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An evolutionary perspective on fertility, intergenerational transfers, and fertility decline

This is a brief note I wrote following our June 6 meeting, trying to touch on points that seem relevant.

1. Evolutionary perspective: Evolution through natural selection moves any species toward greater reproductive fitness over the long run, where this is usually quantified either as the Net Reproduction Rate or as the intrinsic rate of natural increase, IRR. Fitness depends both on the level and timing of fertility and on the proportion of births surviving to reproductive age, and therefore involves tradeoffs between quantity and quality of offspring. Human evolution occurred mostly during our hundreds of millennia as hunters and gatherers. How can this be relevant for our recent history of rapid fertility change which in many populations has dropped fertility well below replacement level?

Humans are a species with low fertility and heavy investment per offspring. This low fertility reflected tradeoffs among i) mother's health and future reproductive capacity, ii) the existing siblings' health (e.g. a short birth interval would terminate the older sib's breastfeeding and the ability of the mother to carry the older sib when they moved camp), iii) the ability to invest as needed in the newborn, and maintain sufficient food for the existing family, iv) the large reduction in foraging efficiency for females who were pregnant, lactating, or carrying small children. Offspring required heavy investment since they were nutritionally dependent up to age 18 or 20 years. This long dependency) was required by the difficulty of birthing the skull housing the large human brain and by the brain's high caloric needs for growth and development. The brain takes 66% of the resting metabolic energy of children and 43% of their total daily energy use (Kuzawa et al 2014 in PNAS). This brain was an important component of the strategic niche occupied by hunter-gatherers and horticulturalists. Lee, Kaplan and Kramer calculated that raising one surviving child to age 18 in hunter/gatherer groups took a direct investment of calories equivalent to about 10 years of average adult consumption to, including costs for children who didn't survive. This does not include the adult time costs of the child. Humans are unlike other Great Apes in having relatively short birth intervals and a number of simultaneously dependent offspring. Orangutans, by contrast, have birth intervals of 7 or 8 years, raising each offspring without assistance until it can be independent. Human females couldn't possibly raise children on their own.

There are several points here: (i) The quantity-quality tradeoff has been strongly present in humans for a very long time (hundreds of thousands of years?). It is manifest in our hardwired biology (a low maximum potential fertility of about 15 lifetime births per woman on average, see articles by John Bongaarts) and also in behavioral quantity-quality decisions by mothers, implemented through infanticide and in other ways to permit only 5 or 6 lifetime births (net of infanticide) in hunter-gatherer societies.

(ii) The high cost and long dependency of modern children are not new, although these both were lower in agricultural societies which had safer and simpler opportunities for children to contribute economically than was true in hunter-gatherer societies.

Given the heavy consumption demands of multiple simultaneously dependent offspring, a woman could not raise her children alone, nor could the mother and father together manage it. When there were two or three dependent children, the parents required assistance from others in the groups in which they lived, who might be grandparents and uncles or aunts, but they could also be non-kin. See Sarah Hrdy, *Mothers and Others*, for a synthesis, and see papers by Kaplan, Gurven, Hooper and others. See *Human Evolutionary Demography* (2024). While individuals were certainly motivated by their own evolutionary self-interest, they had also evolved to be social creatures who supported, cooperated with, and shared food with others, both kin and non-kin. This social behavior was made possible through our co-evolved emotional, cognitive and perceptual traits.

(iii) I think this highly developed human sociality provides the psychological and sociological foundation for the modern welfare state. We might think of the welfare state as an attempt to create substitutes not just for the extended family, but also for the supportive and risk-spreading functions of the groups in which hunters and gatherers once lived. They too worried about free-riding and cheating, and brought intense pressure on individuals to share.

And what of gender? It appears that in hunter-gatherer societies men had main responsibility for hunting and women for gathering. Women had main responsibility for caring for children, and would take turns staying in camp with the children while other women gathered. But there were many exceptions to these arrangements. (See Hill and Hurtado, *Ache Life History*, (1996), and many papers by Kaplan, Gurven, Hooper, Kim Hill, and others).

To what extent were these sex/gender roles biologically shaped and to what extent were they cultural artifacts? This topic is the focus of Sarah Hrdy's (2024) *Father Time*, in which she finds that if men have close exposure to babies starting at their birth then their hormonal reactions are similar to those of women, and they undergo changes leading them to be more other-oriented and empathetic and can become competent and dedicated caregivers. See also Franz De Waal, *Different Gender through the eyes of a primatologist* (2022). There seems to be considerable room for culture and policy to move men toward more equal roles in childrearing, and there are many men now who are primary caregivers for their children.

