Published in final edited form as:
Popul Dev Rev. 2013 February ; 38(Suppl 1): 23–35. doi:10.1111/j.1728-4457.2013.00549.x.

Intergenerational Transfers, the Biological Life Cycle, and Human Society

Ronald Lee

Humans are highly social, living and sharing in families and in larger social groups, not autarkic individuals living in self-reliant isolation. Intergenerational transfers are an economic expression of the links among individuals of different ages and generations, who are often but not always kin. Changes in the population age distribution place stress on some of these links and relax others, affecting the economies of families, social groups, and countries. For autarkic individuals, population age distributions would be irrelevant.

Intergenerational transfers are donations of resources from one age group or generation to another, with no expectation of explicit repayment, and therefore transfers do not include economic exchanges.[1] Examples are resources devoted by parents to childrearing, adult children supporting their elderly parents, and elderly people assisting their adult children or grandchildren.[2]

Intergenerational transfers are central to many important topics in economic demography. For example, expected or planned net transfers to a child by parents are equivalent to the private costs of a child, thus connecting transfers to fertility theory. Transfers to children may also be used for human capital investments (health and education), connecting them to later productivity, well-being, and economic growth. Expectations of future transfers to be received by an individual in excess of transfers expected to be made constitute a form of wealth known as “transfer wealth.” Transfer wealth can substitute for physical wealth or assets in an individual's portfolio, thereby connecting transfers to saving behavior, capital accumulation, and economic growth (Barro 1974; Feldstein 1974). Transfers can be private, or they can take place through the public sector, as in the case of public pensions or publicly provided health care or education. Where transfers are contingent on traits or behaviors other than age alone, they inevitably create incentives and may require monitoring by families or public agencies. Public pensions often create incentives for early retirement (Gruber and Wise 1998), and publicly provided health care can lead to overuse. Transfers can enable societies to achieve more balanced allocations of consumption over the life cycle in some circumstances when markets cannot (Samuelson 1958).

1 This is the way the term “intergenerational transfers” is used in this essay. It is sometimes used in other ways, for example in Cox (1987). The definition I give also excludes reciprocal altruism, since that involves expectations of repayment.

2 Each of these examples could also be an exchange, depending on the implicit or explicit terms and expectations of those involved.

3 National Transfer Accounts, or NTA, is a large international project directed by the author and Andrew Mason, with participating research teams in 37 rich and developing countries around the world. Lee and Mason (2011a, freely downloadable through the ntacounts.org web site) describes the project and presents results for 23 countries.

4 Demeny (1968: 502) supplied the classic and much-repeated definition of the transition: “In traditional societies, fertility and mortality are high. In modern societies, fertility and mortality are low. In between, there is demographic transition.”

5 This portion of the intergenerational flow that is here viewed as a loan and is subject to repayment is not a transfer. Only that part of childrearing costs that is not a loan and is not to be repaid is considered a transfer, according to the definition given earlier.

Here I will weave together some of these themes and observations across the long sweep of human history. Necessarily much will be speculative, and there are many sweeping generalizations in what follows, but I will draw on data from anthropological studies and the National Transfer Accounts[3] project where relevant. In hunter-gatherer societies the central problem was obtaining sufficient food to rear costly dependent children while sustaining the adults, all of whom contributed to this task. Resources flowed downward from adults of all ages to the young, including from the elderly. In modern industrial societies with low fertility, aging populations, and high consumption by elderly who do not work, the central problem is inverted: how can societies afford to support growing proportions of costly elderly? In some rich countries, resources have begun to flow upward rather than down.

The co-evolution of longevity, menopause, sociality, and transfers

The evolutionary strategy of humans is based on heavy investments by families and other adults, including the elderly, in the human capital of a small number of children through many years of dependency (Hrdy 2009). Figure 1 charts per capita consumption and production (labor income) of food calories by people of different ages in hunting-gathering groups, averaged across sexes. We see that children do not produce as much as they consume until around age 20. Lee, Kaplan, and Kramer (2002) estimated that it cost hunter-gatherers 10 years of adult consumption to raise one child to sexual and economic maturity at age 20, including the cost of children dying before maturity. We also see that older people continue to produce more than they consume throughout their whole lives, on average. Lee, Kaplan, and Kramer (2002) report that 80 percent of individuals above age 50 produce more than they consume.

