Spousal age gap and family-produced elderly care

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Abstract

This paper argues that spousal age gap systematically affects the age distribution in an extended family, which in turn affects the way elderly care is provided and consumed within a family. Relatively large spousal age gap in an overlapping-generation setting tends to smooth the elderly-care workloads over women's lifetime. Gender life expectancy gap in favor of women is an alternative channel of smoothing such workloads. And its increase tends to reduce spousal age gap. This substitution effect becomes weaker for rich families and societies, who are more sensitive to the relative cost of men's delaying marriage, which we argue leads to lower long-run birth rate even when the fertility level is fixed. We also show that these novel implications can organize cross-country data into meaningful patterns.

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1 Introduction

Husbands tend to be older than their wives. While the age of marriage changes more frequently, spousal age gap changes much more slowly, though it does systematically vary both over time and across different societies and groups. The laws governing the age of marriage, which are better known to us, do not seem to be most relevant in explaining this deeply-rooted phenomenon. Existing explanations (to be reviewed below) do not have good empirical support.

This paper tries to understand spousal age gap as an institution of organizing elderly care within an extended family. Suppose overlapping generations in the same family have roughly the same spousal age gap, the size of the spousal age gap will systematically affect the age distribution in an extended family, which in turn will affect the way elderly care is provided and consumed within a family. Relatively large spousal age gap in an overlapping-generation setting tends to smooth the elderly-care workloads over the lifetime of relatively young family members (mainly women), which creates efficiency gains but leads to lower long-run birth rate at a given fertility level because of marriage delay.

Our theory identifies three new explanations of spousal age gap variation, among some other regular results. (1) Substitution effect. Gender life expectancy gap in favor of women tends to reduce the need of smoothing workloads through men's marrying younger wives. (2) Income effect. Rich families or societies tend to have smaller spousal age gap because they have less need to sacrifice the number of descendants for the efficiency gains in elderly-care production. (3) Interaction effect. The substitution effect is weaker for rich families and societies, because they tend to have uniformly low spousal age gap. We show that these novel implications can organize cross-country data into meaningful patterns.

Family-based elderly care is a pervasive human phenomenon. There is a vast literature in health studies dealing with this issue in post-industrial societies. For most developing countries, extended families remain to be the main providers of elderly care. Relatively young and healthy women play the dominant role in providing these care. The connection between gender-specific family age structure and elderly-care provision might be obvious. What is less obvious, and a main contribution of this paper, is systematically investigating the implications of such a connection in an overlapping-generation setting.

Existing theories of spousal age gap can not explain such broad marriage patterns encompassed in this paper. Sociologists like Casterline, Williams and Mcdonald (1986) argue that large spousal age gap is caused by low female status within a family, a variable which is difficult to measure. Even their small data set did not produce strong supportive evidence. Our cross-country data suggest that there is a large variation of spousal age gap both across time and between societies, which do not seem to go hand in hand with the change of female status within a family.

According to Becker (1991), searching cost is higher for rich men, which drives them to marry early than poor men. Bergstrom and Bagnoli (1993) instead argue that more productive men use late marriage as a signal in the marriage market. Their theories (also Siow 1998) are at best good at explaining post-industrial societies. For the most part of human history, marriage market tends to be local, and social mobility tends to be low. Their arguments do not seem to be very relevant. Edlund (1999) argues that spousal age gap could be caused by son preference. But even her own evidence shows a very weak connection between sex ratio and spousal age gap.

Other intuitive explanations are easy to refute. Polygamy and re-marriage tend to produce larger spousal age gap, but these are not uniform human experiences. High bride price and poverty may force many young men to marry late, but this is hard to explain why many societies where dowry is practised also display a large spousal age gap, not to mention the fact that many men who can pay high bride prices also choose to marry younger women.

The paper is organized as follows. We will devote the next section to discussing the intuition of the model setup and our main tradeoff. Section 3 presents the model setup. Section 4 presents the theoretical results. Section 5 presents the empirical evidences. Section 6 concludes.

