Intergenerational Resource Sharing and Mortality in a Global Perspective.

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Abstract

Resource sharing has always been a central component of human sociality. In childhood, heavy investments in human capital are required to prepare for adulthood. During working years, help from others is often needed due to illness, disability or bad luck. Hunter-gatherer elders assist their descendants, but more recently older people withdraw from work and require assistance as well. Thus we rely heavily on support from others. The willingness to share has deep biological roots. It has been critically important for our past evolutionary success and our present daily lives. In this study, we document a strong linear relationship between the sharing generosity of a society and the average length of life of its citizens. Our findings from 36 countries on all continents suggest that human survival chances improve in societies that provide more support and care for one another. We discuss the implications of these findings while considering that sharing generosity may be a general indicator of sociality itself that benefits human health and wellbeing.

Introduction:

Using a comprehensive measure of public and private transfers in a society relative to life time income, we find that the greater the share of transfers, the lower the risk of death. Why might this be so? The most obvious explanation would be that transfers improve health and survival by meeting the material needs of the recipients, particularly dependent children and elderly, or the destitute of any age. But the link we find between transfers and survival might reflect more than this. Transfer intensity may reflect the strength of social networks and social capital, which have been found to promote health. Transfer behavior is deeply rooted in human biology and there is growing evidence that both giving and receiving transfers improve health. We will begin by discussing these links and then move on to our empirical analysis.

Like our closer primate relatives, humans are social animals. Of course, we have evolved to behave in our own selfish interests and those of our kin, but we have also evolved to invest heavily in our long-dependent children, and to share resources such as food with others in our groups, even with unrelated individuals, including hunters who have been less successful than ourselves, and with families that are disadvantaged by high dependency ratios (Gurven 2004, Lee 2008, Hooper, Gurven et al. 2015). Human sociality has been critically important for our evolutionary and day-to-day success over the past tens of thousands of years. The growing brain and prolonged cognitive development require prolonged parental nutritional investment in offspring up until ages 18 or 20 years, as assessed in studies of today's hunter-gatherer and horticulturalist groups such as the !Kung (Howell 2010), Ache, Piro and Machegenga (Kaplan 1994, Lee, Kaplan et al. 2002, Hooper, Gurven et al. 2015), and many others. Relatively short birth intervals and long child dependency together imply that parents must raise a number of simultaneously dependent offspring. Given these heavy nutritional costs, even the joint foraging efforts of the two parents would not suffice without assistance from others such as grandparents, aunts and uncles, and unrelated group members (Hooper, Gurven et al. 2015).

In these societies resources flowed downwards from older to younger, and even elderly adults typically produced more than they consumed and helped to provision the young. Transfers to the elderly were not the norm, except in relatively short periods of illness and disability. This intergenerational flow of food and other resources is only a part of the story, however, because there was also important food sharing between households. The food gathered by women tended to rise or fall together since they gathered in groups, but the success of individual hunters of larger game was highly uncertain. Even good hunters were successful only about 10% of the time (Hill and Hurtado 2009), so risk pooling through sharing the kill within the group was very important.

Such sharing with others and investment in offspring are motivated not only by cultural values but also by hormones such as oxytocin, which enhances generosity, love and empathy. It is released

during interactions with infants, romantic partners, and others in the social group (MacDonald and MacDonald 2010). Indeed, the social environment has been found to alter the expression of hundreds of genes, with implications for health (Slavich and Cole 2013).

The beneficial effects of sharing extend beyond inter-individual, intra-familial or small group network relationships. They are also found in larger societies where giving and receiving is institutionalized and where shared genes or commonalities are less important. In societies with formalized support systems, humans may still derive emotional reward from giving despite the anonymity of individuals and the insecurity about the use of shared resources. Aknin, Barrington-Leigh et al. (2013) found that "Human beings around the world derive emotional benefits from using their financial resources to help others (*prosocial spending*)." A study by Harbaugh, Mayr et al. (2007) found that mandatory, taxation-like, transfers to the public good are linked to neurological reward processing. However, as for inter-individual or family relationships, the benefits of formalized transfer systems go beyond emotional reward. They provide resources to sustain the life of recipients who are in need of support. Additionally, they may serve as a precautionary security system for givers who may rely on other's resources in the future.

The evolutionary and biological literature is consistent in several ways with studies of modern societies. There is ample evidence that both public and private investment in the material and emotional wellbeing of children is of great importance to their development, educational success, economic success as adults, and health and survival in later life. Similarly, a vast array of need-based public welfare programs and private charitable giving aims to improve the lives and health of individuals with lower incomes or otherwise in vulnerable social positions. Vogt and Kluge (2015) find that increased pension benefits for East German elderly following reunification reduced their mortality. Huang and Zhang (2016) found that new social pensions in rural China improved the health of both the elderly and of children. Gelber, Mooreet al. (2018) find that disability benefits in the US strongly reduce the mortality of recipients (with an elasticity of -.6).

There is also evidence that more general social connectedness is itself beneficial. Helliwell, Akninet al (2017) find that social capital and prosocial behavior are positively associated with subjective wellbeing. Steptoe, Shankar et al. (2013) found that mortality was 25 percent higher among socially isolated individuals than others. Holt-Lunstadt, Smith et al. (2010) found, in a meta-analysis of 148 studies, that survival was 50 percent greater for those with stronger social relationships.

In this study, we suggest that in today's societies, public and private resource sharing promotes health and survival. We take a new approach to investigating the relation of health and longevity to participation in social networks and networks of public and private transfers. Previous studies have looked at the efficacy of focused public programs on the health and longevity of target populations, such as disadvantaged children or the elderly. In this paper, we will instead investigate

the relation of mortality outcomes to the magnitude of resource flows through intergenerational transfers across the life course, where the measure of transfer flows is very comprehensive. It includes all public programs, for people at all life cycle stages, and all private familial transfer flows as well, with the exception of end of life bequests. Intergenerational transfers are certainly only a piece of the general relationship between prosocial behaviors and health, but they are a large and quantitative piece and a very different piece than has so far been used in this context. Using these data on intergenerational transfers and mortality, we find a strong log-linear relationship between levels of mortality and the generosity of transfer support in 35 countries around the globe.