The long dependency is needed for the development of the brain and its cognitive and emotional aspects, along with acquisition of necessary knowledge (Kaplan and Robson 2002). This evolutionary strategy posed two difficult problems. First, without some form of life insurance, the long dependence of a few children on food and care provided by a parent risked the children's death following a parental death, with inefficient loss of reproductive fitness (Queller 1994). Cooperative breeding, with inputs from a broader array of relatives and others in the sharing group, provided such insurance because others could fill in following a premature parental death. Such sharing groups also spread the considerable risk of illness and disability. Second, total child dependency became systematically too high in the middle of parents' childbearing ages for a couple to handle on their own (Chayanov 1986; Lee and Kramer 2002). Cooperative breeding funneled resources from extended family and non-kin to families with high dependency burdens (Gurven 2004). According to Hill and Hurtado (2009), “food provisioning is ubiquitous, generally biased in favour of helping families with large dependency loads and not limited to kin assistance.”

A number of articles by Lee (2003, 2008), Lee and Chu (2012), Chu and Lee (2006, 2012), and Chu, Chien, and Lee (2008, 2010), analyze the way that this human pattern of intergenerational transfers would have shaped the evolution of other characteristics, as summarized in Lee and Chu (2012). The importance of continuing parental investments in offspring appears to explain why, unlike most other species, humans experience quite long survival after reproduction ceases. It also lies behind most theories of the evolution of menopause in humans, which is an exceedingly rare trait among other species. The mounting accumulated value of past transfers to a child as it ages is one reason why mortality drops so sharply from birth until the mid-teen years. Both of these patterns run counter to the analysis in Hamilton's seminal article (1966). The necessity of male involvement in transfers to offspring explains widespread monogamy and explains why there is relatively little difference in the size, ornamentation, and weaponry of human males and females—that is, humans have low sexual dimorphism.

Intergenerational transfers operate somewhat like a credit market in nature, whereby young offspring are able to borrow to invest heavily in their growth and development, repaying this debt through the transfers they subsequently make—if they survive—to their own offspring. Because of this possibility of reallocating energy across the life cycle, the marginal impact of resources on reproductive fitness at different ages varies less than otherwise, so the evolved age pattern of time preference (patience versus impatience) over the life cycle also varies less than otherwise, and time preference is lower. Our evolved sociality, including our willingness to share food and to contribute it to others with heavy dependency burdens, even without prospect of repayment, paves the way for our current willingness—ambivalent as it may be—to create and sustain a social welfare state with substantial transfers through the public sector.

Our evolutionary past endowed us with traits that are still evident in modern society. Fertility is relatively low, children are dependent until around age 20, and children are typically raised cooperatively (often by two parents or with help from grandparents, aunts and uncles, or other relatives, or with assistance from the state). Our long lives include long post-reproductive survival, and older people frequently assist their children in various ways including material, financial, child care, and advice. While families and households are more economically independent than in the past, we still show a propensity toward communal assistance when needed, a propensity that in rich countries is mainly mediated by the state. We attempt to plan over long horizons, reflecting our relatively low rate of time preference. We are only slightly sexually dimorphic with similar cognitive capacities but somewhat different physical strength, reflecting a basically monogamous orientation (despite the prevalence of polygamy in some societies) and the substantial contributions by men toward provisioning children.

Agricultural societies

When population was sparse and land was abundant and of little value, swidden agriculture was practiced, and property rights in land were not well-defined (Boserup 1965). From limited evidence (Lee and Kramer 2002) it appears that the elderly continued to be net producers. As density increased, returns to labor declined and land became more valuable, leading to establishment of property rights in land (Boserup 1965). Typically the land was owned by the elderly, and yielded them income, whether it was worked by adult children or by outside labor. Land ownership gave older people leverage over their adult children who hoped to inherit. In the agricultural societies included in the National Transfer Account (NTA) collection (Lee and Mason 2011a), the elderly consume more, on average, than they earn through labor (see poor countries in Figure 1), while their adult children provide more of their material needs. This stage may seem to fit Caldwell's (1976) demographic transition theory best. But adult children who work on the farm could also be seen as generating labor income for themselves and asset income for the farm's owner, their parents. In this case, the elderly are consuming their own labor income plus at least a portion of their asset income. A remaining portion may actually be transferred to their coresident children and grandchildren, rather than the reverse. In NTA data, in some poor countries such as the Philippines, Indonesia, or India, this seems to be the case: on average, the elderly continue to work but consume more than they earn in labor income; at the same time, they make significant net transfers to their adult children and grandchildren, transfers that must be funded by the elder's asset income, for example from a home or a farm. In other countries, particularly in East Asia, the elderly do receive net transfers from their children. This is so in Taiwan, China, South Korea, and Thailand (Lee and Mason 2011a). These countries have somewhat higher incomes than the first, yet one suspects that this same pattern held when they were poorer. It is also possible that the East Asian practice of transferring ownership of the elders' assets when they move into their children's homes clouds the interpretation of the NTA data.