2 Intuition

Consider an overlapping generation of homogeneous males and females who live for 4 periods. A male agent is fecund in the 2nd and 3rd period. A female agent is only fecund in the 2nd period. Suppose every female marries one male agent in her 2nd period. She can either marry a two-period-old male agent (endogamy), or a three-period-old one (exogamy). Suppose all generations of the same family stick to one particular marriage regime.

To see how marriage regime affects the way personal care is provided within a family, let's first assume that personal care can only be produced by two-period-old or three-period-old female family members. We also assume that only family members who are one-period old or four-period old require care. In a word, care is produced and consumed within an extended family. For the moment, we also assume that the women do not participate in the labor market.

Because of the difficulty of shifting women's time from one period to another, it makes economic sense to smooth the workloads over their lifetime. If the production of care requires other economic inputs in addition to women's time, smoothing has an additional advantage in traditional societies with incomplete capital market.

Such smoothing can be arranged under the exogamous marriage regime. This is due to the key insight that whenever the husbands are older than their wives at the time of their marriage, they will start to require care earlier than their wives do. As a result, a typical woman's workloads are smoothed over her lifetime. She first takes care of her babies, then the aging father-in-law (or father), then the aging mother-in-law (or mother), and finally her aging husband. Such smoothing is not possible in an endogamous marriage regime unless men age faster than women, an important topic which will be discussed later.

TABLE 1 HERE.

Table 1 describes the detailed aging history of a patrilocal family (wives living with her husbands' families) under different marriage regimes. The fertility is set at the replacement level, namely one boy and one girl.

First consider the case of endogamy. At $t = 1$, a boy (m_1) and a girl (f_1) are born into the family. They grow up in the next period. The female marries someone outside of the family and is no longer tracked by our table. The male (now denoted as M_1 after marriage) marries another young woman (F_1) of his age, and together they give birth to a boy (m_2) and a girl (f_2). The same pattern is repeated. At $t = 3$ and $t = 4$, M_1 and F_1 enter their middle age and old age, respectively. For the exogamy case, the difference occurs for the male m_1 at $t = 2$. He remains single in this period and marries a younger woman (F_2) only at $t = 3$. They give birth to two children (m_3 and f_3). At $t = 4$, M_1 becomes old while his wife F_2 is still in her middle age. At $t = 5$, F_2 (now widowed) also becomes old.

It is clear from Table 1 that only under exogamy is it the case that the husband requires care one period ahead of his wife. Smoothing is not very helpful in our discrete example since we assume that the women can only provide care in two periods (young and middle age) while her potential workloads are already distributed over these two periods even under endogamy. However, it is easy to imagine that smoothing could be very helpful for old-age care provision under exogamy if time is continuous and child-caring only consumes part of a woman's adult life.

Exogamy, however, is not a free lunch. It necessarily leads to a loss of marriage gains for both sexes. m_1 is a bachelor at $t = 2$, while F_2 is a widow at $t = 5$. As gains to marriage are typically higher for the rich people (Becker 1991), this tends to discourage them from adopting exogamous marriage regime. Another disadvantage of exogamy is its small family size. It is clear from Table 1 that at any time the the adult population size under exogamy is always a half of that under endogamy (3 v.s. 6). This is true despite the fact that the fertility is set at the same level under both regimes. Note that under exogamy, the birth rate is 0 every other period, a result of male marriage delay. Since maximizing the number of descendants is a basic human instinct, exogamy is a costly institution.

The intuition of the tradeoff between these two marriage regimes can be summarized in Table 2.

TABLE 2 HERE.

3 Model Setup

Now suppose that instead of living for 4 periods, an agent lives for a_i ($i = 1$ for male, $i = 2$ for female). We assume that $0 < a_1 \leq a_2$, i.e. women liver longer than men. The agent is an infant and requires care at $[0, \theta_1]$. The agent needs old-age care at $[\theta_2, a_i]$, with $i = 1, 2$. For simplicity, suppose all women marry at $b \in (0, a_1)$ and immediately gives birth to n children. Men marry at $x \geq b$. The upper bound of x is to be specified later.

This is a patrilineal society without social mobility. Each family is indexed by their wealth W, which is a constant inherited by all the male descendants of the same family. We assume that there are enough families at the same wealth level and people do not marry out of their wealth class.

