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**Son Preference, Sex Selection and Economic Development:  
Theory and Evidence from South Korea**

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# Son Preference, Sex Selection and Economic Development: Theory and Evidence from South Korea\*

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## Abstract

Motivated by high and rising sex ratios in countries such as India and China, we formulate a theoretical framework for analyzing the impact of economic development on parental sex choice when sons are culturally prized and children provide old age support. Two key assumptions drive our model. First, the cultural valuation of children vary not only with gender but also with marital status. In particular, while a married son is preferred to a married daughter, the latter is preferred to an unmarried son. Second, we assume that faced with a shortage of brides, poor parents will have a harder time marrying their sons than rich parents. Our model predicts male sex ratios at low levels of development, where the surplus sons are chosen by the poorest who forego grand-children for old age support. With development, incomes and the bride price rise, allowing the poorest reproductive children. Consequently, sex ratios fall, and the relationship between parental income and offspring maleness turns positive. We also present corroborative evidence from South Korea, a now developed country which shares with India and China a strong patriarchal culture and a recent past of poverty.

JEL: J11, J16, O15.

Keywords: Son preference, sex choice, development, sex ratios, South Korea.

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# 1 Introduction

The arrival of prenatal sex determination in the early 1980s combined with age old preference for sons have resulted in unnaturally high sex ratios (males to females) in a number of Asian countries, notably India [Miller, 1981, Das Gupta, 1987] and China [Banister, 1987, Zeng et al., 1993, Tuljapurkar et al., 1995, Scharping, 2003], where for the latter, the 2000 census returned a sex ratios at birth of 120 boys per 100 girls, and level that remained unchanged in the 2005 inter-census, leaving China with an estimated 25 million more males than females under age 20.<sup>1</sup> The corresponding figure for India may be in the vicinity of 20 million.<sup>2</sup>

This development has provoked a number of questions as to the motives underlying this proclivity to choose sons and, and by extention, whether this practice will continue in the face of *inter alia* a mounting surplus of males, moral suasion, and economic development (see e.g., Li et al. [2000], Chung and Das Gupta [2007], Almond and Edlund [2008], Lipatov et al. [2008], Almond et al. [2009]).

This paper proposes a theoretical framework for analyzing the impact of economic development on parental sex choice under son preference and non-random matching on the marriage market. Children, we propose, provide two types of benefits to parents, psychic utility and material support in old age, where the latter is gender neutral: a dollar is a dollar irrespective of whether from a son or a daughter. In contrast, sons are assumed to only deliver higher psychic utility *conditional* on marital status. That is, a married son yields higher psychic utility than a married daughter, but a married daughter is preferred to an unmarried son *ceteris paribus*. This second inequality is important but we believe realistic. For instance, the Confucian value of a son is closely linked to his having sons, suggesting the value of children who have children.<sup>3</sup> While we are not the first to note that the cultural value of a son may depend on his marital status [Lipatov et al., 2008], the assumption of non-random mating has additional implications for the sex ratio in the cross section.

Our model predicts that when society is poor, the poor in that society may choose sons to support them in old age although these sons would not be able to marry – the aggregate implication of which is a surplus of sons. As society grows richer, even the poor may afford themselves married children. The reason is two-fold. First, the additional consumption afforded by an unmarried son may seem

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<sup>1</sup>Zhu et al. [2009] states 32 million, but that seems to be from assuming that the sample is 1% instead of 1.3%, pointed out by Avi Ebenstein.

<sup>2</sup>Sex ratios in the Indian 2001 census was reported to be 1.09 for the ages 0-14, which translates into 15 million more boys than girls below age 15, or roughly one million surplus males for each single-year cohort.

<sup>3</sup>If unmarried sons yielded higher psychic utility than married daughters, everybody would be better off with sons only, and the population would rapidly vanish.

less worthwhile at higher incomes, rendering a married daughter (grand-children) more appealing. Second, a richer society can sustain a higher bride price, reducing (or even reversing) the economic disadvantage of daughters. If so, as a society grows richer, the poor may choose daughters who marry over sons who do not, resulting in a decline in the aggregate sex ratio. Thus, the substitution of daughters for sons among lower class parents, in turn, allows for the converse substitution among the upper class, resulting in the relation between parental status and maleness of offspring to go from u-shaped to positive as society grows richer.

Explicitly allowing for parents to care about consumption and thus the earnings ability of their children (net of marriage transfers, if any) provides a framework for analyzing the impact of development without positing that development acts on the cultural motives for son preference, although that is of course a possibility [Lipatov et al., 2008]. Economic development, in our model, directly influences choices by lowering the valuation of consumption at the margin, which lowers parental valuation of higher earnings potential of sons over daughters, and raises the willingness to pay to have a married son. The higher bride price further contributes to making a married daughter a more attractive option compared to an unmarried son.

We also present corroborative evidence from Korea, a country which shares with India and China a strong tradition of favoring sons and rising sex ratios at birth following the introduction of sonography in the early 1980s.<sup>4</sup> Importantly, however, excess female mortality predates the 1980s, which combined with rapidly falling fertility resulted in a noticeable shortage of brides already in the 1990s, a period of relative affluence thanks to two decades of rapid growth – per capita income in 2000 US dollars rose from \$873 in 1970 to \$11,675 in 1995, and in 1996, Korea joined the OECD. Thus, Korea offers an attractive case study for our model’s predictions for sex-choice under son preference and economic development.

To start with the overall sex ratio at birth, the introduction of ultrasound sex determination in the early 1980s resulted in rising sex ratios at birth and in 1993, 117 boys per 100 girls were born. However, sex ratios have actually declined since and are now normal, see Figure A-1.<sup>5</sup> The decline supports our model’s prediction that in a rich society parents choose married children (of either gender) over non-reproductives (sons by virtue of higher male than female productivity) for old age support. (The initial rise is likely linked to the arrival of ultrasound screening.)

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<sup>4</sup>A weekly popular magazine reported the cost of sex determination through ultrasound in 1984 at 60,000 won (USD 75) [Park and Cho, 1995].

<sup>5</sup>In 2007 the sex ratio at birth was 106.1. Korea National Statistics Office, 2007 Annual Report on Live Births and Death Statistics.