(iv) This topic seems highly relevant to the possibility of gender symmetry in social and economic roles, or at least to substantially increased sharing by men of childcare and other household tasks, which in turn seems relevant (in its absence) to fertility decline. I suspect that we are still at relatively early stages of a long process of cultural change in this direction.

The co-evolution of biology and culture has been receiving a lot of attention for humans and other species (e.g. a special issue of PNAS), with causality running in both directions (for humans, most famously from domestication of cattle to lactose tolerance; development of agriculture and the ability to metabolize alcohol; and perhaps evolution of analytic ability with urban living and the development of markets and trade).

2. The Demographic Transition: No need to rehearse the broad outlines of the demographic transition. The main point is the transition from life expectancy at birth in the range of 22 to 35 in pre-transitional settings to wherever it is headed now, let's say 80-85; and the somewhat lagged transition of fertility from 4.5 to 7 or so to wherever it is headed. Initially the NRR was near to unity, with around one female birth per female surviving to reproduce, and population growth rates (on average) low and near zero. Given the lagged decline in fertility a great disequilibrium developed in which some of our grandparents or great grandparents ended up with very large numbers of surviving children, 8 or 10 perhaps. Fertility gradually adjusted to the new low mortality and also to the costs of children in urban settings including the opportunity costs to mothers. Education became economically important for children, introducing a new dimension to the quantity-quality tradeoff, also powering fertility decline, either out of concern for the future welfare of the children or out of concern for the parents' support in old age, or both.

That is all a standard story. But how do we fit it in the evolutionary framework? How can evolution, usually (for important traits) an extremely slowly unfolding process over many tens of thousands of years, contribute anything to our understanding of rapid fertility change? The evolutionary anthropologist Hilly Kaplan proposed one explanation in the 1990s. Humans have evolved, he suggested, to locate the level of investment in a child's human capital at which diminishing returns to future investment set in. The problem is, he said, that in the modern world with formal education, there is no such point. The returns to an additional year of education rise or remain flat. As a result, parents just keep heaping investment on a single child with more schooling, higher education, piano lessons, karate lessons, tutors, etc. Some economists (e.g. Galor and Clark) have suggested (I have not reviewed their work recently and this summary may not be quite correct) that economic change leading up to the industrial revolution created rewards for a certain kind of analytic ability and natural selection then favored individuals who had a stronger preference for that kind of quality over quantity. I don't think that evolutionary anthropologists or evolutionary biologists absorbed those ideas or responded to them.

The quantity-quality dynamic, if combined with competition for top spots in a hierarchically structured universities and later for top jobs -- that is, in pursuit of relative rather than absolute status-- has been suggested as driving the extreme fertility decline in S. Korea and perhaps East Asia in general (Kim, Tertilt, and Yum, AER 2024). This seems very plausible to me.

3. Adjusting to the demographic transition – cultural, institutional and behavioral lag: Before the transition, life was shorter and women had more births. I calculated that on average a woman would have spent 70% of her adult life pregnant, lactating, and caring for young children. Once fertility dropped to two births and adult life grew much longer, that 70% dropped to only 14% of a woman's adult life. New opportunities for education and career emerged, or perhaps the desire for these opportunities drove the fertility decline. Either way, the new opportunities were there. On top of this, the changing nature of work further reduced any rationale for asymmetry in the economic roles of women and men. But millennia of development and entrenchment of socio-cultural views and values regarding appropriate gender roles make very difficult the adjustment of gender roles in the face of these new demographic realities. This cultural lag is seen both in the labor market where work by women is often undervalued or not permitted, and in the home where for the most part women do the lion's share of work whether or not they also work in the market.

As young two-career parents of three kids my wife and I were invited to dinner at the home of a graduate student who lived in married student housing (45 years ago). Apartments were arranged around a central courtyard where children played safely and could be watched by one parent in one household, with no driving for playdates. Sharing of meals, shopping and other tasks was simple and natural. To us in our nice single family house it looked like heaven. The arrangement was much closer to our deep evolutionary past, providing both privacy for individual families and space for easy and efficient cooperation and socializing. Very different than the 1950s model nuclear family which was viewed by many such as Simon Kuznets as the natural and efficient endpoint of a process of change as the inefficient and incentive-stifling extended family and kin network gave way to this new sleek family in which you didn't have to tolerate, share with, or be slowed down by your relatives, and geographic mobility was unhindered. But many (though certainly not all) stay-at-home fulltime moms and homemakers found it to be limiting and less than satisfactory.

The inefficiencies of one adult woman caring for her own one or two young children can be reduced or eliminated by grouping children for care in private or public childcare. This can also better align education and training with the needs of different work tasks including childcare.