In agricultural societies, the net direction of transfers in NTA is invariably downward from older to younger when we consider the whole life cycle. The direction of flows can be found by calculating and comparing the average ages of consuming and producing based on age profiles like those in Figure 1, weighted by the actual population age distribution (Willis 1988; Lee 1994). In every poor country in NTA, as well as in some other cases (Lee and Mason 2011a, 2011b; Lee 2000), the average age of consuming is younger than the average of producing, indicating that the average unit of output travels down the age distribution before being consumed. This is true despite the fact that children start work early and work long hours as teens, while the elderly consume more than they produce. In these societies, at least before the demographic transition, there are vastly more children than elderly.

Another approach is to calculate the implicit rate of return that a parent earned by rearing a child. Comparing the net consumption of the child to the survival-weighted return earned in old age, Lee (2000) found a large negative value, minus 7 percent. Put differently, on average a parent recovered in old age about one tenth of the net cost of raising a child. And some of that recovered cost could be viewed as asset income earned from a farm or other asset owned by the older parent.

The fertility transition[4]

At some point technological progress, capital accumulation, and urbanization raised the rate of return to education. This led altruistic parents to bear fewer children to allow higher investments in the health and education of each, raising their future productivity and improving their health and longevity. A similar calculus may have led some parents who were concerned about their support in old age to invest greater expenditure in fewer children. Support for both versions can be found in Knodel, Chamratrithirong, and Debavalya (1987). This quantity–quality tradeoff is one view of the driving force behind the demographic transition (Willis 1994; Becker 1981; Galor 2011). But in the most fully developed theory (Willis 1994), the relation of intergenerational transfers and institutions to childbearing motivations is more complex. Parents care about the future welfare of their children, but parents' altruism toward their children is balanced by concerns for their own consumption and survival. If there are few jobs in which good returns to human capital can be realized, then parents may opt for high fertility and low education. In this case, they may receive little familial support in old age, since some old-age support may be in repayment of earlier parental spending on education beyond the level motivated by altruism. Even if there are high returns to human capital, the limited altruism and limited income of parents may lead them to invest relatively little in the education of each child. Since transfers to children are also the effective “price” of a child, a low level of investment in education per child also makes children cheap to parents, and high fertility prevails, while familial support of elderly parents will be limited. If, however, culture or institutions offer a credible guarantee that children will repay parental “loans” for additional education by supporting their parents in old age, then parents might pay for more education than would be motivated by altruism alone. Then fertility might be lower, but familial old-age support would be greater as earlier “loans” were repaid. This is one interpretation of the East Asian pattern of very low fertility, very high private expenditures on children, and relatively high net familial support of the elderly.[5]

Using NTA data, we can measure for each country the total societal investment in the human capital of a child by summing the per capita public and the private expenditures on education and health at each age from 0 to 24 for education and 0 to 17 for health (Lee and Mason 2010). For comparison across countries it is convenient to divide this amount by each country's average labor income at ages 30–49, so that the investment per child is expressed in terms of years of adult labor. This can be compared to the total fertility rate for the

country over the five preceding years. Figure 2 shows the result, which is a moderately strong negative association as the quantity–quality theory would predict. A similar association is found for eight Asian countries whether we look at total human capital investment or just private investment (Lee and Mason 2012). We also find a similar pattern over time within a country for Taiwan, Japan, and the US (Lee and Mason 2011a). Taiwan, South Korea, China, and Thailand have the lowest fertility of the developing countries and also have very high investment in human capital per child. These four countries are also the only ones that have net familial support for the elderly. However, one should not make too much of this point, because Thailand and China are close, in Figure 2, to the Latin American countries that do not have familial support of the elderly.