Moreover, in line with our model's predictions, we document a changing relationship between parental socio-economic status and maleness of offspring. Using the 2005 census, and focussing on women with completed fertility (45 years of age or older), we find that for cohorts born 1931-40, the least educated mothers report the highest sex ratios, 1.10 (sons to daughters), and the sex ratio falls monotonically with maternal education to the biologically normal 1.05 for mothers with college education. This relationship remains negative for the next ten-year cohort, born 1941-50, albeit substantially flatter. However, for the last cohorts with completed fertility, those born in 1951-60, the relationship was reversed: the least educated had borne 1.04 sons per daughter while mothers with a college degree or more had borne 1.12 sons per daughter.

Correlates of cross-county variation in sex ratios using the 2005 Korean Vital statistics provide further evidence of parental sex choice decisions being influenced at least in part by marriage market considerations. Poor counties, or counties with a high sex ratio among adults 20-29 (prime marriage years, see footnote 9), exhibit lower sex ratios at birth suggesting that current marriage market conditions may impact the decision of whether to have a girl or a boy.

The remainder of the paper is organized as follows. We conclude this section by providing a brief literature review and background describing the Korean marriage market, institutions for old age support. Section 2 presents our model of parental sex choice. Section 3 our evidence from Korea and Section 4 concludes.

## 1.1 Literature Review

This paper's model builds on Edlund [1999], whose main prediction of positive relation between parental status and maleness of offspring coincided with that of Trivers and Willard [1973]. These studies focus exclusively on children's reproductive success. By contrast, numerous studies routinely assume that son's greater earnings ability is a sufficient reason for parents to prefer sons. Allowing for both motives to matter may be important for understanding future developments in countries such as India and China.

Somewhat ironically, the modeling of the cultural component of son preference, and its transmission across generations has been done outside the social sciences. In Li et al. [2000], the son preference is transferred through inheritance (vertically) or from society (obliquely), where the rate of transmission is governed by exogenous transmission parameters. In Lipatov et al. [2008] economic development impacts the cultural preference by effects on the earnings advantage of males. The marriage market feeds back into the cultural value attached to sons because it is assumed that peo-

ple who prefer sons also choose more sons. Consequently, if mating is random and fertility constant, mothers whose parents had a son preference are under-represented in the next generation. Clearly, the assumptions that preferences and choices coincide, and that mating is random is different from this papers model that traces out aggregate and cross-sectional implications for the sex ratio as a society develops without assuming that development acts on the cultural valuation of sons. Indeed, high sex ratios among South and East Asian immigrants to the UK and North America suggest that such cultural biases may persist in developed societies [Dubuc and Coleman, 2007, Almond and Edlund, 2008, Abrevaya, 2009, Almond et al., 2009].

Kim [2005] focussed on the effect of sex selective abortion on fertility and sex ratios. Using detailed information on fertility history, including abortions and their timing, from the Korean National Fertility and Family Surveys, 1988 and 1991, and information on the number of ultrasound machines in a region, estimated that better access would lower fertility and raise the sex ratio.

Chung and Das Gupta [2007] analyzed the Korea National Fertility and Family Health Surveys (various years). These surveys include questions about about son preference. They found that between 1985 and 2003, there was a marked decline in the fraction of women reporting “must have a son.” Whether this result reflects a change in underlying preference or an internalization of marriage market constraints is debatable.

## 1.2 Demographic Background Korea

Normally, there are about 1.05:1 boys to girls at birth, and the sex ratio then declines to balance around age 20.<sup>6</sup> Figure 1 plots the population by age and gender in 2009. As can be seen, men outnumber women until age 55, indicating excess female mortality predating ultrasound screening [Goodkind, 1996]. This is not to say ultrasound had no impact. The male surplus is larger for the younger cohorts, especially those who were born in the late 1980s, early 1990s, some ten plus years following the introduction of the technology. This is further illustrated in Figure 2 which plots the sex ratio by age.

What is also evident from Figure 1 is a marked slowdown in fertility, which has further exacerbated the marriage squeeze facing Korean men, who on average marry women three years younger than themselves.<sup>7</sup> The total fertility rate went from 6 in the 1960s, to 4.5 in 1970 to below replace-

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<sup>6</sup>The crossing-over normally happen around age 20. For instance, the US 1980 census returned 10,663 thousand males to 10,655 thousand females in the age group 20-24. Later censuses return slightly later crossing over points, a fact we suspect is driven by immigration.

<sup>7</sup>This age gap has been quite stable since 1990.

ment level in the early 1980s, and is now one of the lowest in the world at some 1.2 children per woman.<sup>8</sup> Cohort sizes halved in the last three decades and thus “surplus” men born in say 1980 seeking brides from the 1983 cohort face a sex ratio of 1.24, or a deficit of some 80,000 women, see Figure 3.

Figure 4 presents the gender gap among singles by age for the years 1985, 1995 and 2005 (drawn from the micro samples of the censuses). Since men marry women on average three years younger than themselves, at young ages, men outnumber women among the unmarried. As men move into prime marriage ages (and women out), the gap dwindles to eventually turn negative. In 1985, the number of single men and women balanced by age 34. In 1995, parity is only reached at age 38 and in 2005, this age had been further pushed back to 44 – a change by 11 years despite the age at marriage only having moved by 3 years over the period.<sup>9</sup>

The deficit of women of marriageable age has visibly impacted marriage patterns. While in 1981, men were almost three times as likely to remarry as women, by the mid-90s, women had overtaken men, and in 2005 there were 1.5 more marriages between a remarrying bride and never-married groom, than the reverse combination, Figure 5.<sup>10</sup> Lately, Korean men unable to marry nationals have turned to poorer Asian countries for brides – the Philippines, Vietnam, Cambodia and China being major source countries. In 2006, 9 percent of marriages involved a foreign bride, up from less than one percent in 1990, and among men in agriculture or fishery, low status occupational groups, 41 percent of grooms married foreign women.<sup>11</sup> Although Korea’s economic development has afforded even its poorest men brides, such foreign marriages have been warily received by a culturally and ethnically homogenous society.<sup>12</sup> Add to the public opprobrium marital strife stemming from short courtship and divergent expectations.

#### *Bride price and old age support*

In Korea, traditionally it is the groom’s (or his parents’) responsibility to provide housing for the newly-weds. In the case of the oldest son, this residence would be shared with his parents, an important form of old age support. Parents of daughters would see their daughters being provided

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<sup>8</sup>TFR was 1.08 in 2005; 1.13 in 2006; 1.26 in 2007 (Korea National Statistics Office, 2007 Annual Report on Live Births and Death Statistics).

<sup>9</sup>Male and female average age at first marriage was 27.8 and 24.8 respectively in 1990 and 31.1 and 28.1 in 2007.