Data and Method:

Our study draws on data from the National Transfer Accounts project (www.ntaccounts.org) to measure sharing generosity in and across countries (Lee and Mason 2011). The major aim of national transfer accounts (NTA) is to document how individuals finance their needs over the life course and to improve our understanding of the generational economy. NTA consist of economic age profiles that estimate government revenues and expenditures and corresponding private transfers by single years of age. The theory is rooted in Samuelson (1958), Diamond (1965), Lee (1994), and Bommier and Lee (2003). In 2018, the NTA network comprises 54 countries, across all continents, offering at least partial data for comparative analysis. The results show how people at each age produce, consume, share resources, and save for the future in a respective country. Therefore, the NTA framework provides valuable information for studying how resource sharing among populations is related to average length of life.

Our measure of sharing generosity derived from the NTA profiles captures the ratio between lifetime income and net transfers given to age groups in need of support (see equation 1). For a representative individual in a respective country we calculate the per capita net transfers received as a share of lifetime income an individual earns in the respective country over the life course. First, we estimate the net public and private transfers by age. These are calculated at each age *a* and country *i* following

eq 1: $$\tau(a)_i = \tau(a)_i^{g^+} + \tau(a)_i^{f^+} - \tau(a)_i^{g^-} + \tau(a)_i^{f^-},$$

where $\tau(a)_i^{g^+}$ denotes government transfers received by the individual at age *a* in country *i*, $\tau(a)_i^{f^+}$ denotes familial transfers received by the individual at age *a* in country *i*, $\tau(a)_i^{g^-}$ denotes government transfers given by the individual at age *a* in country *i*, and $\tau(a)_i^{f^-}$ denotes familial

transfers given by the individual at age *a* in country *i.* We then determine the ages for an individual in a respective country when the individual is a net recipient of transfers. These vary by country depending on the underlying transfer schedule. For example, Americans receive net transfers from birth to age 25 and from age 66 onwards while Indians receive net transfers between the ages of 0-25 and from age 71 onwards. In contrast, we find rather long periods of dependency in European welfare states where net transfers are received until the mid or late 20s and with elderly becoming net recipients around age 60.

We sum the positive net transfers over all ages of the individual lifecycle a representative individual lives through. Then the sharing generosity *g* for the individual in country *i* is the ratio of the sum of the net transfers received by an average individual in country *i* across all ages and the sum of labor income *yl(a)* that is generated by an individual over the life course in country *i*.:

eq 2: $$g_i = \frac{\sum_{a=0}^{max(a)} \tau(a)_i^+}{\sum_{0}^{max(a)} yl(a)_i},$$

Labor income comprises income from employment and in addition self-employment income. The ages over which income *yl(a)* is generated differ as well between NTA countries. For an average individual in China labor income rises above zero at age 10 and declines to zero at age 90 while the average French starts at age 15 and reaches zero at age 80.

Our measure g_i relates the total resources an average individual generates over the life course to the average amount of resources the individual shares with others. The transfer measure g_i is very comprehensive and includes the monetary value of a variety of public and private transfer items that may benefit young and old age groups. Transfers to the young comprise expenses for health care, food, shelter with education being the largest single item. Older adults benefit from transfers for health and long-term care and especially pension payments (A detailed overview of the variables included can be found in the appendix Table A1). Savings and assets are excluded from our measure as they are intertemporal transfers to oneself (or to the descendants in case of bequests). Net transfers are the difference between transfers received and transfers made to others at a given age over the life course. This net transfer measure should capture the overall generosity quite accurately as it accounts simultaneously for overall transfer in both directions. Focusing only on gross in- or outflows would under- or overestimate sharing generosity. Receivers of large transfer inflows may themselves give only a small transfer. Likewise, givers of large transfers may receive only little in return.

g_i is a ratio of quantities measured in the monetary units of each country, the units cancel and no conversion is necessary. Our measure does not differentiate between public and private transfers and implies that these sharing mechanisms are equally beneficial. In practice, public transfers may be less efficient than private due to administrative costs and less accurate targeting relative to needs. However, we assume that a major part of the observed relationship of mortality to sharing generosity is mediated by the general willingness to share rather than the efficiency of sharing.

We use data from NTA and from the UN's world population prospects revision 2017 (United Nations Population Division 2017) to test the relationship between sharing generosity and risks of death across countries. The UN database provides comparable indicators for all NTA countries included in our studies. As Taiwan is not included in the UN database, we used information from the Human Mortality Database instead (Human Mortality Database (HMD) 2017). Overall, we relate country specific information on sharing generosity to country specific mortality rates. To account for the different population age structures, we used direct age standardized with the overall population of NTA countries as the standard. As NTA profiles are not estimated for every year, we use the latest available information per country and demographic information for the corresponding time period (see appendix Table A2). For each country, age standardized mortality rates for all ages, age-standardized mortality rates for the ages 0-20 and age-standardized mortality for ages above 65 are used in relation to different age specific measures of sharing. As most NTA profiles do not account for sex differences, we use mortality information combined for both sexes. It might well be that sharing generosity and volume differ between women and men but to thoroughly test the relationship we would need to include the value of time transfers in our measures. Otherwise, transfer generosity of women might be seriously underestimated (National Research Council 2005, Donehower 2013). This is certainly an additional aspect of sharing generosity which we may consider in the future but that goes beyond the aim of this analysis.

We also assumed that the association between transfer generosity and mortality might be spurious as the ability to give and survive is affected by economic development and per capita wealth (Preston 1975). To control for this potential bias, we included the log of country specific GDP per capita information as a covariate in a weighted least square regression between the logarithm of age standardized mortality rates and the log transfer generosity. This log-log model allows us to estimate the elasticity of mortality with respect to change in economic development and transfer generosity. GDP per capita in current US$ for each NTA country (except Taiwan) and profile year comes from the World Bank Database (https://data.worldbank.org/). The information for Taiwan comes from the Statistical Office of Taiwan (https://eng.stat.gov.tw). We decided to use weighted least square regression to account for the impact of potential outliers. NTA profiles reflect particular transfer settings for each country and are sensitive to political reforms that may be implemented in a year when a profile was estimated (see results section for country specific details). The weighted regression approach allows us to consider these particularities without distorting the

overall association between welfare generosity and mortality. Another reason for using weighted lease squares is the violation of the assumption of constant variance in the regression errors. We used the reciprocal of the variance as weight.

