant predictor and is omitted (# of children from prior unions [total or < age 10] is also not significant). <sup>e</sup>Literacy (vs. none or partial) is not a significant predictor and is omitted. <sup>f</sup>Neither partner literacy nor partner Spanish fluency are significant predictors and are omitted. <sup>g</sup>As reported by husband; logged value also yields a nonsignificant result. <sup>h</sup>Includes both "asymmetric altruistic" and "extreme altruistic" classifications. <sup>i</sup>No altruist reported a dispute over paternal disinvestment.

\*  $p\leq 0.1$  \*\*  $p\leq 0.05$  \*\*\*  $p\leq 0.01$

Figure 1. Classification of husbands (H) and wives (W) based on aggregate distribution task preferences for each resource type (n=53 husbands and wives from the same marriage).

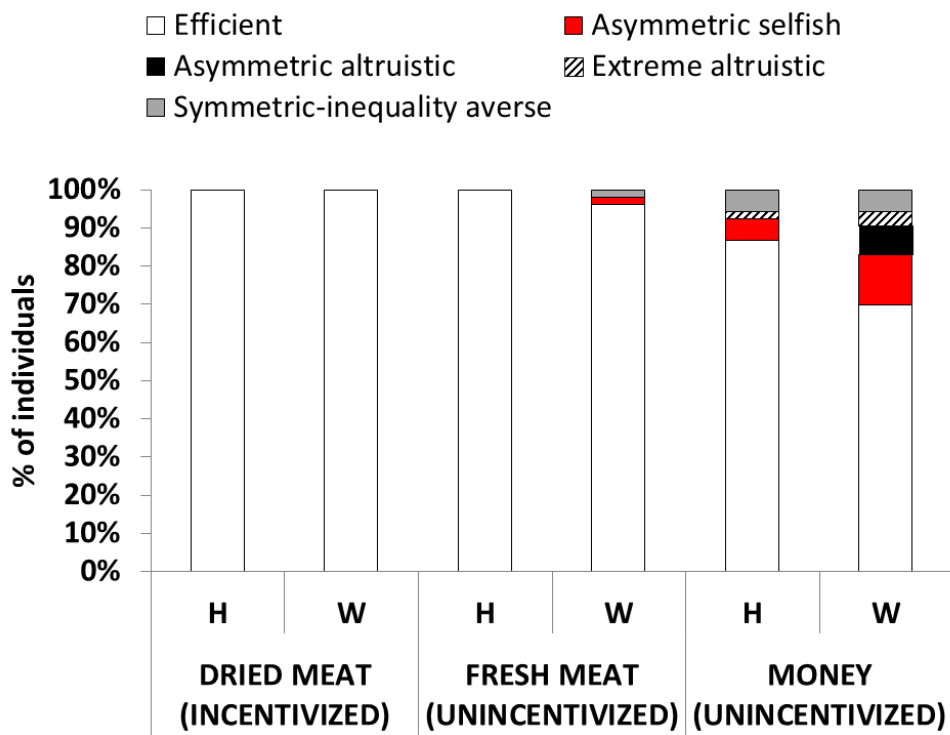




Figure 2. Marital assortment by money distribution preferences among Tsimane (n=53 couples).

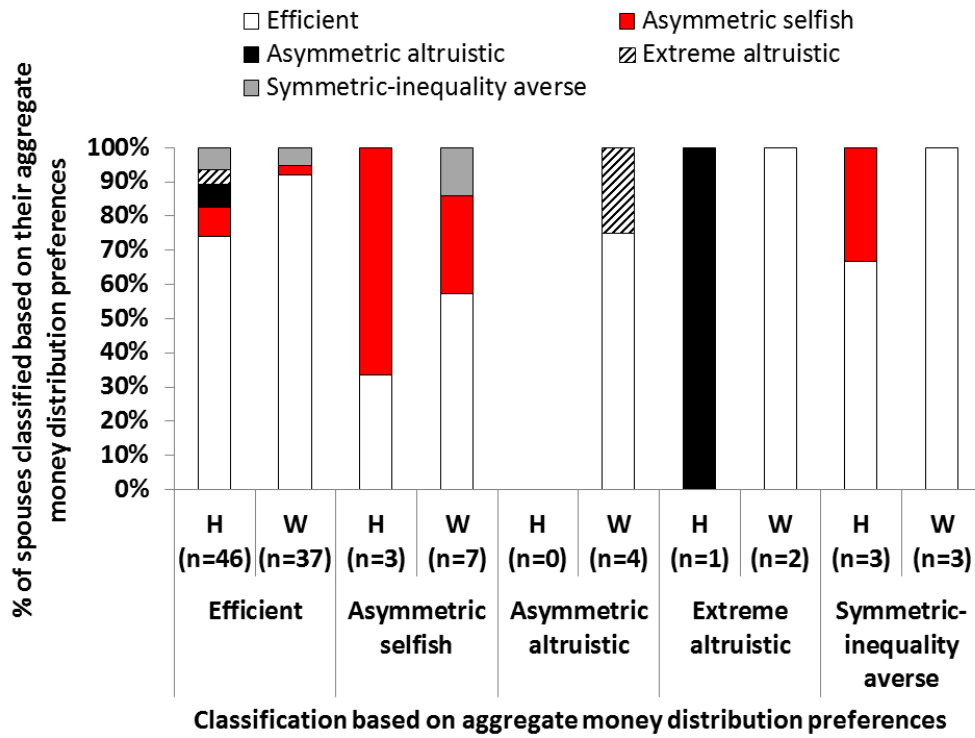


Figure 3. Money distribution preferences of Western European and Tsimane spouses (n=209 total couples).