The welfare state

Becker and Murphy (1988) built a different theory on a similar foundation, suggesting that inefficiencies of familial investment in human capital, as a result of the absence of institutions guaranteeing the repayment of parental loans, trapped societies in equilibriums at low levels of education and income. One way to escape, they suggested, was by introducing public education funded by taxing the parental generations. These were repaid in old age through the introduction of public pensions that taxed their higher-earning adult children to pay for parents' old-age support, and later for their health care and long-term care as well. While the rearing of children (other than human capital investment) remained largely a private familial matter, support for the elderly, who in earlier times would have helped to invest in children, has been taken over by the state in most rich countries and many poor ones. Meanwhile, low fertility and longer life lead to population aging.

Whether or not we credit the Becker–Murphy theory sketched above, there are important regional variations in the basic patterns observed in NTA data. Figure 3 shows sources of support for the per capita consumption of the elderly (65+) in NTA countries, net of their labor income. The position of the country markers on the triangle indicates the mix of asset income, public transfers, and private transfers that is used to pay for net consumption by the elderly, as explained in the note to the figure. European countries are found along the right edge of the triangle toward the bottom, indicating that they rely two thirds or more on public transfers, with the remainder provided by asset income. The US is farther up on the line, relying two thirds on asset income and one third on public transfers. Latin American countries are also scattered along this line, but all except Mexico rely two thirds or more on public transfers. Mexico is much like the US, except that the elderly in Mexico make larger net transfers to their children. Only Asian countries are well inside the triangle or on the left edge. While Japan looks similar to the European or Latin American countries, China, Taiwan, and South Korea are all fairly close to the center of the triangle, indicating that they rely on all three of the sources, and most notably, they rely on the family. Off to the left, Thailand relies on a mix of familial support and asset income. The Philippines relies almost entirely on asset income. The elderly in India fund their own consumption from asset income and have enough left over to make substantial transfers to their children.

We can consider together the patterns of transfers to children and the elderly. In East Asia, public transfer programs for children and the elderly have remained small, while the family plays a larger role than elsewhere. Private expenditures on children's education complement public, with tutors, cram school, and other educational activities taking place after public education is done for the day. In Latin America a different pattern is observed. Public pensions are generous, sometimes leaving the elderly with resources to transfer to their adult children. Net familial transfers flow downward from the elderly (Brazil, Uruguay, Mexico) or are insignificant. Public education is funded less generously than are pensions, and the rich send their young children to private school, and then to public institutions for higher

education. In Europe, the elderly rely heavily on public transfers, which fund virtually 100 percent of their consumption in Austria, Sweden, Slovenia, and Hungary, with Germany and Spain not far behind. But public funding for education is also generous, with very little private expenditure.

The source of consumption funding for the elderly may influence the level of consumption. In those Asian countries where the elderly get substantial familial transfers, the level of consumption of the elderly tends to be similar to or lower than that of younger adults. In the US, the move to more generous Social Security benefits and the inception of Medicare and Medicaid are associated with a great increase in the relative level of consumption by the elderly (NRC Committee, in press: Figure 3–10). The ratio of consumption by an 80-year-old to that by a 20-year-old doubled between 1960 and 2007, and while non-health private consumption began to decline at age 60 in 1960, it did not start to decline until age 80 in 2007. These changes in the age pattern of consumption have made population aging much more costly in the US.

Transfers, incentives, behavior

When the public sector assumes transfer functions that were originally familial, the incentives facing family members may change, as may their choices and behaviors. Publicly funded education reduces the cost of a child and could lead to higher fertility. Alternatively, the effect may be in the opposite direction: by reducing the price of quality, public education may lead to substitution of quality for quantity, causing fertility to fall. Either way, it alters the incentives and opportunities for the family and alters its behavior.

When the public sector makes pension transfers to the elderly, the value of children is reduced to the extent that parents were planning to rely on them for old-age support. Many researchers have suggested that this could be a cause of low fertility, undercutting the sustainability of the public pension programs. Public pensions have also been structured in such a way that they create incentives, sometimes intentional, for workers to retire at younger ages (Gruber and Wise 1998). This, however, is not an essential feature of public or private pensions, which can be made neutral in this regard, as in Sweden's Notional Defined Contribution system. For whatever reason, we find in our NTA data that transfer support in old age, either from the family or from public pensions, is associated with lower labor supply than if net consumption in old age is funded from asset income.