Results:

Our analysis suggests that differences in sharing generosity across countries are indeed related to mortality disparities. Figure 1 shows that the log of age standardized mortality rates declines quite linearly with increasing proportions of lifetime income shared. with increasing life cycle net transfers relative to life time earning. Countries in Sub-Saharan Africa like Mozambique or Senegal share the lowest percentage of their lifetime income and have the highest risk of death of all countries in our study. South Africa, despite being economically more developed than the other African

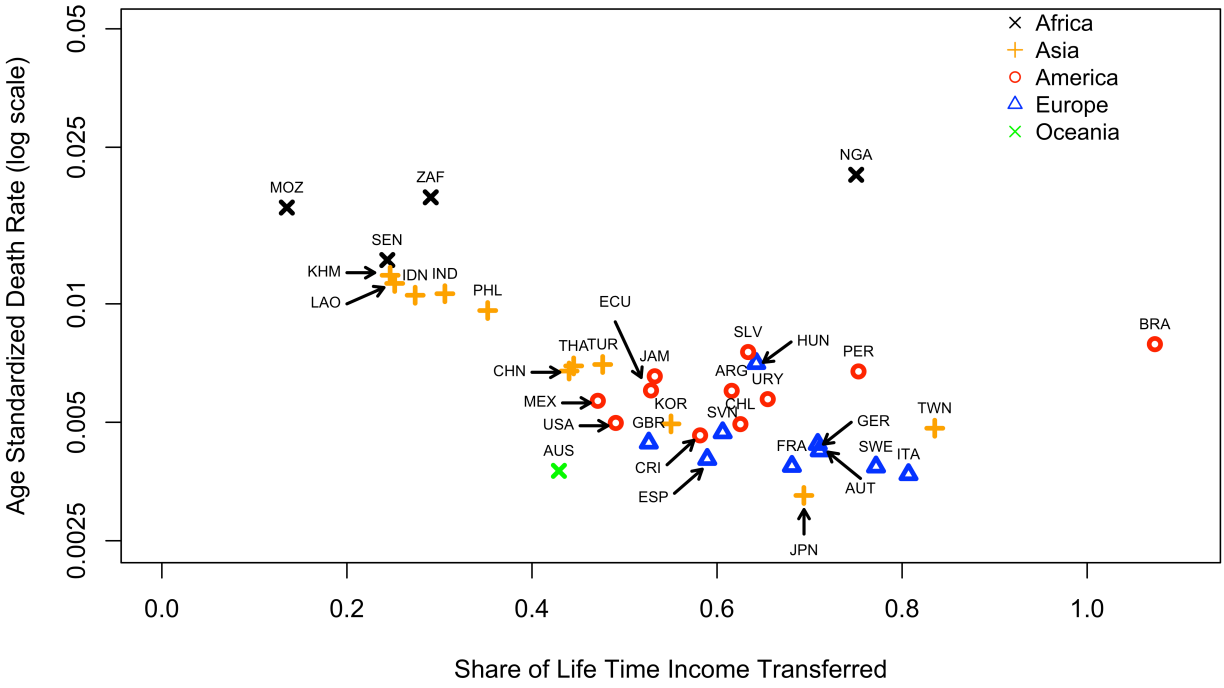

Figure 1: Age standardized death rare and share of life time income transferred to others (Source: National Transfer Accounts and UN population prospects 2017)

countries, ranks among the other low sharing countries in terms of age standardized mortality. One reason for South Africa's lower life expectancy is certainly the HIV epidemic that considerably lowers the chances of many South Africans to survive to higher ages. However, the pattern of comparatively higher mortality despite advanced economic development also holds true for other

countries. Western European countries and Japan are among the leaders in sharing resources and achieving low levels of mortality. However, countries like Italy, Sweden, Germany or Taiwan seem to be less successful in achieving the lowest levels of mortality despite their generosity in sharing resources. (Partially, this might be caused by their extensive public redistribution schemes that are potentially less efficient). It might also be an indication for a certain threshold in the relationship between transfer generosity and mortality outcomes where more transfers are not directly translated into more life years. South American countries rank also high in terms of generosity as they share more than 60% of an average individual's lifetime income. Their mortality levels remain above the values for Western Europe, Australia, Japan and Taiwan. Brazil is an interesting outlier here where an average individual shares more than 100% of his/her lifetime income. This peculiarity is largely explained by Brazil's unusually generous pension scheme that resulted in massive transfers to the elderly when the latest profile was estimated for Brazil (Turra, Queiroz et al. 2011). Another outlier is Nigeria where the comparatively large amounts of transfers are explained by the public redistribution of revenues from producing oil, which make up over 80 percent of total government revenues (Soyibo, Olaniyan et al. 2010).

Apart from the importance of transfer generosity, the association depicted in Figure 1 may also imply that economically developed countries are more successful in reducing mortality than developing countries and that relative wealth is the underlying cause for the relationship between transfers and mortality (see also Figure A3 in the appendix). In our regression analysis, we sought to account for this potential confounder. Table 1 shows the main effect of sharing generosity on mortality as well as the effect of transfers when we control for economic development measured as GDP per capita.

Table 1: Elasticity of age standardized mortality with respect to changes in transfer generosity and GDP per capita

	Transfer Generosity and Mortality (1)	Transfer Generosity and Mortality controlling for GDP per capita (2)
Constant	-5.58*** (0.11)	-4.02*** (0.47)
Log Share of Lifetime Income Transferred	-0.8*** (0.11)	-0.47*** (0.12)
Log GDP per capita		-0.15** (0.045)
Adjusted R-squared	0.74	0.80

Standard errors in parentheses

*** p<0.01, **p<0.05, *p<0.1

It becomes apparent that transfer generosity has a sizeable effect on the age-standardized risks of death. According to model 1, a 1% increase in sharing generosity would reduce mortality by almost 80%. The effect size of sharing generosity declines if we control for the economic development of countries but it remains significant. A 1% increase in the proportion of transferred lifetime income still reduces mortality by 47%. An increase of GDP per capita by 1% reduces age-standardized mortality by 15%. Our transfer measure does not allow for making direct comparisons between the relative importance of economic development and transfer generosity but it suggests that sharing resources is an important determinant of mortality independent of a country's per capita GDP.