A social planner decides for all the males in the same family when to marry. His objective function is

$$U(x) = \alpha ln(S) + (1 - \alpha) ln(N) \tag{1}$$

where S denotes the effective level of care provided by his prospective wife to the elderly family members, N denotes the number of descendants he can get over his lifetime, and α is a parameter which lies between 0 and 1.

The social planner is not a selfish gene, who would only care about maximizing the number of descendants, but would pay no attention to old people's welfare. To a selfish gene, $x = b$ is obviously the optimal regime in our setting. Our social planner cares both old-age care and the number of descendants. To increase old-age care, it typically requires $x > b$ such that women's workloads can be smoothed. To increase the number of descendants, x needs to be set as close as possible to b. There is a tradeoff the planner has to make.

N is defined as

$$N = \frac{a_1}{x} n \tag{2}$$

S is defined as

$$S = WL - \sum \Delta s^2 \tag{3}$$

where $L = a_2 - \theta_2 - b$ (the length of a wife's productive period), and $\sum \Delta s^2$ measures the loss of failing to smooth workloads over a woman's lifetime.

Since a woman's workloads depend upon the aging pattern in her husband's family, the age structure of her patrilineal family members is summarized in Table 3. First she needs to take care of her own children. Then there are three people who consecutively need this woman's attention when they age: the father-in-law, the mother-in-law, and the husband. Workload smoothing is perfect when all four intervals when an individual needs care can be *fitted without intersections* into the large interval of a woman's productive period, i.e. $[b, a_2 - \theta_2]$. This is typically impossible, and loss of efficiency is created when these intervals intersect with each other and with the woman's own old age period $[a_2 - \theta_2, a_2]$. The overall loss is small when these intersections tend to be short overall.

TABLE 3 HERE.

Since the intervals when these four persons need care are roughly ordered, loss of efficiency arises in four cases: (1) when the father-in-law overlaps with children, the loss is $[(a_1 - \theta_2 - (2x - b)) - (b + \theta_1)]^2$; (2) when the mother-in-law overlaps with the father-in-law, the loss is $[(a_1 - (2x - b)) - (a_2 - \theta_2 - x)]^2$; (3) when the husband overlaps with the mother-in-law, the loss is $[(a_2 - x) -$

$(a_1 - \theta_2 - (x - b))]^2$; (4) when the husband overlaps with her wife's old age, the loss is $[(a_2 - \theta_2) - (a_1 - (x - b))]^2$. $\sum \Delta s^2$ is defined to be the sum of these four terms.

4 Results

The social planner maximizes his objective function subject to the constraint that $b \leq x \leq (a_1 - \theta_2)/2$. The upper bound comes from the requirement that $a_1 - \theta_2 - (2x - b) \geq b$, i.e. the father-in-law starts to age after his daughter-in-law is admitted into the household. These working assumptions can be easily relaxed. Also note that there is no need to specify how many daughter-in-laws exist in our model, as they are all of the same age, and what is efficient for one person will be efficient for any number of them.

The first-order condition can be simplified as

$$\frac{4x(3x - 2a_1 + a_2 + \theta_1 - b)}{1 - \alpha} = \frac{\sum \Delta s^2 - W(a_2 - \theta_2 - b)}{\alpha} \tag{4}$$

This is simply

$$\frac{S'_x}{N'_x U'_N} = -\frac{1}{U'_S}$$

.

The optimal x to our problem exists and its comparative statics properties can be studied. We use a special case to illustrate our main conclusions, which hold generally. Take $\alpha = .5, b = 18, a_1 = 55, \theta_1 = 10, \theta_2 = 3$. Figure 1 plots the optimal x against a_2 at 4 different family wealth levels ($W = 0, 5, 10, 15$).

FIGURE 1 HERE.