Public pensions and other public transfers to the elderly have the essential feature of creating a positive externality to childbearing (the seminal article by Demeny, 1969, is the first discussion of externalities to childbearing, and the first analysis of the economics of population control in a welfare theoretic context). Parents making fertility decisions do not take into account that each child makes the pension system slightly less expensive per worker to maintain. The same is true for publicly provided health care for the elderly and long-term care. The externalities to childbearing generated in this way can be quite large. Wolf et al. (2011) report a fiscal externality for a birth to a parent with above high school education of $247,000 in 1996 US$, which equals $400,000 in 2012 US$.

Conclusion

Evolution is partly about optimization of reproductive fitness through mutation and selection. When transfer behaviors evolve, as they did for humans, they create new advantages and disadvantages for patterns of fertility and mortality across ages, and thereby shape the direction in which the age structure of vital rates evolves (Lee 2003, 2008; Chu and Lee 2006; Lee and Chu 2012). In a similar way, patterns of transfers in modern life alter

the incentives we face and influence our optimizing behavior, not always in socially beneficial ways.

The sociality of humans, including food sharing, intergenerational transfers, and assistance for families with high dependency ratios, evolved in the setting of small food-sharing groups containing 8 to 25 people, during the lean season when larger groups dispersed to forage (Binford 2001; Lee 2008). These people, who were often kin, would have known each other well and have known one another's circumstances. Humans have brought this basic psychology into the modern world, though heavily shaped by cultures. The rise of the welfare state could be seen as an expression of these culturally modified evolved propensities, but with the intent of improving on deficiencies in family transfers as a vehicle for investment in human capital, old-age support, and need-based assistance, somewhat along the lines of Becker and Murphy (1988). However, the anonymous nature of public-sector transfers has led to its own problems. In some cases, the public transfers have helped to create a need, rather than meeting a preexisting one, as in the case of public pensions and the emergence of a prolonged period of retirement and leisure at the end of life.

Humans have an altruistic impulse to assist the young, within limits. This impulse is reflected in the downward direction of net private transfers in all NTA societies, rich and poor (Lee and Mason 2011a: Ch. 4, Ch. 8). Public transfers are a different story, however. In some rich and aging societies, these now flow upward, from working ages to the retired elderly, as gauged by the difference between the average ages of paying taxes and of receiving benefits (Lee and Mason 2011a: Ch. 4). This is true of all European NTA countries, plus Japan, Uruguay, and Brazil, but not the US. In some of these countries the upward public transfers are large enough to overcome the downward private ones, so that the net direction of total transfers has shifted upward, as in Germany, Austria, Slovenia, and Japan. This is a sea change in human history.

We know that the current structures of public transfer programs in many countries are unsustainable in the face of population aging. Certain ages and generations have benefited from windfall gains as these programs expanded, and doubtless some will suffer painful losses as benefits are cut and taxes raised. It remains to be seen, however, whether social support of the elderly will be a dominant function of societies once they have adjusted to the radical population aging of the next few decades.

Acknowledgments

The author's research for this essay was funded by NIA grant R37-AG025247. He is grateful to the country teams for the 23 countries whose data are used in this essay; to Andrew Mason, who co-directs the National Transfer Accounts project; and to Gretchen Donehower, who helped with the data analysis and charts.

References

Barro, Robert J. Are government bonds net wealth? Journal of Political Economy. 1974; 28(6):1095–1117.

Becker, Gary S. A Treatise on the Family. Harvard University Press; Cambridge MA: 1981.

Becker, Gary S.; Murphy, Kevin M. The family and the state. Journal of Law and Economics. 1988; 31(1):1–18.

Binford, LR. Constructing Frames of Reference. University of California Press; Berkeley: 2001.

Boserup, Ester. The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure. Aldine Publishing; Chicago: 1965.