<sup>10</sup>As a comparison, the fraction of marriages where it is the bride’s first marriage but the groom’s second or higher marriage was slightly lower than the reverse combination in the US, Statistical Abstract, 2000, table 145, covering the years 1970 to 1988.

<sup>11</sup>Vital Statistics of Korea, Marriage and Divorce.

<sup>12</sup>The topic of numerous news paper articles, for instance, “Korean Men Use Brokers to Find Brides in Vietnam,” *The New York Times*, February 22, 2007.

for, but would not benefit from co-residence with prime aged adults. Thus, while the tradition implies an implicit bride price, it leaves parents of daughters at a disadvantage, a common feature of pre-industrial patriarchal societies [Das Gupta et al., 2003].

Over the last several decades, the advantage of sons over daughters became weaker as public old-age pension system was introduced and traditional social norms were gradually replaced by the Western-style individualism.<sup>13</sup> For instance, the extended family has given way to the nuclear reflected in a decline in co-residence with old-age parents and other forms of old-age support from child to parent (such as transfers). While these changes applied across the board, they may have been more important for the poor who relied more heavily on their sons for old age support.

Figure A-2 (in Appendix) graphs the percent of elderly being primarily supported by their sons for support by education between 1994 and 2006. Two facts stand out. First, the less educated are more reliant on sons. In 1994, 70% of those with only primary education relied on sons, whereas the corresponding figure for those with a college education was slightly less than 40%. Second, in the relatively short period 1994-2006, there has been almost a halving in the reliance on sons, from close to 50% in 1994 to 27% in 2006.

## 2 Model

We model parental sex choice under son preference where parents care about grand-children and old-age support, children's spouses are allocated on monogamous, two-sided marriage market with an endogenous bride-price. We are particularly interested in the role of development for the population sex ratio and who, in the cross section, chooses sons and daughters respectively.

### Key Assumptions

1. Sons are more productive than daughters.
2. Grand-children through sons are more valued than grand-children through daughters.
3. Grand-children through daughters are better than no grand-children.

Assumption 1 together with positive valuation of grand-children means that the bride price paid by groom parent to bride parent must be positive. Assumption 1 also means that no equilibria

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<sup>13</sup>The original old-age pension law was passed in 1973, although its implementation was postponed due to the oil crisis. The National Pension System was finally created in 1988 based on a new law passed in 1986, and its coverage expanded over the 1990s.



can have unmarried daughters (if a child remains unmarried, that child would yield higher utility to its parents if male, since more productive). Assumption 2 is in keeping with Confucian tradition. Assumption 3 is based on the evolutionary argument that an all male society is a short lived proposition, and therefore the empirically relevant cases are those which allow for daughters.

While economic development may affect the extent to which sons are better providers of old age support than daughters (e.g., lower labor market gender pay gap, emancipation of adult children), we will abstract from that channel to focus on how higher income affects the valuation of grandchildren: the standard assumption of decreasing marginal utility of consumption imply that as a society grows richer, parents' willingness to trade consumption for grand children increases.

These simple assumptions will deliver a model where as a society grows richer:

1. The sex ratio declines and asymptotes to 50/50.
2. The cross-sectional relationship between sex ratios and parental SES goes from u-shaped to positive.

## 2.1 Set Up

We assume a large, two-sex, population. Marriage is assumed heterosexual and monogamous, and short hands for children. The marriage market clears with the help of a bride price  $t$ . For simplicity, we assume that each married couple has one child.<sup>14</sup> Parents decide offspring sex and whether the child marries. Again for simplicity, we assume that the technology that governs offspring sex is perfect and costless. We will treat the parent couple as a single decision unit and for expositional ease we will refer to it as the parent.

Parents are indexed by  $i$  where  $i$  is continuous and uniformly distributed on the unit interval, where parent  $i$ 's income is a continuous, increasing, function of  $i$ ,  $y_i > y_j$ , for  $i > j$ . We assume that a child yields two types of benefits to parents: psychic and material (e.g., old age support). We assume utility to be given by the following function,

$$u(g^m, c) = \gamma_{g^m} + f(c) \tag{1}$$

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<sup>14</sup>This is purely for expositional purposes. An earlier version of the paper assumed two children, which allowed for couples to choose one son and one daughter. Three children would allow for yet more finely granulated outcomes, etc. However, the qualitative flavor of the model would not change. In Section 3 we will consider the case of laxer fertility restrictions.

where  $g^m$ , indicates the gender ( $g = S$  - son,  $g = D$  - daughter) of the child and its marital status ( $m = 0$  - unmarried,  $m = 1$  - married),  $\gamma_{g^m}$  denotes the psychic utility from a child of gender  $g$  and marital status  $m$ , and  $f(c), f'(c) > 0, f''(c) < 0, c \geq 0$ , is the utility derived from consumption  $c$ .

Consumption depends on exogenous income  $y(i)$  and the gender and marital status of children.<sup>15</sup> For simplicity, we assume that sons earn  $\delta$  and daughters zero. A daughter, however, commands a bride price  $t > 0$  (from assumptions 1 and 2, for a parent to choose a daughter, the bride price must be positive).<sup>16</sup> For simplicity, we assume that women are homogenous as brides, so that the bride price is unique (and set by marginal man's willingness to pay for marriage).

Unmarried children are always feasible, and from assumption 1 it follows that an unmarried daughter is dominated by an unmarried son. Therefore, the relevant offspring choices are:

$$S^0, D^1 \text{ and } S^1.$$

For notational ease, let the psychic rewards from the above offspring choices be denoted by  $\gamma_j, j = 0, 1, 2$  respectively, and let that of one unmarried sons,  $\gamma_0$ , be normalized to 0. From assumptions 1-3, and the normalization, it follows that:

$$0 = \gamma_0 < \gamma_1 < \gamma_2.$$

Choices over the child's gender and marital status are made given income, the bride-price, productivity of the child and the restriction that consumption is positive.

**Equilibrium** The bride price  $t$ :

1. clears the marriage market; and
2. no parent would obtain a higher utility from a child gender and marital status choice than that chosen.

**Definition** We will say that society A is richer than society B (and that B is poorer than A) if  $y_i^A > y_i^B, \forall i \in [0, 1]$ , where the superscript indicates the society.

We will also use the terms richer and developed synonymously when referring to a society.

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<sup>15</sup>This could be because the parent own the child's income and are responsible for marriage market payments. Alternatively, the parent cares about the earnings power of its child, net of marriage market transfers. In the latter case, one could allow incomes and marriage expenditures to enter as a separate term in utility function, but we opt for the, for our purposes, innocuous but simplifying assumption that parents own their children.