Observation 1. *At a given wealth level, spousal age gap (measured by husband's age minus wife's age) tends to be a decreasing function of the spousal life expectancy gap (measured by wife's life expectancy minus husband's life expectancy). We call this "substitution effect".*

The intuition is straightforward. For the purpose of smoothing women's workloads over her lifetime, spousal age gap and spousal life expectancy gap are substitutes. Suppose husbands and wives in a particular family always marry at the same age but the wives live much longer, the husbands will also become old earlier than their wives do. This helps smooth workloads over a typical woman's lifetime, just as spousal age gap does. What's more, in a family where wives live much longer than the husbands, further smoothing through increasing spousal age gap is unnecessary.

Observation 2. *(1) Other things equal, spousal age gap (measured by husband's age minus wife's age) tends to be a decreasing function of the family wealth level. (2) What's more, the effect of spousal life expectancy gap on spousal age gap tends to be smaller for rich families. Put in another way, the substitution effect is smaller for rich families. We call these two parts "income effect" and "interaction effect," respectively.*

The first part of our Observation 2 (the income effect) is quite intuitive. In our model the rich families enjoy a higher level of elderly care, because wealth enters the production function and plays the role of capital. As a result, they have weak incentive to further increase the spousal age gap at the cost of reducing the possible number of descendants.

Because b is the lower bound for x, and the optimal x for the rich families tend to be quite small, the optimal spousal age gap is simply 0 when the spousal life expectancy becomes sufficiently large. From Figure 1 we can see that the optimal $x - b$ as a function of spousal life expectancy gap is closer to a flat line (evaluated at 0) at the highest wealth level. This is the intuition behind the second part of our Observation 2, namely the interaction effect. So for the rich families, spousal life expectancy gap quickly stops to be a meaningful predictor of optimal spousal age gap, which tends to be 0 with little variation.

Finally, our model also predicts that when women start to delay marriage (b increasing) and spend less time taking care of children during their lifetime (θ_1 decreasing), men's age of marriage will also increase.

5 Empirical Evidences

Our model predictions are consistent with well-known stylized facts. Here we will provide some empirical evidence to our main results, especially the novel prediction that spousal age gap is related to spousal life expectancy gap.

Over the past century, life expectancy for both men and women has increased dramatically, but the increase tends to favor women more than men. Over the same period, average age of marriage has increased for both sexes, and the spousal age gap has narrowed. We find that the magnitude and direction of the changes are consistent with our predictions in a number of countries where spousal age gap data are readily available.

In U.S., the life expectancy gap between women and men increased from about 3 year in 1900 to about 6 years in 2000. The spousal age gap narrowed from nearly 5 years in 1900 to just over 2 years in 2000. The magnitude of the change supports our prediction very well. When the spousal life expectancy gap is doubled, the spousal age gap is halved.

In Australia, the life expectancy gap between women and men increased from about 4 year in 1920 to about 6 years in 1995. The spousal age gap narrowed from 3.6 years in 1921 to 2.6 years in 1995. Note that $6/4 = 150\%$, while $3.6/2.6 = 138\%$.

In U.K., the life expectancy gap between women and men remained at about 5 years from 1960 to 2000. At 2 years, the median spousal age difference was the same in 1998 as in 1963.

Cross-country marriage patterns are also consistent with our observations. The top graph in Figure 2 plots the husband-minus-wife spousal age gap against female-minus-male life expectancy gap. It is apparent that there is a negative correlation between these two variables. The estimated OLS regression coefficient in the first column of Table 4 is $-.314$ ($p < .001$), meaning that a one-year increase in gender life expectancy gap would reduce the spousal age gap by about 4 months.

There are some mild outliers with fairly large female-minus-male life expectancy gap. Almost all of them are former USSR countries which have experienced a period of declining male life expectancy ever since the end of the Cold War. Since it is not clear whether these changes in life expectancy will remain permanent, it could be argued that these states could be removed from the full data set. Removing these outliers will slightly increase the fit of the linear regression model, and the estimated coefficient is increased to $-.458$, meaning that a one-year increase in gender life expectancy gap would reduce the spousal age gap by about 6 months (result omitted). The estimated substitution effect between gender life gap and spousal age gap in relative terms is about 50%.