4. The public sector enters the scene and serves many of the functions of the older social group – efficient childcare (in some countries), insurance against disability and unemployment, training for children, health care, and poverty relief to name a few. Because these functions are performed for strangers, costly and error-prone monitoring is needed to avoid cheating.

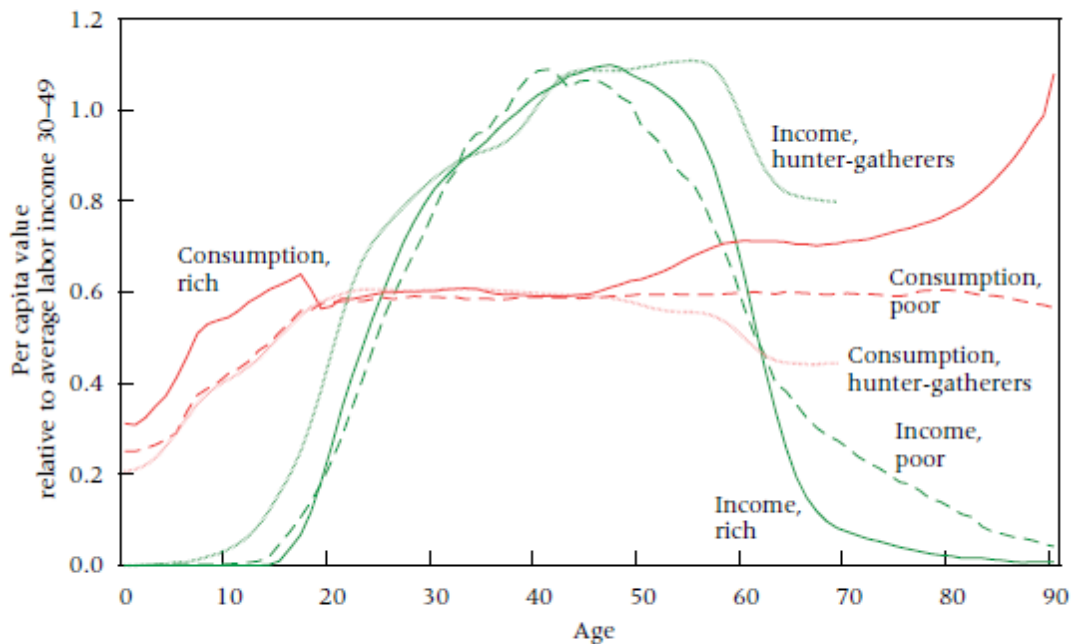
In hunter-gatherer societies older people continued to work and produce a caloric surplus on average until close to their time of death, as has been observed in contemporary hunter-gatherer societies in sub Saharan Africa and in the Amazon Basin for the past 60 or 70 years. See figure below which shows caloric production and consumption by age up to age 70, and contrasts this to labor income and consumption on average in high income countries today and in lower income countries today.

In our deep past, all adults including the elderly contributed to investment in growth and development of the group's children, despite being far less healthy than the elderly today, at least those in higher income countries. The elderly of today are a different story. The figure shows that in high income countries, the elderly have very little labor income after around age 60, in contrast to the lower income and hunter-gatherer groups, and the elderly consume more than children and younger adults, again in contrast to the other groups. This change in labor income in part reflects the rise in public pensions and their (in many cases) incentives for early retirement, and the rise of employer-provided pensions and better vehicles for individual saving and investment. The change in consumption is driven in part by income from public and private pensions, but also by the rapidly rising costs of health care, particularly publicly funded health care.

This reduction in labor income and increase in relative consumption interacts with population aging (brought on by low fertility and longer life) to generate rapidly rising costs of these public transfer programs for the elderly. These rising costs then compete with funding for public programs for children and to support families, at least in the US.

I see this current situation with low and declining fertility, slowing or declining population growth, and population aging as a sort of secular disequilibrium that will gradually get worked out by changes in culture, behavior and policy, but which may persist for many decades to come during this process of adjustment.

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 anthropologists (for details, see Kaplan 1994; Howell 2010; and Lee 2000).

Age profiles of hunter gatherer caloric production and consumption: averages of estimated profiles for Amazon Basin Ache, Piro, Machiguenga (50%, based on Kaplan 1994) and Botswana !Kung (50%, based on Howell 2010). Figure copied from Ronald Lee and Carl Boe (forthcoming) "Sociality, Food Sharing, and the Evolution of Life Histories" in *Human Evolutionary Demography*, edited by Oskar Burger, Ronald Lee, and Rebecca Sear. Free access at <https://www.openbookpublishers.com/books/10.11647/obp.0251>