<sup>16</sup>For practical purposes, we note that females can produce socially recognized offspring on their own, while males cannot. Men obtain social fatherhood through marriage, for examples see, e.g., Edlund and Korn [2002].

**Proposition 1** 1. *Equilibria can be described as follows:*

$i \in [0, i_1)$  choose  $S^0$ ,

$i \in [i_1, i_2)$  choose  $D^1$ ,

$i \in [i_2, 1]$  choose  $S^1$ .

where  $0 \leq i_1 \leq i_2$  and  $0 < i_2 < 1$ .

2. *The bride price is positive and makes up at least half of the productivity difference between a son and a daughter.*

3. *The bride price is higher in a richer society.*

*Higher bride price implies that (married) daughters become more attractive relative to sons (married or unmarried).*

4. *If  $0 = i_1$  characterizes the equilibrium for a society, then equilibria for richer societies are also thus characterized.*

*That is, if all couples choose children who marries, this would be true in richer societies as well.*

5. *If  $i_1 > 0$  in a society, then  $i_1 > 0$  in poorer societies.*

*That is, if a society has parents choosing unmarried sons, then poorer societies would as well.*

**Corollary 1** *As a society grows richer:*

1. *The sex ratio declines until it reaches unity and then stays balanced.*

2. *A u-shaped relationship between maleness of offspring and parental status gives way to a positive relationship.*

Corollary 1 is illustrated in Appendix Figure A-3. *Proof:*

Intuitively, to see that  $0 \leq i_1 \leq i_2 < 1$ , note that the associated choices give successively higher psychic utility and thus must be more expensive (and therefore chosen by successively richer parents).

**Bride price.** The equilibrium bride price  $t$  must be greater than half of the productivity advantage of sons:

$$t > \delta/2.$$

Otherwise, a married son,  $S^1$ , would yield higher monetary returns than a married daughter,  $D^1$ , and everybody would choose married sons, an impossibility in equilibrium.

There are two cases to consider:  $\delta/2 < t < \delta$  and  $t \geq \delta$ .

**Equilibria,  $t \geq \delta$ .**  $t \geq \delta$  is a sufficient condition for a married daughter,  $D^1$ , to dominate an unmarried son,  $S^0$ . Consequently, everybody chooses married children, and  $i_1 = i_2 = 0$ .

Moreover, in this case, sex ratios must balance, that is  $i_2 = 0.5$

To see that an endogenous bride price  $t > \delta$  results in a balanced sex ratio, note that if there were too many sons,  $i_2 < 0.5$ , there would be upward pressure on the bride price, which would raise  $i_2$ . Conversely, if there were too many daughters,  $i_2 > 0.5$ , downward pressure on the bride price would lower  $i_2$ , a process that would continue until  $i_2 = 0.5$  (assuming that  $y_{0.5}$  supports a bride price greater than  $\delta$ ).

That  $i > 0.5$  choose sons and  $i < 0.5$  choose daughters follows from the standard assumption that consumption enters concavely in the utility function and that  $y_i > y_j$ , for  $i > j$  (while the psychic utility difference between a married son and a married daughter does not). These assumptions also drive the result that, comparing societies, if one society is richer, its bride price would also be higher (point 3).

**Equilibria,  $\delta/2 < t < \delta$ .** In this case, another type of equilibrium is possible:  $i_1 > 0$  and  $i_2 = \frac{i_1+1}{2}$ .

That is, the bride price does not make up for the productivity difference between a son a daughter. An unmarried son yields higher monetary return than a married daughter and therefore parents may chose to have sons who do not marry. That these parents would be the poorest follows from the same logic underpinning why the poorer half choose daughters and the richer half sons in the above case: the lower psychic utility is offset by higher consumption, the utility value of which is highest for the poor.

A necessary condition for this type of equilibria is that the bride price is sufficiently low, that is, the unmarried son choice  $S^0$  requires not only that the poor are poor, but that society is also poor, rendering the bride price too low to ensure a balanced sex ratio.

For  $i_1 > 0$  we need that

$$\begin{aligned} f(y_i + \delta) &> f(y_i + t) + \gamma_1 \Rightarrow \\ f(y_i + \delta) - f(y_i + t) &> \gamma_1, \end{aligned}$$

which clearly can hold for large enough productivity differences between men and women, low enough bride price, low enough valuation of grandchildren from daughters (relative to non-grand-children), or some combination of the above.

q.e.d.

## 2.2 Model Discussion

The model predicts that high status parents always choose sons. Low status parents may choose sons. When a society is poor, the bride price and own income is insufficient to make low status parents prefer reproductive children (grand-children) over non-reproductive children, and therefore they opt for sons (the more productive sex), and sex ratios are male. If the non-reproductive bottom is large relative to the top, then the relationship between sex ratios and parental status may appear negative. In a rich society, even low status parents may be able to afford grand-children and thus low status parents may choose daughters over non-reproductive sons. Married daughters instead of unmarried sons could be chosen by low status parents either because they have sufficiently high income themselves, or because of a high bride price (that is, higher status parents are sufficiently rich). In this case, population sex ratios balance, the bottom is female, and there is a positive relationship between maleness of offspring and parental status.

Thus our model can account for the decline in the sex ratio seen since the mid 1990s. It does not account for the increase in the sex ratio between 1980-1995, but that increase may be the result of technology diffusion and the fact that early cohorts (with respect to ultrasound) have a “first mover” advantage (since a high sex ratio in their cohort could “force” younger cohorts to more female).

The model elucidates that scarcity of brides does not guarantee that the bride price equalizes the economic returns from sons and daughters, a common feature of poor patriarchal societies [Chung and Das Gupta, 2007]. For that, society needs to be sufficiently rich.

## 3 Sex Ratios in Korea

We now proceed to present some evidence from Korea, where rapid economic growth and development of social insurance programs since the 1970s should have diminished the value of sons as a means of old-age security; and a deficit of women among young adults became noticeable already in the early 1990s (stemming from sex selection predating ultrasound technology).

According to the model developed above, such changes in incomes and marriage market should have transformed the relationship between parental status and maleness of offspring. The model also predicts that parents, poor parents in particular, would be less likely to choose sons if anticipated marriage market conditions for sons are less favorable.

In the balance of this section, we offer some empirical evidence drawn from Korea in support of these conjectures.