We find the negative relationship between transfer generosity and mortality not only for the whole population but also for younger and older age groups. Overall sharing generosity decreases the risk of death also among the young and the old. If we were specifically looking for the direct effects of material transfers received we could have used net transfers to this age group alone, but as explained earlier, we think that the broader measures of social cohesion and sharing is more

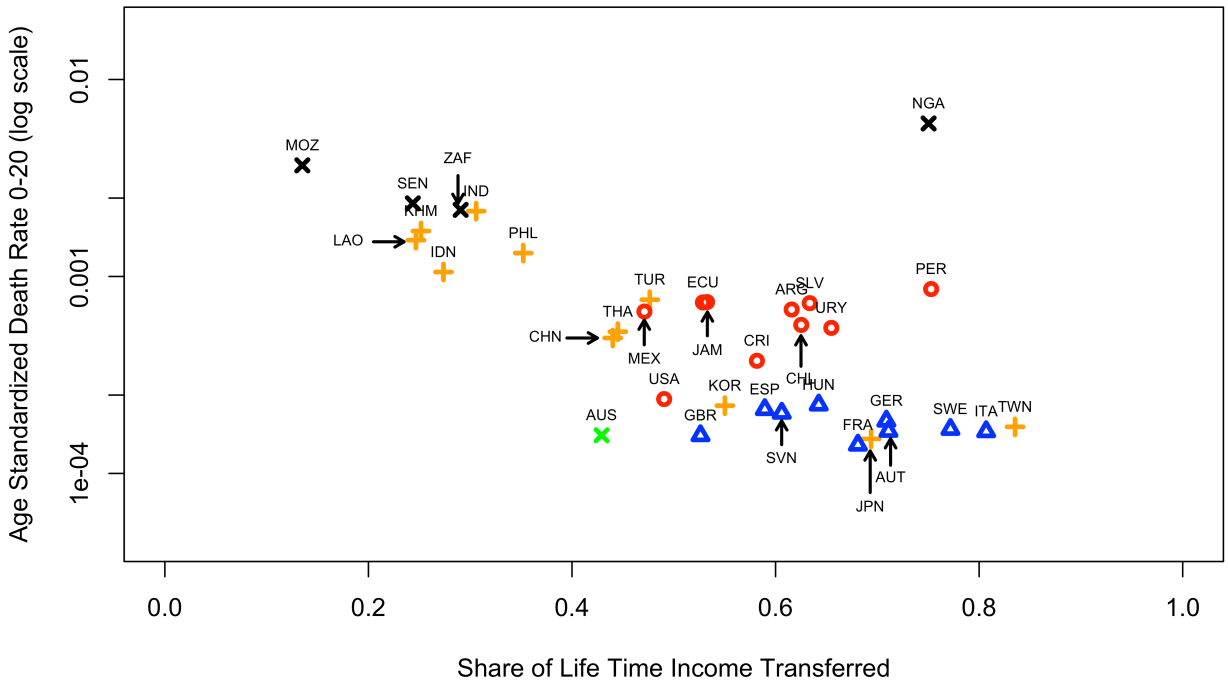

Figure 2: Age-standardized risk of death between age 0 and 20 and share of life time income transferred to others (Source: National Transfer Accounts and UN population prospects 2017)

relevant, This holds true for the age-standardized mortality between age 0 and 20, an age range where children in most countries benefit from public or private transfers in education, health care or every day needs (see Figure 2). Countries like Mozambique or Kenya that transfer comparatively little to their young age groups suffer from high child mortality. The risk of death between age 0 and 20 declines for countries that share higher proportions of lifetime income. A larger group of mainly industrialized Western countries has reduced the mortality of the young to very low levels but we still find differences between them.

The negative relationship between transfer generosity and mortality outcomes becomes also apparent for older age groups (see Figure 4). Countries in Sub-Saharan Africa, South and South-East Asia who share comparatively little of their lifetime income have the highest levels of old age mortality among the NTA countries. For example, Indonesia and Laos transfer 27% and 25% of an average individual's lifetime income and have a mortality risk of 6.8 deaths per 1000 above the age of 65. Increases in transfer generosity for the elderly are also related to lower levels of mortality above age 65. In France and Japan, the countries with the lowest risk of death, an average individual shares between 68 and 69% of its lifetime income and mortality is roughly 2 times lower than in China or Turkey which share 44-48% of an average lifetime income. The relationship be-

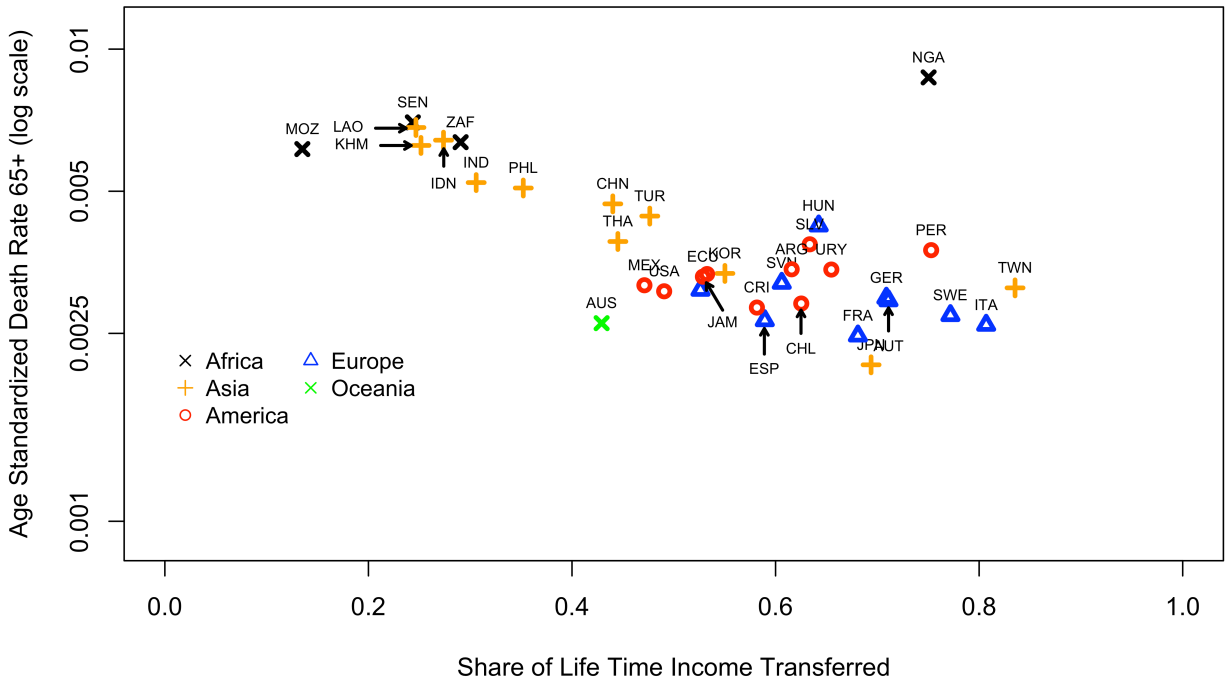

Figure 3: Age-standardized death rate of age groups above age 65 and share of life time income transferred to others (Source: National Transfer Accounts and UN population prospects 2017

tween transfer generosity and mortality does not depend on the choice of the mortality indicator. We find a similar pattern for the probability of death between birth and age 5 or remaining life expectancy at age 65 (see Figures A4 and A5 in the appendix).