This result is not driven by the confounding income effect. The bottom graph in Figure 2 plots the female-minus-male life expectancy gap against the Log average GDP per capita in 1995. It is mainly for those very poor countries (with average GDP $\leq$ 3000 U.S. dollars, or its log value ≤ 8) that income increase would dramatically raise the gender life expectancy gap in favor of the women. Beyond that threshold, the data reveal no clear pattern. Regression estimations also confirm this point (results omitted).

To better understand the substitution effect, income effect, and their interactions, we specify a multivariate OLS regression model with gender life expectancy gap, log GDP per capita in 1995, and their interactions as explanatory variables. The estimated coefficients are reported in the second column of Table 4. All of them are statistically significant, lending strength to our predictions in Observation 1 and Observation 2.

The average gender life expectancy gap in our data is about 4.91 years. So the average income effect is $-1.24 + .138 * 4.91 = -.56$. It means that for an country with average gender life expectancy gap (about 4.9 years), a one-percentage increase in average GDP per capita would reduce the spousal age gap by nearly 7 months. However, this effect will become much smaller when gender life expectancy gap increases in women's favor.

The interaction effect is also significant. For countries with GDP per capita less than or equal to $3000 in 1995, which we call poor countries, their average log GDP per capita is about 7.134, and the substitution effect (the marginal impact of gender life expectancy gap on spousal age gap) for the poor countries is estimated to be $-1.32 + .138 * 7.134 = -.336$. For the rest of the world, which we call non-poor countries, the estimated substitution effect is $-1.32 + .138 * 9.096 = -.065$. So the substitution effect is indeed smaller for the rich. These two estimated substitution effects using a full interaction model are consistent with the results of simple regression by income group, which are reported in in the last two columns of Table 4.

6 Discussions

We want to discuss three related topics. The details are to be added.

(1) endogenous fertility choice. The model can be extended to show that the poor have the incentive to select higher fertility level to compensate the loss of descendants when they choose exogamy. This helps to explain the co-existing phenomenon of high fertility rate and large spousal age gap.

(2) intra-household relationship. The husbands prefer lower fertility since his relatively young wife is a substitute of children in terms of elderly-care provision. On the other hand, the wife depends upon children for such service. This explains why women are nicer to kids and grand-kids, and want to invest more in their education. This rationale is not a simple extension of Lundberg and Ward-Batts (2005) who argues that wives want to save more because of longer life horizon. Bargaining between husband and wife tends to be important. In a separate we provide evidence, based upon China census data, that supports our argument.

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Table 1: Patrilocal family aging path under different marriage regimes

	endogamy				exogamy			
t	infant	young	middle	old	infant	young	middle	old
1	m_1, f_1				m_1, f_1			
2	m_2, f_2	M_1, F_1				m_1		
3	m_3, f_3	M_2, F_2	M_1, F_1		m_3, f_3	F_2	M_1	
4	m_4, f_4	M_3, F_3	M_2, F_2	M_1, F_1		m_3	F_2	M_1
5	m_5, f_5	M_4, F_4	M_3, F_3	M_2, F_2	m_5, f_5	F_4	M_3	F_2
...								

1. A married woman gives birth to a boy (denoted as m_i) and a girl (denoted as f_i) at $t = i$ (replacement fertility level).

2. Upper case refers to a married/widowed person. So m_i and M_i refer to the same male within a family. Because a married woman lives with her husband's family, f_i and F_i do not refer to the same female.

Table 2: Costs and benefits of different marriage regimes

	endogamy	exogamy
female workloads smoothing	NO	YES
large descendant size	YES	NO
child caring	YES	YES

Table 3: Patrilocal family aging pattern

	age*	age diff	interval when care is needed
children	0	$-b$	$[b, b+\theta_1)]$
father-in-law	$2x$	$2x-b$	$[a_1-\theta_1-x-(x-b), a_1-x-(x-b)]$
mother-in-law	$x+b$	x	$[a_2-\theta_2-x, a_2-x]$
husband	x	$x-b$	$[a_1-\theta_2-(x-b), a_1-(x-b)]$

* Age upon the marriage of the woman (i.e. when her age is b)