Caldwell, John C. Population and Development Review. Academic Press; 1976. Toward a restatement of demographic transition theory; p. 113-180.reprinted as Chapter 4 of John Caldwell (1982), *Theory of Fertility Decline*

Chayanov, AV. The Theory of Peasant Economy. Thorner, Daniel, et al., editors. University of Wisconsin Press; 1986. p. 53-81.originally in 1925

Chu, C.Y. Cyrus; Chien, Hung-Ken; Lee, Ronald D. Explaining the optimality of U-shaped age-specific mortality. Theoretical Population Biology. 2008; 73(2):171–180. [PubMed: 18178233]

Chu, C.Y. Cyrus; Chien, Hung-Ken; Lee, Ronald D. The evolutionary theory of time preferences and intergenerational transfers. Journal of Economic Behavior and Organization. 2010; 76(3):451–464. [PubMed: 21218165]

Chu CY, Lee Ronald D. The co-evolution of intergenerational transfers and longevity: An optimal life history approach. Theoretical Population Biology. 2006; 69(2):193–201. [PubMed: 16406044]

Chu CY, Lee Ronald D. Sexual dimorphism and sexual selection: A unified economic analysis. Theoretical Population Biology. 2012 DOI: «http://dx.doi.org/10.1016/j.tpb.2012.06.002».

Cox, Donald. Motives for private income transfers. Journal of Political Economy. 1987; 95(3):508–546.

Demeny, Paul. Early fertility decline in Austria-Hungary: A lesson in demographic transition. Daedalus. 1968; 97(2):502–522. Spring. [PubMed: 11609516]

Demeny, Paul. The economics of population control. Proceedings of the International Conference, London 1969, Vol. III. International Union for the Scientific Study of Population; Liège: Ordina Press; 1969. p. 1459-1474.reprinted 1971

Demeny, Paul. Rapid Population Growth: Consequences and Policy Implications. Johns Hopkins Press; Baltimore: 1971. “The economics of population control,” in National Academy of Sciences; p. 199-221.

Feldstein, Martin. Social Security, induced retirement, and aggregate capital formation. Journal of Political Economy. 1974; 82(5):905–926.

Galor, Oded. Unified Growth Theory. Princeton University Press; 2011.

Gruber, Jonathan; Wise, David. Social Security and retirement: An international comparison. American Economic Review. 1998; 88(2):158–163.

Gurven M. To give and to give not: The behavioral ecology of human food transfers. Behavioral and Brain Sciences. 2004; 27:543–583.

Hamilton, William D. The molding of senescence by natural selection. Journal of Theoretical Biology. 1966; 12(1):12–45. [PubMed: 6015424]

Hill, Kim; Hurtado, A. Magdalena Cooperative breeding in South American hunter-gatherers. Proceedings of the Royal Society. 2009; 276(1674):3863–3870.

Howell, N. Life Histories of the Dobe !Kung. University of California Press; Berkeley: 2010.

Hrdy, Sarah Blaffer. Mothers and Others: The Evolutionary Origins of Mutual Understanding. Harvard University Press; Cambridge, MA: 2009.

Kaplan, Hillard. Evolutionary and wealth flows theories of fertility: Empirical tests and new models. Population and Development Review. 1994; 20(4):753–791.

Kaplan, Hillard S.; Robson, Arthur J. The emergence of humans: The coevolution of intelligence and longevity with intergenerational transfers. Proceedings of the National Academy of Sciences U.S.A. 2002:10221–10226.

Knodel, John; Chamratrithirong, Aphichat; Debavalya, Nibhon. Chapters 7 and 10 of *Thailand's Reproductive Revolution*. University of Wisconsin Press; 1987. “Societal change and the demand for children,” and “Synthesis and Conclusions: toward an understanding of Thailand's rapid fertility decline,”; p. 117-154.p. 193-205.

Lee, Ronald. The formal demography of population aging, transfers, and the economic life cycle. In: Martin, L.; Preston, S., editors. The Demography of Aging. National Academy Press; Washington, DC: 1994. p. 8-49.

Lee, Ronald. A cross-cultural perspective on intergenerational transfers and the economic life cycle. In: Mason, Andrew; Tapinos, Georges, editors. Sharing the Wealth: Demographic Change and Economic Transfers between Generations. Oxford University Press; Oxford: 2000. p. 17-56.