Discussion:

Our analysis suggests that there is a negative relationship between sharing generosity and mortality. This relationship holds true across countries that have very different transfer mechanisms and country specific frameworks. For example, older Brazilians receive large transfers by generous public pension schemes, Mexicans rely quite heavily on transfers from remittances and oil revenues account for major parts of public transfers in Nigeria. There are also cultural differences between all NTA countries that may affect how resources are shared in a society. However, in all countries transfers flow to a certain degree within the family from parents or grandparents to children and vice versa. Also other relatives or members of groups or communities may benefit from these forms of private resource sharing. At the same time, individuals in all countries share resources via the state. How resources are shared does not seem to affect the differences in mortality levels across countries. Far more important is the relative generosity of transfers here defined as shares of lifetime income for a representative individual. We assume that there are three aspects in sharing resources that may contribute to the observed positive health outcomes. Firstly, transfers flow from one individual or family to another in need. There are different motivations to provide transfers but most of these transfer flows take the form of risk sharing or reciprocal altruism such that a future reciprocal transfer is expected, but some transfers seem to be made without expectation of return. Secondly, in the development from hunter-gatherer to modern societies, transfers from kin and non-kin were predominantly meant as an investment into children's development. Net-transfers to the elderly are a rather recent phenomenon but of great importance in modern societies. Both types of prosocial behavior seem to have deep roots in the human evolution. Thirdly, transfer relationships may be a facet of prosocial behavior that affects the physical, mental and emotional health of recipients and givers of transfer. These aspects are interlinked and may affect health outcomes either independently or in a more complex mechanism. We will discuss their relevance for our results from an economic, psychosocial and evolutionary anthropology perspective in the reminder of this section.

There are numerous motives for individuals to give transfers to each other (see Lüth (2001) for a detailed overview). They extend from pure altruism (Barro 1974, Becker 1974), through accidental bequests (Yaari 1965) to exchange and reciprocity(Cox 1987, Koh and MacDonald 2006, Norton and Van Houtven 2006). The exact borders between all the different motivations are not clear-cut. However, they can be subsumed into two standard sets of motivation that explain the provision of private transfers: altruism or self-interest (Cigno 1993). While pure altruistic transfers seek to ben-

efit the recipient without an expectation of return they might still be beneficial for the giver. There are several motives that suggest that altruistic behaviors are not entirely selfless (see Kolm (2006) for a review). Motives like the “warm-glow” or the joy of giving (Andreoni 1990) are in line with the psychological and sociobiological literature pointing out that the actual giving is not only rewarding in itself but contributes to health and wellbeing. Altruism and empathy are therefore motives that could help to explain the emergence of the transfer generosity- mortality pattern from the side of the giver and the recipient. The recipient benefits in the form of resources that may improve survival directly and the giver benefits rather indirectly in the form of emotional gratification.

In contrast to altruism or empathy, self-interest as a motivation seeks to increase the benefit of the transfer giver instead of the recipient. While it is still the predominant transfer motive mentioned in economic literature, it is far from being a mutually exploitive behavior (Fehr and Schmidt 2006). Studies from behavioral economics show that individuals and groups sanction behaviors that are deemed unfair and normatively unacceptable (Fehr and Gächter 2002, Fehr and Fischbacher 2004). Therefore, individuals might coordinate their transfer interaction in order to obtain the most beneficial outcome for each participant (Cox 1987, Henretta, Hill et al. 1997). Exchange or reciprocity are found as balancing forms of prosocial behavior in game interactions between purely egoistic individuals (Schokkaert 2006). The expectation to receive a return (material or emotional) to a given transfer may also extend over a longer time horizon and reflect a certain insurance principle (Becker and Murphy 1988). Parents who transferred resources to their offspring receive backward transfers from their children in the future (Silverstein, Conroy et al. 2002). Also indirect reciprocity can play a role as parents may help their own parents expecting to receive comparable support from their children (Cox and Stark 1994, Arrondel and Masson 2001). Individuals tend to adhere to reciprocity and risk sharing norms also outside of the family in the support of welfare states and the redistribution of resources (Fong, Bowles et al. 2006). While pure self-interest may only contribute to improvements in individual health outcomes, its normatively embedded form may help to increase the average length of life in a society. Reciprocity, exchange and particularly the insurance principle are strong motivations that may explain the benefits that givers and receivers derive from sharing resources in the family or in the wider society.

The motivation to provide financial and material resources is only one aspect of the transfer-mortality relationship. We believe that transfer generosity and intergenerational exchange are also an indicator for the general social connectedness and solidarity within societies. There is mounting evidence that altruistic behaviors and risk sharing in form of exchange and support are deeply rooted in human evolution (Silk and House 2011, Silk and House 2016). Anthropological studies found these altruistic behaviors and the general willingness to help others among chimpanzees (Boesch, Bole et al. 2010) and other non-human primates (De Waal, Leimgruber et al. 2008). Hu-

man societies exhibit high levels of prosocial behavior[1] going beyond close kinship relatedness to the beneficiary (Fehr and Fischbacher 2003, Silk and House 2016); an aspect that is controversially discussed in research for primates (Burkart, Fehr et al. 2007, Amici, Visalberghi et al. 2014). These general forms of prosocial behavior seem to be rewarding for humans and primates alike (De Waal, Leimgruber et al. 2008, Silk, Beehner et al. 2010).