Table 4: OLS regressions of spousal age gap

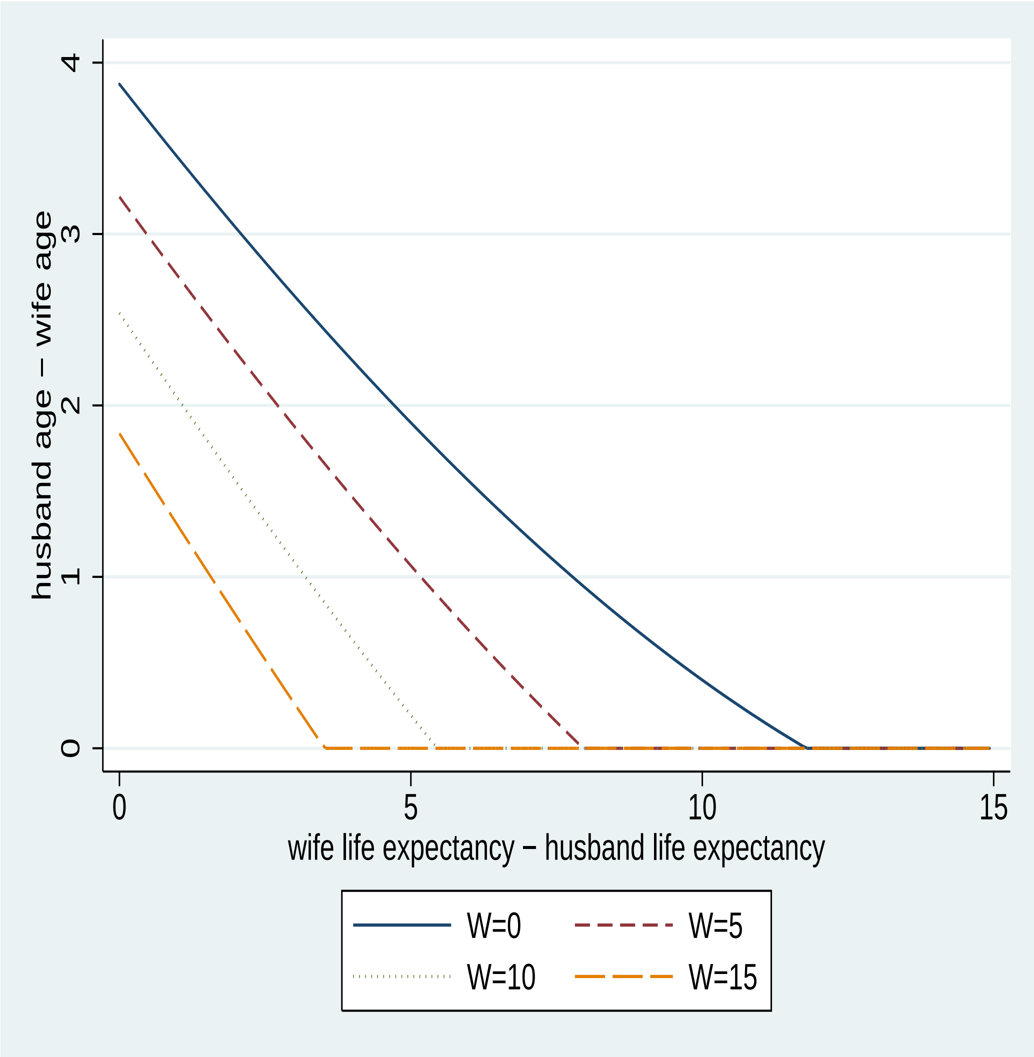
	All	All	Poor	NonPoor
Gender Life Gap	-0.314***	-1.319**	-0.343*	-0.085*
	(0.052)	(0.455)	(0.135)	(0.042)
Log(GDP p/c)		-1.240***		
		(0.289)		
Log(GDP p/c) $\times$ Gender Life Gap		0.138*		
		(0.055)		
R-squared	0.192	0.343	0.105	0.043
N	152	152	57	95

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Poor subsample includes those countries with average GDP per. capita. $\leq$ \$3000 in 1995.