### 3.1 Changes Across Cohorts

To examine the long-term changes in the maleness of children and parental status, the offspring sex ratio by mother's education is estimated for the three different birth cohorts (those born in 1931-1940, 1941-1950, and 1951-60) who had passed child-bearing age (45 and older) by 2005. For the computation, we use a 2% micro random sample of the 2005 Population and Housing Census (Census, hereafter). Of the six Censuses taken from 1980 to 2005, for which micro random samples are currently available, only the 2005 census provides information on the number of all children ever born by sex, including the children who were dead and those who were not present in the household at the time of the census enumeration. Thus, this source is free from potential bias arising from selective death and leaving home of children that other Censuses are subject to.<sup>17</sup> Another advantage of this Census is that religions of respondents are reported. A weakness of estimating the offspring sex ratios of multiple cohorts from a single-year census is that only the children of surviving mothers are counted. However, if the mortality of mothers is not strongly correlated with the gender of their children, which is likely, such a survivorship bias should be small.

The sample used in the estimation is limited to women who had completed child-bearing for the following reasons. First, more educated women tend to have children at older age than less educated women in Korean, as in many other developed countries. Second, son preference is more strongly

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<sup>17</sup>Infant and child mortality would typically be higher in poorer families than in richer ones. If boys are weaker than girls, as is widely known to be the case, an increase in child mortality means more deaths of sons than of daughters. For this reason, the sex ratio of living children is likely to understate the true sex ratio; and such a downward bias should be larger for poorer families. It is likely that children of poorer parents leave home at a younger age than affluent children. Prior to the 1980s, teenage children of many poor families in Korea, especially those in rural areas, left home to be employed as factory operatives or domestic servants. The direction of bias in the sex ratio in this case depends on whether children of a particular sex were more likely to leave home earlier, which is unclear. If daughters tend to leave home earlier than sons, for example, the sex ratio of children living with parents would overstate the true sex ratio; and this upward bias would be greater for poorer families than for richer families.

revealed for higher-parity births.<sup>18</sup> This means that highly-educated women would be more likely to have a son at a relatively older age than the low-educated. Thus, if younger mothers still at child-bearing ages were included in the analysis, the offspring sex ratio of high-education women could be underestimated compared to that of less educated females.

The results reported in Figure 6 report sex ratios by maternal education for the three successive ten-year cohorts. For the women born between 1931 and 1940, the off-spring sex ratio falls monotonically with maternal education, from 1.10 for the least educated mothers to 1.05 for college-educated mothers. The relationship between mother's education and offspring sex ratio remains negative for the cohort born in the next decade (1941 to 1950), but is substantially flatter. Finally, the relationship has flipped for the cohort born between 1951 and 1960. The least educated bore 1.04 sons per daughters whereas mothers with a college degree or more had borne 1.12 sons per daughter. Using father's education instead of mother's as a measure of parental status provides similar results.<sup>19</sup>

The timing of the changes is also consistent with the story offered by the model. The majority of the 1931-1940 cohort bore their children in the 1950s to the early 1970s. Since the country was much poorer then than it is today and there were no public transfer programs available, it is likely that economic considerations played a major role in determining whether to favor sons or daughters, and that this motive was particularly strong for poorer families. On the other hand, the majority of the youngest cohort gave birth to their children from the early 1970s to the mid 1990s. During these two and half decades, per capita income increased by 13 times and major social welfare programs were established. Thus, the 1951-60 birth cohort was perhaps the first generation who anticipated that means of old-age security other than the support of children would be available to them.

The Korean data show not a u-shaped but a negative relationship between sex ratio and maternal education for the earliest cohort, mothers born 1931-1940 (and were between 15-45 years of age between 1945-1985). Over time, fertility patterns have also changed. While more educated mothers have fewer children, the gradient has become less pronounce, Table A-1.

A simple, albeit ad hoc, modification that would bring the model (roughly) in line with these stylized facts would be to allow parents to have many children. For simplicity, let us maintain the assumption that parents can have at most one married child, but allow any number of unmarried

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<sup>18</sup>For example, whereas the overall sex ratio in Korea was 117.2 in 1990, the sex ratio of the third-parity children was 195.9, and those of fourth- and fifth-parity children were 234.4 and 228.8, respectively.

<sup>19</sup>The offspring sex ratio of the least educated fathers fell from 1.085 for the 1931-1940 cohort to 1.056 for the 1951-1960 cohort, whereas the ratio of sons to daughters of the college-educated fathers increased from 1.065 for the 1931-1940 cohort to 1.132 for the 1951-1960 cohort.

children. Since men are more productive than women, these non-reproductives would be male. Moreover, let each child bring additional consumption in old age, at a constant non-monetary cost. From decreasing marginal utility of consumption, it is straightforward to see that lower income parents would choose higher fertility. If sufficiently strong, maleness of offspring could decline with mother's social status in the cross section (save for the very top that would always be male). Development would bring a decline in fertility across the board until only married children are chosen, eliminating fertility differences across mothers of different socio-economic status.

### 3.2 Marriage Market Influences on Sex Ratios at Birth

Our model hinges on the assumption that parents take their children's marriage market prospects into account when evaluating respective benefits of sons and daughters. To investigate this premise, we examine the relationship between the sex ratio at birth in a locality and the male-to-female ratio of the population aged 20 to 29 old residing in that locality.

To that end, we construct a county/district-level cross-sectional data set from various micro data pertaining to variables on sex ratios at birth and their correlates. First, sex ratios at birth in each county/district were computed from the micro data on the 2005 Vital Statistics for Birth and Death. Second, the sex ratio of the population aged 20 to 29 and the fraction of the population with a particular religion (Buddhists, Protestants, and Catholics) in each locality were drawn from the 2% sample of the 2005 Census. Finally, the average earning of employed residents in each locality aged 20 to 55 were calculated from the micro data on the 2005 Occupational Employment Structure Survey (OES). There were 327 counties and districts in 2005. Of these localities, 249 were selected based on the following criteria: first, the total number of births was 100 or more (253 counties and districts satisfy this condition), and second, the variables on the sex ratio of younger adults, religion, and earnings, as measured by male earnings, drawn from Census and OES are all complete.<sup>20</sup>

The following four variables are employed as indices of sex ratios at birth: (1) the overall sex ratio, (2) the sex ratio of second- or higher-parity births, (3) the sex ratio of children born to high-education mothers (those with college education or higher), and (4) the sex ratio of children born to low-education mothers (those with high school education or lower). Since discrimination against girls has been found to be particularly pronounced at higher parity and absent sons, e.g., Das Gupta [1987], Zeng et al. [1993], Jha et al. [2006], Almond and Edlund [2008], the relationship between the

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<sup>20</sup>While it would be useful to look into the male and female earnings separately, the relatively modest sample size of the OES (about 60,000 employees in total) makes it difficult to estimate average earnings in each county/districts for females.



sex ratio and marriage market condition, if any, could be more strongly revealed for higher-parity births.<sup>21</sup> The third and fourth variables are considered to examine if the relationship between offspring sex ratio and marriage market prospect differs by parental status. With non-random marriage market matching, sons of poorer parents would be more vulnerable to an aggregate shortage of brides, which may make poorer parents’s sex choice more sensitive to the local sex ration.