Sharing, volunteering or supporting others contributes to wellbeing, physical and mental health (Schwartz, Gerin et al. 2003) or longevity (Okun, Yeung et al. 2013). The protective effect of prosociality is found at different ages over the life course. Psychological or neurological studies suggest that these behaviors increase the wellbeing not only at older ages but also for children and adolescents (Weinstein and Ryan 2010, Aknin, Hamlin et al. 2012). Giving and sharing is not only advantageous for recipients of support. Also donors benefit from the protective effect of giving which seems to be independent of specific exchange motives or expected mutual benefits (Oman, Thoresen et al. 1999, Post 2005). Providing support and informal care has a protective effect even for caregivers and is found to outweigh the positive effects of receiving it (Brown, Nesse et al. 2003). Although the evidence supporting this positive effect is mixed (Vitaliano, Zhang et al. 2003, Roth, Fredman et al. 2015), there are studies that find the benefits of providing care for different intergenerational arrangements- from grandparents to grandchildren (Arpino and Bordone 2014, Hilbrand, Coall et al. 2017) or from children to parents (López, López-Arrieta et al. 2005). Even taxation and voluntary giving were found to affect neural activities linked to reward processing (Harbaugh, Mayr et al. 2007). This positive link between giving, wellbeing and health is found across culturally and ethnically different societies (Brown, Consedine et al. 2005) suggesting a certain universality of the underlying relationship (Aknin, Barrington-Leigh et al. 2013).

As prosocial behaviors are a fundamental feature of our lives (and coexistence), it is not surprising that the lack thereof represents a major risk for health and survival (House, Landis et al. 1988). Social isolation, the absence of supportive networks and contacts, is a key predictor for mortality at older ages outweighing traditional risk factors such as smoking or alcohol consumption (Holt-Lunstad, Smith et al. 2010, Pantell, Rehkopf et al. 2013). This does not exclusively refer to the effects of resource provision and instrumental support (Glass and Maddox 1992). Also social attachment and positive affection diminish general mortality risks (Lyyra and Heikkinen 2006) and increase the survival chances after ovarian cancer treatments (Lutgendorf, De Geest et al. 2012), breast cancer diagnosis (Kroenke, Kubzansky et al. 2006), acute myocardial infarction (Krumholz,

[1] The term “prosocial behavior” refers to any behavior that seeks to foster the benefits of others and comprises a multitude of different motivations and types of social interactions (Weinstein and Ryan 2010, Brown and Brown 2015). The motivations for prosocial behavior range from empathy over reciprocity to selfishness. Here, we apply prosocial behavior as an umbrella term to include all sorts of interactions from which benefits could be derived.

Phillips et al. 1998, Mookadam and Arthur 2004), dialysis treatment (Untas, Thumma et al. 2010) and the resistance to common cold (Cohen, Doyle et al. 1997). In general, the need of interpersonal relationships and affection seems to be even more important than the material benefit of receiving instrumental support (Bloom, Stewart et al. 2001).

Apart from the psychological links, there is the increasing evidence that our social environment affects health and survival changes through our genes (see Cole (2014) for a review). Cole, Hawkley et al. (2007) found in a genome wide transcriptional activity analysis that the degree of social isolation had an impact on the expression of 209 different genes related to pro- and anti-inflammatory signaling. Findings from the research field of socially influenced human gene expression suggest that stress reduction has a protective effect on inflammatory pathways (Kaliman, Álvarez-López et al. 2014). This implies that social integration, affection and social support as remedies to cope with stress are indirectly affecting gene regulations. The long lasting effect of this protection is suggested by studies that document different DNA methylation patterns among adolescents that were exposed to high infant stress levels (Borghol, Suderman et al. 2011, Essex, Thomas Boyce et al. 2013).

We conclude from this discussion that transfers are a fundamental feature of the life course and play a central role in human development. There are different reasons and motivations why humans share their resources with others. It is certainly far more than selfishness or quid-pro-quo expectations that makes us givers of transfers. Many resources are shared with no specific aim to get an immediate or future reward. Receiving resources in vulnerable ages may directly contribute to better health and survival outcomes. Likewise, transfers equip recipients to withstand unfavorable conditions over their lives. There is ever growing evidence that education, health care access, and nutrition have protective effects over the life course. Transfer generosity might also be seen as an indicator for overall prosociality in a country that has beneficial effects beyond the provision of material resources. Social connectedness, social support and other forms of prosocial behavior were found to improve health outcomes particularly of the elderly. We believe that this study shows a new perspective on mortality disparities across countries. There is the well-established positive relationship between measures of economic development like GDP or national income and life expectancy levels (see Preston (1975). This relationship might be closely related to our observed transfer-mortality pattern but it does not confound our results. GDP might be seen as a summary measure for the resources a society can provide but it gives no information how members of a society benefit from these resources. It might well be that our transfer measure accounts for this shortcoming. It is also conceivable that resource sharing and support allow societies to be innovative and productive and achieve higher economic outputs. The transfer mortality association may also account for social inequalities that are usually measured across countries with concentration indices like the Gini coefficient. Sharing enables individuals to get access to

resources they would otherwise be deprived of. In comparison to these concentration indices, our measure allows us to identify population age groups that are most vulnerable and in need of resources and the type of support others provide for them.

The comprehensiveness of our transfer measure might be a problem if we were to seek to uncover underlying mechanisms on the individual level. It can only account for the sharing generosity within societies. It might, however, be possible to decompose differences in the transfer-mortality pattern into contributions from different transfer types like education or pensions. Another limitation of this study is that it uses only one data point per country. The work of the NTA network is ongoing and new countries have joined in every year since its foundation in 2002. One aim of the network is to repeat the estimation of country profiles to provide insight in the transfer activities of a society over time. With countries such as Sweden, US or Germany where we have more than one data point we checked if the transfer-mortality relationship varies considerably over time but we find them to be relatively stable for the short time horizon considered. Our results are only based on monetary transfers as source for mortality differentials. We disregard time transfers that would matter for example for studying the relationship by gender. Time transfers would also allow us to strengthen our assumption on the non-monetary solidarity within a country and give a more complete picture of the overall transfer-mortality association. This aspect might be particularly important for developing countries where support systems for children and elderly are less institutionalized. Addressing these limitations is certainly a promising challenge for future research.