Lee, Ronald. Rethinking the evolutionary theory of aging: Transfers, not births, shape senescence in social species. Proceedings of the National Academy of Sciences. 2003; 100(16):9637–9642.

Lee, Ronald. Sociality, selection, and survival: simulated evolution of mortality with intergenerational transfers and food sharing. Proceedings of the National Academy of Sciences. 2008; 105(20): 7124–7128.

Lee, Ronald; Chu, CY. The evolution of transfers and life histories. Experimental Gerontology. 2012; 47(10):803–806. [PubMed: 22750486]

Lee, Ronald; Kaplan, Hillard; Kramer, Karen. Children and elderly in the economic life cycle of the household: A comparative study of three groups of foragers and horticulturalists. paper presented at the Annual Meetings of the Population Association of America; 2002.

Lee, Ronald; Kramer, Karen. Children's economic roles in the Maya family life cycle: Cain, Caldwell, and Chayanov revisited. Population and Development Review. 2002; 28(3):475–499.

Lee, Ronald; Mason, Andrew. Fertility, human capital, and economic growth over the demographic transition. European Journal of Population. 2010; 26:159–182. PMCID: PMC2860101. [PubMed: 20495605]

Lee, Ronald; Mason, Andrew. Population Aging and the Generational Economy: A Global Perspective. Edward Elgar; Cheltenham, UK: 2011a.

Lee, Ronald; Mason, Andrew. Generational economics in a changing world. Population and Development Review. 2011b; 37(Supp.):115–142. [PubMed: 21804657]

National Research Council, Committee on the Long-Run Macroeconomic Effects of the Aging U.S. Population. Aging and the Macroeconomy: Long-Term Implications of an Older Population. National Academies Press; Washington, DC: In Press

Queller, David C. Extended parental care and the origin of eusociality. Proceedings of the Royal Society B. 1994; 256:105–111.

Samuelson, Paul. An exact consumption-loan model of interest with or without the social contrivance of money. Journal of Political Economy. 1958; 66(6):467–482.

Willis, Robert J. Life cycles, institutions and population growth: A theory of the equilibrium interest rate in an overlapping-generations model. In: Lee, RD.; Arthur, WB.; Rodgers, G., editors. Economics of Changing Age Distributions in Developed Countries. Oxford University Press; Oxford: 1988. p. 106-138.

Willis, Robert J. Economic analysis of fertility: Micro-foundations and aggregate implications. In: Kiessling, Kerstin Lindahl; Landberg, Hans, editors. Population and Economic Development and the Environment. Oxford University Press; Oxford: 1994. p. 139-172.

Wolf, Douglas A.; Lee, Ronald D.; Miller, Timothy; Donehower, Gretchen; Genest, Alexandre. Fiscal externalities of becoming a parent. Population and Development Review. 2011; 37(2):241–266. [PubMed: 21760651]

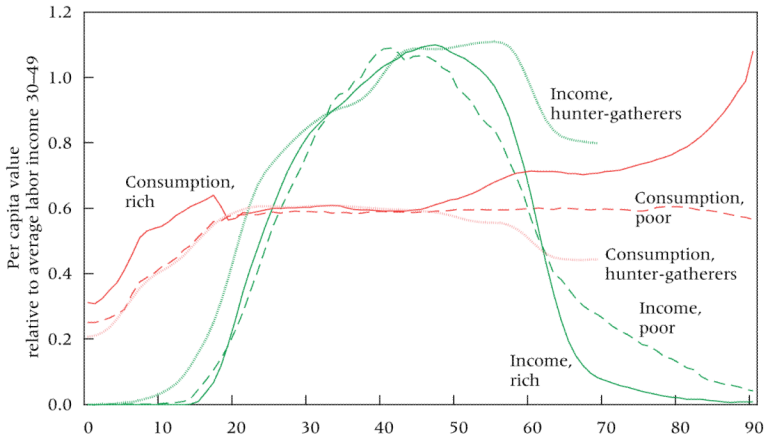

FIGURE 1. Per capita consumption and labor income of hunter-gatherers and average for six poorest and six richest populations

NOTE: For rich and poor countries, the data are averages of the six countries with highest and lowest incomes in the NTA data used in Lee and Mason (2011a). For hunter-gatherer populations, labor income is estimated as average food calories acquired at each age, drawing on estimates by anthrologists (for details, see Kaplan 1994; Howell 2010; and Lee 2000).