Figure 7 plots the relationship between these four sex ratios at birth and the male-to-female ratio of the residents at marriageable age in each locality. The overall sex ratio at birth is negatively related to the sex ratio of young adults, indicating that parents are less likely to choose sons in localities where marriage-market prospect for males is poorer. This negative relationship stands out more clearly if the sex ratio at birth for second- and higher-parity births is concerned, top right panel. For highly-educated mothers, the local marriage-market condition does not appear to matter much in choosing offspring gender, lower left panel. For low-education mothers, in contrast, a stronger influence of marriage market condition on sex ratio at birth is observed, lower right panel.

### 3.2.1 Regression Results

Clearly, the local adult sex ratio is only one predictor of a son’s future marriage market. For instance, as mentioned, rural men have felt the marriage market squeeze more acutely. We therefore turn to regression analysis. Using our county-level data, we estimate by OLS the following regression equation:

$$\text{ratio0}_i = \text{ratio2029}_i + \ln y_i + x_i + \epsilon_i,$$

where  $i$  subscript indicates the county (or district),  $\text{ratio0}_i$  is the sex ratio at birth,  $\text{ratio2029}_i$  is the sex ratio of 20-29 year olds, and  $\ln y_i$  is the log of average earnings in the county. These latter two variables are indicators of marriage market conditions, where we expect a higher sex ratio and lower earnings to lower the sex ratio at birth.

We also include the fraction who are Christians in the county,  $x_i$ , to capture possible religious or cultural influences on son preference and attitudes toward abortion. Chung [2007] found Christians to be significantly less likely to have use induced abortion to screen out girls in her analysis of the 2000 Korea National Fertility and Family Health Survey, a finding echoed in Almond et al. [2009]’s study of Asian immigrants to Canada using the 2001 Canadian Census. The log of earnings of

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<sup>21</sup>Although the overall sex ratio at birth has recently returned to a normal level in Korea (106.1 in 2007), the son-to-daughter ratio for the third or higher parity births remains still high (115.7 in 2007).

employed workers is included to capture economic conditions in the locality.

The results are reported in Table 1. Adding the Christian share and the average male earnings, the overall relationship between sex ratios at birth and the index of marriage-market condition, presented in Figure 7, remains largely unchanged.

The  $\text{ratio}_{2029_i}$  is negatively related to the overall sex ratio at birth (column 1). The sex ratios of second- and higher-parity births (column 2) and of those with low-education mothers (column 4) are more strongly influenced by this measure of marriage-market condition. In fact, for college educated mothers, the effect is positive, albeit marginally insignificant, (column 3). Our model suggests a rationale for why low and high education mothers would exhibit opposite effects: any parent who choose a daughter instead of a son, will allow another parent's son to marry. A reason the poor would be the first to make the switch to daughters is that they are the ones most at risk of having their son not marrying at all in case of an overall surplus of sons.

The effect of log average earnings mirrors those of the adult sex ratio: low education mothers seem particularly affected and in the expected direction – low earnings depress the sex ratio at birth.

That low education mothers' offspring sex choice would be particularly sensitive to adverse male marriage market conditions is consistent with the Korean experience where men in agriculture and fishery – men who are both in poor areas and in low earning occupations – have had particular difficulty finding wives, as well as studies of studies of internal migration patterns in China [Fan and Huang, 1998] and the Western Industrialized world [Edlund, 2005].

It is interesting that high sex ratio of 20-29 year olds depresses sex ratios at birth.<sup>22</sup> One reason this might be case is that this sex ratio reflects the economic status of the area [Fan and Huang, 1998, Edlund, 2005] . Parents in poor areas may foresee greater problems for their sons in the marriage market than for daughters. Alternatively, our finding may be related to how marriage market information filters through to parental decisions. From a marriage squeeze perspective, the relevant sex ratios to watch if parents were concerned with their child's marriage market prospects would be those of much younger cohorts. However, as the more than ten years of rising sex ratios in Korea (and 20 years and counting in China), suggest, while the marriage market consequences of unbalanced sex ratios may be perfectly predictable in the aggregate, the extent to which this information filters through to individual decisions may be less than perfect.

Finally, Christianity exerts a strong negative effect on sex ratio, in line with previous findings of Chung [2007], Almond et al. [2009].<sup>23</sup>

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<sup>22</sup>In preliminary analysis, we did not find effects for the sex ratio for the 10-19 or the 30-39 age groups.

<sup>23</sup>If the share of Buddhists is included as a covariate, it has a strong positive effect on sex ratios at birth, but does

## 4 Summary and Discussion

We have provided a theoretical framework for analyzing the impact of economic development on parental sex choice when sons are culturally prized and children provide old age support. Two key assumptions drive our model. First, the cultural valuation of children vary not only with gender but also with marital status. In particular, while a married son is preferred to a married daughter, the latter is preferred to an unmarried son. Second, we assume that parents of higher social standing are more likely to be able to marry their son than parents of low status. We use the model to trace out predictions for how sex ratios would vary over time and cross sectionally with economic development. We have also presented corroborative evidence data from South Korea. Korea shares with India and China a strong patriarchal culture favoring sons, and a recent past of poverty. Korea went from being a poor developing country in the 1960s to joining the OECD in 1996.

Explicitly allowing for parents to care about consumption and thus the earnings ability of their children net of marriage transfers (if any) provides a framework for analyzing the likely impact of development without positing that it acts on cultural motives for son preference. Economic development, in our model, directly influences choices by lowering the valuation of consumption at the margin, which lowers parental valuation of higher earnings potential of sons over daughters, and raises the willingness to pay to have a married son. The higher bride price further contributes to making a married daughter a more attractive option compared to an unmarried son.