Appendix

Table A 1: Detailed overview of age-varying transfer in- and outflows included in the analysis

1. Inflows:

Public transfer inflows (in-kind and monetary transfers)

- Education (child care, schooling, advanced training)
- Health and long-term care expenditures
- Other public transfers in-kind (national defense, public administration, etc.)
- Pensions received (own and survivor benefits)
- Sickness and disability payments received
- Transfers for family and children (child allowances, parental leave money, etc.)
- Unemployment benefits
- Housing allowances
- Other social security transfers received

Private transfer inflows (intra-household transfers)

- Transfers for education
- Transfers for health
- Transfers for housing
- Transfers for durables
- Transfers other

Private inter-household transfer inflows by age

2. Outflows:

Public transfer outflows

- Taxes on labor and social security contributions
- Taxes on assets
- Consumption taxes (VAT)
- Self-employed contributions

Private transfer outflows (intra-household transfers)

- Transfers for education
- Transfers for health
- Transfers for housing
- Transfers for durables
- Transfers other

Private inter-household transfer outflows by age

Note: private transfer in- and outflows net to zero, inter-household transfers net to the balance of transfers to/from rest of the world (ROW)

Table A2: Data sources for each country per year

Country (ISO 3 Abbreviations)	Year of NTA Profile	Net Transfer Receiving Age Groups	Year of UN population and mortality information
Argentina (ARG)	1997	0-21, 58-90+	1995-1999
Australia (AUS)	2010	0-22, 64-90+	2010-2014
Austria (AUT)	2010	0-22, 60-90+	2010-2014
Brazil (BRA)	1996	0-25, 62-90+	1995-1999
Cambodia (KHM)	2009	0-22, 64-90+	2005-2009
Chile (CHL)	1997	0-25, 64-90+	1995-1999
China (CHN)	2002	0-23, 55-90+	2000-2004
Costa Rica (CRI)	2004	0-24, 61-90+	2000-2004
Ecuador (ECU)	2011	0-24, 64-90+	2010-2014
El Salvador (SLV)	2010	0-26, 65-90+	2010-2014
France (FRA)	2005	0-23, 61-90+	2005-2009
Germany (GER)	2003	0-25, 62-90+	2000-2004
Hungary (HUN)	2005	0-23, 57-90+	2005-2009
India (IND)	2004	0-24, 71-90+	2000-2004
Indonesia (IDN)	2005	0-21, 82-90+	2005-2009

Italy (ITA)	2008	0-24, 61-90+	2005-2009
Jamaica (JAM)	2002	0-20, 63-90+	2000-2004
Japan (JPN)	2004	0-24, 63-90+	2000-2004
Laos PDR (LAO)	2012	0-27, 87-90+	2010-2014
Mexico (MEX)	2004	0-25, 71-90+	2000-2004
Mozambique (MOZ)	2008	0-31, 44-90+	2005-2009
Peru (PER)	2007	0-26, 63-90+	2005-2009
Philippines (PHL)	1999	0-25, 71-90+	1995-1999
Senegal (SEN)	2005	0-24	2005-2009
Slovenia (SVN)	2004	0-25, 58-90+	2000-2004
South Africa (ZAF)	2005	0-26, 86-90+	2005-2009
South Korea (KOR)	2000	0-26, 63-90+	2000-2004
Spain (ESP)	2000	0-26, 61-90+	2000-2004
Sweden (SWE)	2006	0-24, 63-90+	2005-2009
Taiwan (TWN)	1998	0-25, 58-90+	1995-1999 (Source: Human Mortality Database)
Thailand (THA)	2004	0-32, 80-90+	2000-2004
Turkey (TUR)	2006	0-22, 73-90+	2005-2009

United Kingdom (GBR)	2010	0-23, 62-90+	2010-2014
Uruguay (URY)	2006	0-26, 66-90+	2005-2009
US (USA)	2003	0-25, 66-90+	2000-2004

Figure A3: GDP per capita and age standardized mortality in NTA countries

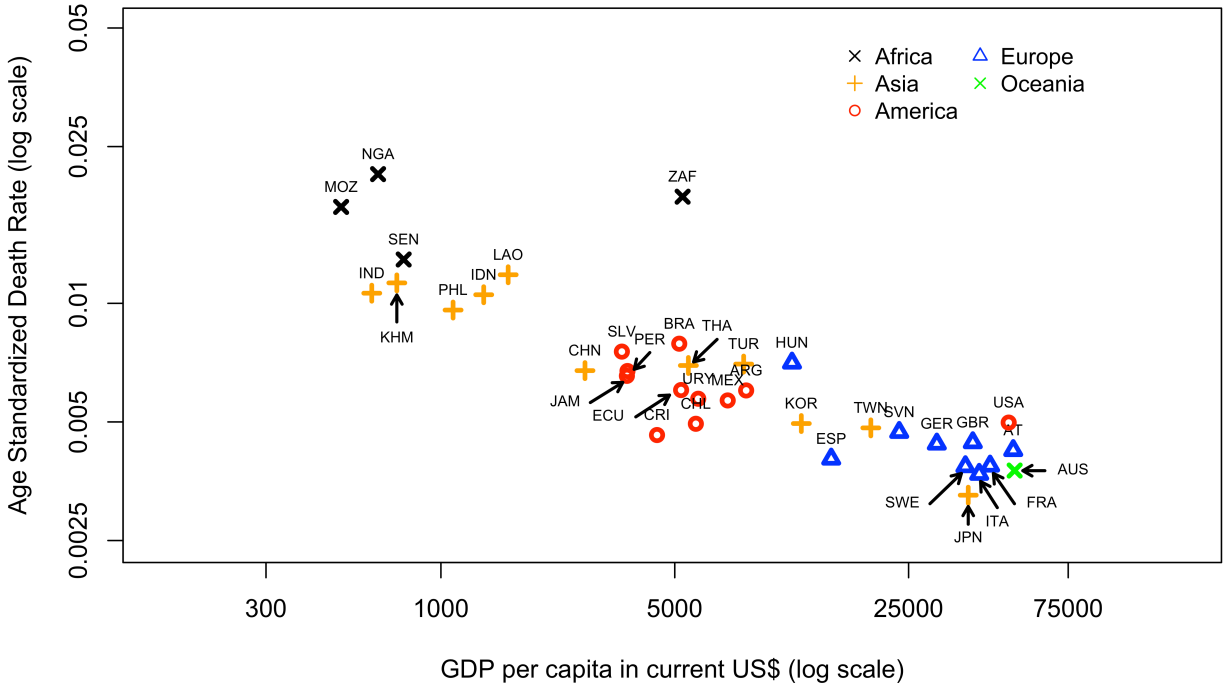

Figure A3: Age-standardized death rate and GDP per capita (Source: Worldbank 2018, Statistical Office Taiwan 2018, and UN population prospects 2017)