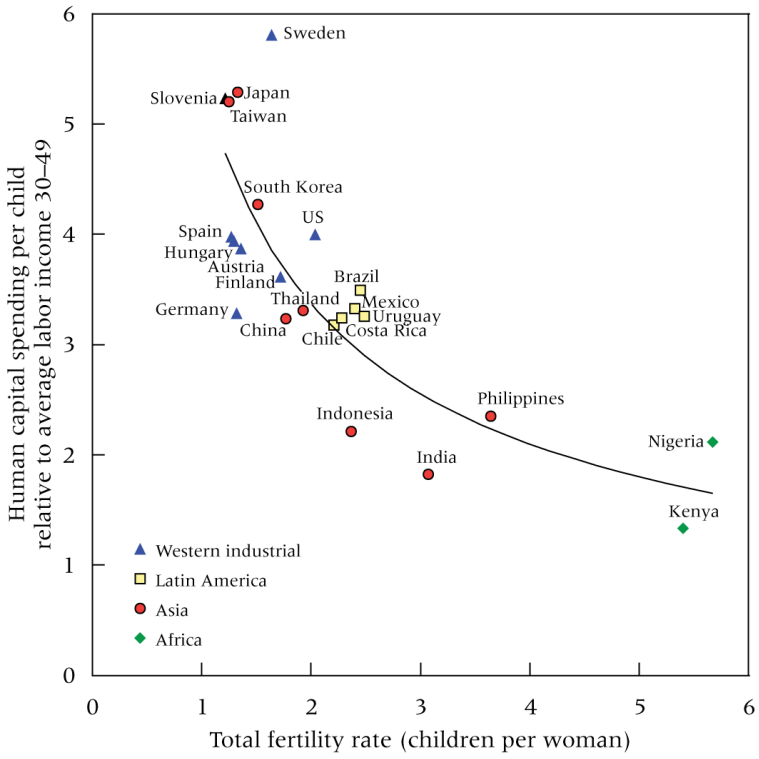

FIGURE 2. Tradeoff between fertility and human capital spending

NOTE: Human capital spending is total private and public spending per child on health from age 0 to 17 and on education from age 0 to 24 expressed as a percent of average annual labor income at ages 30–49 in each population.

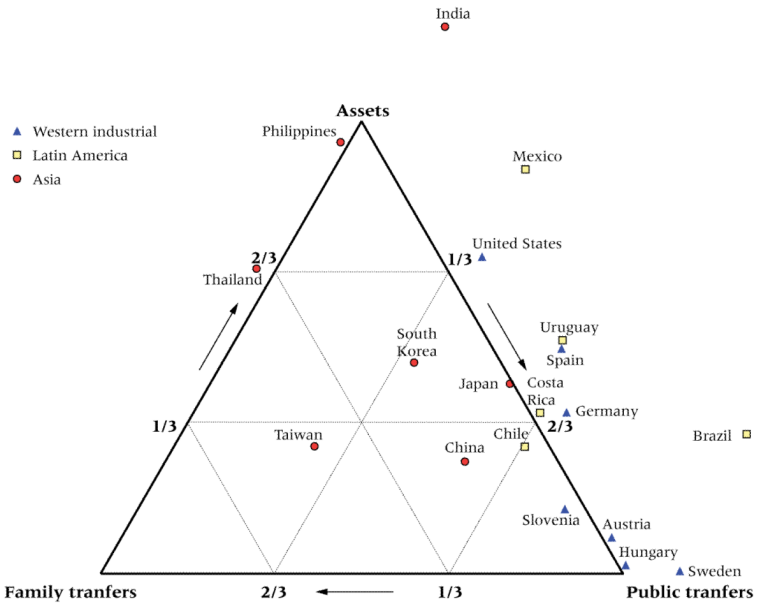

FIGURE 3. Support systems for the elderly 65+ according to NTA data

NOTE: Countries located at a vertex derive 100 percent of support for old-age consumption from the labeled source at that vertex. Countries along an edge derive support from a mixture of the two sources at its ends. Countries within the triangle derive support from a mixture of the three sources, more from the closer vertexes. In countries outside the triangle, the elderly make net transfers to the opposite source. For example, in Mexico the elderly make net transfers to younger people.