There are of course other avenues through which development may reduce the material advantage of sons. With less emphasis on physical strength and lower desired fertility, the earnings gender gap is closing. Moreover, with the adoption of more individualistic values, parents' claim on their children's labor may be lessened (possibly facilitated by growing importance of wage work).

In Korea, the sex ratios at birth peaked at 1.17 in 1993 but have since returned to normal. In line with our model's prediction, as Korea grew more affluent, not only did sex ratios decline, but the relationship between parental status and offspring sex ratios turned increasingly positive. The return to normal sex ratios in Korea has been welcomed and taken as an indication that sex selective abortion is a problem of the past. In July 2008, South Korea's top court overturned a ban on revealing sex of unborn babies, in place since 1987. Our finds suggest that while development may bring balances sex ratios, sex choice may still be practised to the detriment of girls.

Moreover, we find, in the cross-section, that marriage market conditions have a bearing on parents' sex choice using vital statistics and census data from 2005. Poor counties, or counties with

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not change our main results.

a high sex ratio among adults 20-29, had lower sex ratios at birth, suggesting that *current* marriage market conditions may impact the decision of whether to have a girl or a boy. If correct, this finding suggests that policy interventions may be welfare improving (reducing the cycles resulting from over and undershooting).

The role of the marriage market in tempering the proclivity to select sons may also contribute to the understanding of the recent findings of high offspring sex ratios among Asian immigrants in a number of Western countries [Dubuc and Coleman, 2007, Almond and Edlund, 2008, Abrevaya, 2009, Almond et al., 2009] – being of high socio-economic status and forming minorities in their host countries, these groups can run a significant deficit of females without compromising their sons' ability to marry.

A number of studies have documented a positive relationship between parental socio-economic status and offspring sex ratio. However, absent deliberate sex choice, the relationship is typically much muted (see Almond and Edlund [2007] and references therein). This paper's empirical findings stand out by their effect size, illustrating the predictive power of sex choice models [Trivers and Willard, 1973, Edlund, 1999] in environments where parents consciously choose the sex of offspring.

## References

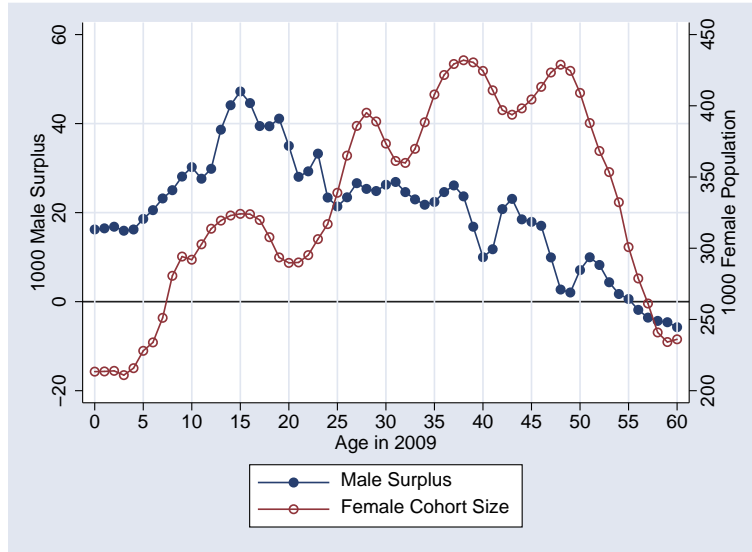
- Jason Abrevaya. Are there missing girls in the United States? Evidence from birth data. *American Economic Journal: Applied Economics*, 1(2):1–34, April 2009.
- Douglas Almond and Lena Edlund. Trivers-Willard at birth and one year: Evidence from U.S. natality data 1983-2001. *Proceedings of the Royal Society B: Biological Sciences*, 274:2491–2496, 2007. Published online August 8.
- Douglas Almond and Lena Edlund. Son biased sex ratios in the U.S. 2000 census. *Proceedings of the National Academy of Sciences*, 105(15):5681–5682, April 15 2008.
- Douglas Almond, Lena Edlund, and Kevin Milligan. Son preference and the persistence of culture: Evidence from asian immigrants to canada. Working Paper 15391, National Bureau of Economic Research, October 2009. URL <http://www.nber.org/papers/w15391>.
- Judith Banister. *China's changing population*. Stanford University Press, 1987.
- Woojin Chung. The relation of son preference and religion to induced abortion: The case of South Korea. *Journal of Biosocial Science*, 39:707–719, 2007.
- Woojin Chung and Monica Das Gupta. The decline of son preference in South Korea: The roles of development and public policy. *Population and Development Review*, 33(4):757–783, December 2007.
- M. Das Gupta, Jiang Zhenghua, Li Bohua, Xie Zhenming, Woojin Chung, and Bae Hwa-Ok. Why is son preference so persistent in East and South Asia? a cross-country study of China, India and the Republic of Korea. *Journal of Development Studies*, 40(2):153–187, 2003.
- Monica Das Gupta. Selective discrimination against female children in rural Punjab, India. *Population and Development Review*, 13:77–100, March 1987.
- Sylvie Dubuc and David Coleman. An increase in the sex ratio of births to India-born mothers in England and Wales: Evidence for sex-selective abortion. *Population and Development Review*, 33(2):383–400, June 2007.
- Lena Edlund. Son preference, sex ratios, and marriage patterns. *Journal of Political Economy*, 107(6):1275–1304, December 1999.
- Lena Edlund. Sex and the city. *Scandinavian Journal of Economics*, 107:25–44, 2005.