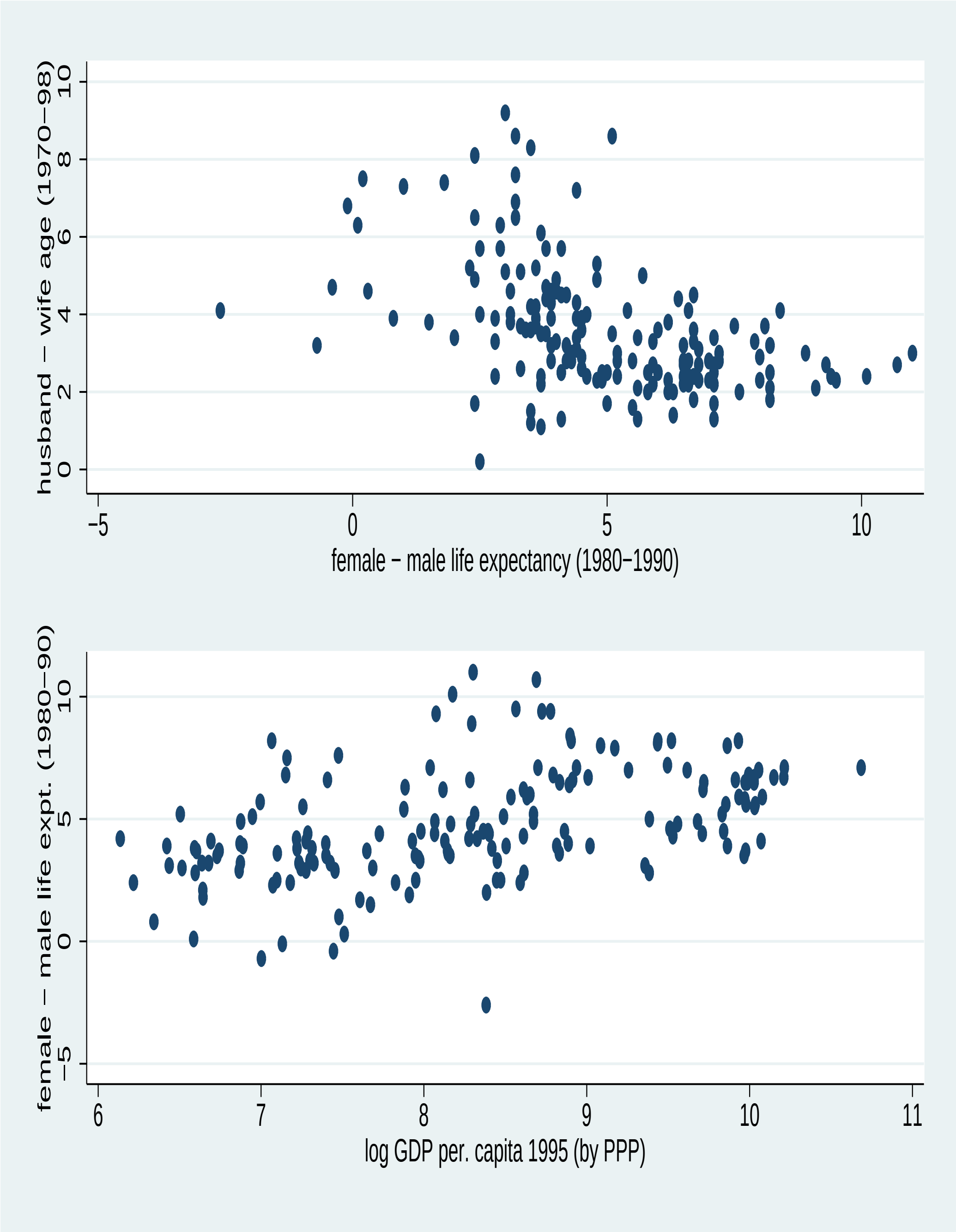
Source: UN (2000, 2006), IMF (2007)

Figure 1: Optimal spousal age gap w.r.t the spousal life expectancy gap at four family wealth levels



This is a special case, with $\alpha = .5, b = 18, a_1 = 55, \theta_1 = 10, \theta_2 = 3$.

Figure 2: Cross-country patterns of spousal age gap, gender life expectancy gap, and average GDP



Source: UN (2000, 2006), IMF (2007)