Figure A4: Probability of death between age 0 and age 5 and lifetime income shared

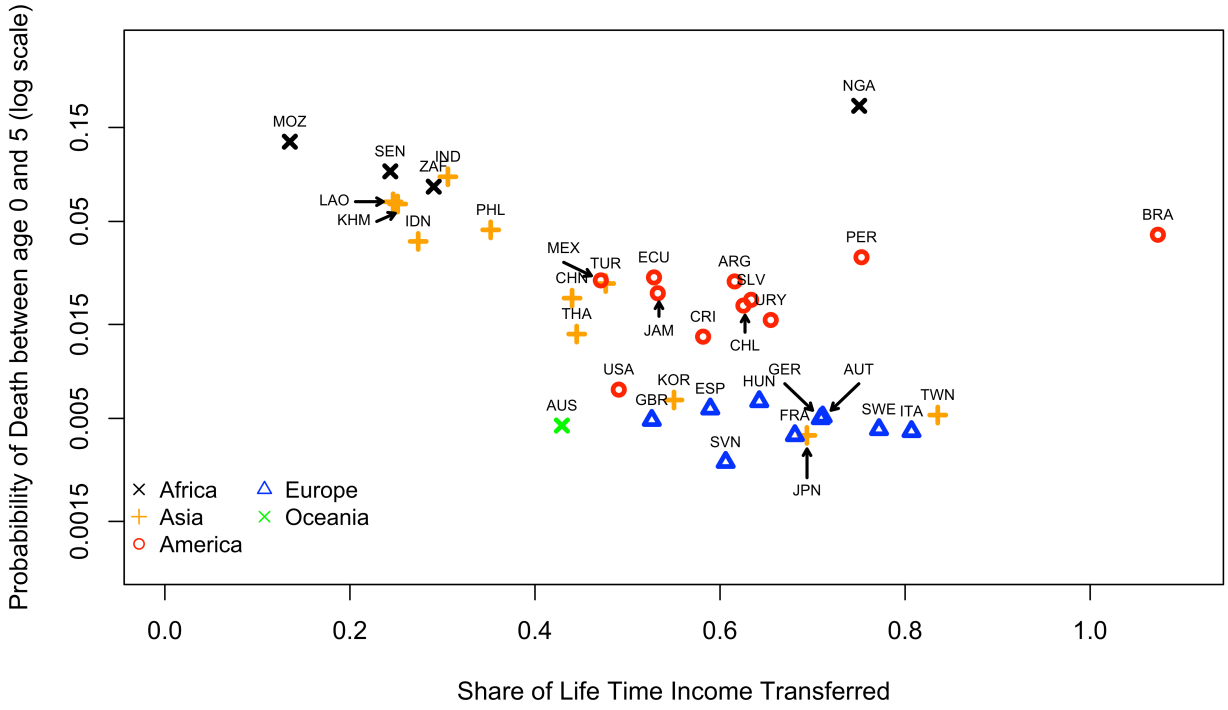

Figure A4: Probability of death between ages 0 and 5 and share of life time income transferred to others (Source: National Transfer Accounts and UN population prospects 2017)

Figure A5: Remaining life expectancy at age 65 and lifetime income shared

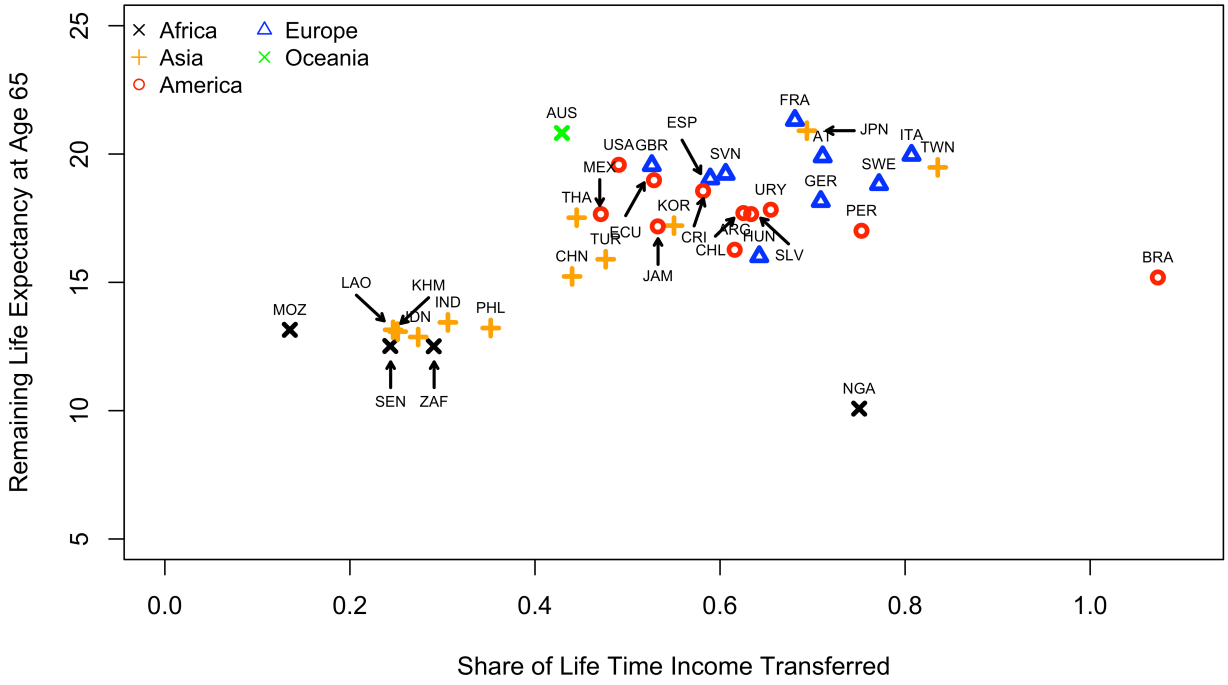

Figure A5: Remaining life expectancy at age 65 and share of life time income transferred to others (Source: National Transfer Accounts and UN population prospects 2017)

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