- Lena Edlund and Evelyn Korn. A theory of prostitution. *Journal of Political Economy*, 110(1): 181–214, February 2002.
- Cindy F. Fan and Youqin Huang. Waves of rural brides: Female marriage migration in China. *Annals of the Association of American Geographers*, 88:227–251, June 1998.
- Daniel Goodkind. On substituting sex preference strategies in East Asia: Does prenatal sex selection reduce postnatal discrimination. *Population and Development Review*, 22(1):111–125, March 1996.
- Prabhat Jha, Rajexh Kumar, Priya Vasa, Neeraj Dhingra, Deva Thiruchelvam, and Rahim Moineddin. High male-to-female sex ratio of children born in India: national survey of 1.1 million households. *The Lancet*, (January 21):211–218, 2006.
- Jinyoung Kim. Sex selection and fertility in a dynamic model of conception and abortion. *Journal of Population Economics*, 18:4167, 2005.
- Nan Li, Marcus W. Feldman, and Shuzhuo Li. Cultural transmission in a demographic study of sex ratio at birth in China’s future. *Theoretical Population Biology*, 58:161–172, 2000.
- Mikhail Lipatov, Shuzhuo Li, and Marcus W. Feldman. Economics, cultural transmission, and the dynamics of the sex ratio at birth in china. *PNAS*, 49(105):19171–19176, December 9 2008.
- Barbara D. Miller. *The Endangered Sex: Neglect of Female Children in Rural North India*. Cornell University Press, Ithaca, 1981.
- Chai Bin Park and Nam-Hoon Cho. Consequences of son preferences in a low-fertility society: imbalance of the sex ratio at birth in Korea. *Population and Development Review*, 21(1):59–84, March 1995.
- Thomas Scharping. *Birth Control in China, 1949-2000: Population Policy and Demographic Development*. Routledge, London and New York, 2003.
- Robert L. Trivers and Dan E. Willard. Natural selection of parental ability to vary the sex-ratio of offspring. *Science*, 179:90–92, January 5 1973.
- Shripad Tuljapurkar, Nan Li, and Marcus W. Feldman. High sex ratios in China’s future. *Science*, 267:874876, February 1995.

Yi Zeng, Ping Tu, Baochang Gu, Yi Xu, Bohua Li, and Yongping Li. Causes and implications of the recent increase in the reported sex ratio at birth in China. *Population and Development Review*, 19(2):283–302, 1993.

Wei Xing Zhu, Li Lu, and Therese Hesketh. China's excess males, sex selective abortion, and one child policy: analysis of data from 2005 national intercensus survey. *British Medical Journal*, 338, 2009. doi:10.1136/bmj.b1211.

Figure 1: Population by Age and Gender, 2009

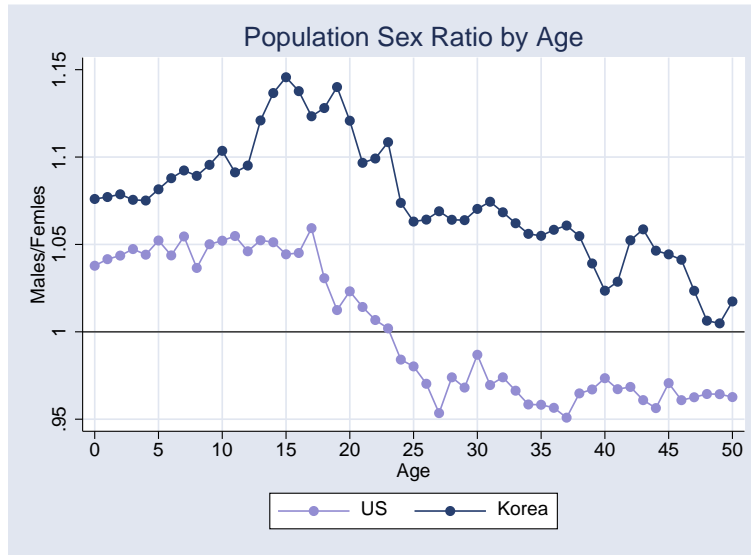


Source: 2009 Projected Population in Korea; Drawn from the website of Korean Statistical Information Service (<http://www.kosis.kr>).

Note: According to the Chinese zodiac, children born in the year of the Horse (12-year cycle) are independent and rebellious, characters considered particularly troublesome in daughters. Every 60 years, the year of the Fire Horse, these traits are exaggerated. The dates of the last Fire Horse occurred 21 January 1966 - 8 February 1967.

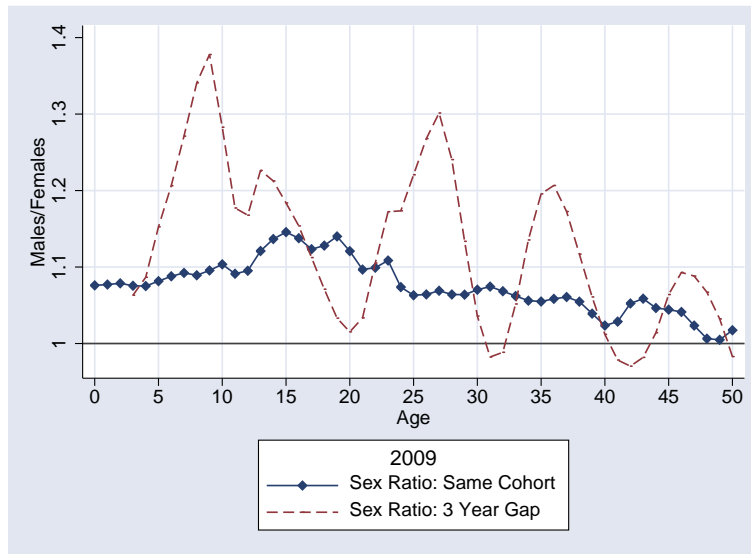


Figure 2: Sex Ratio by Age, Korea and the US



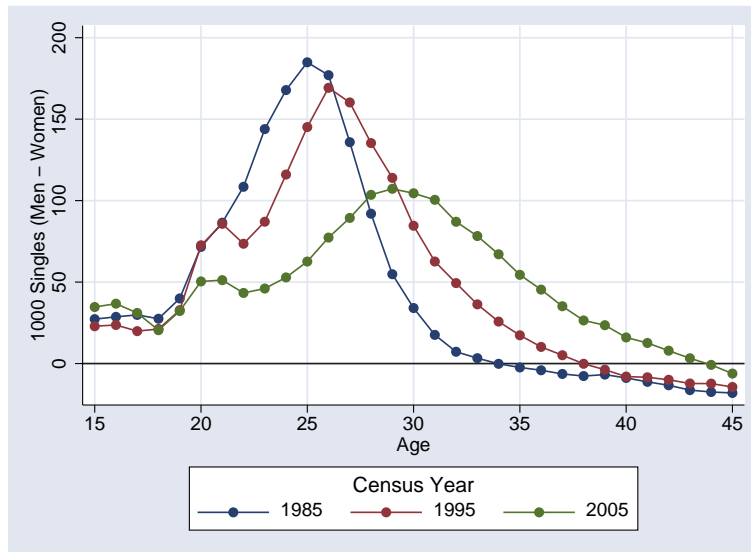
Source: For the US, 2000 Census. For Korea, 2009 Projected Population in Korea; Drawn from the website of Korean Statistical Information Service (<http://www.kosis.kr>).

Figure 3: Sex Ratio by Age, 2009. Same cohort and lagged three years.



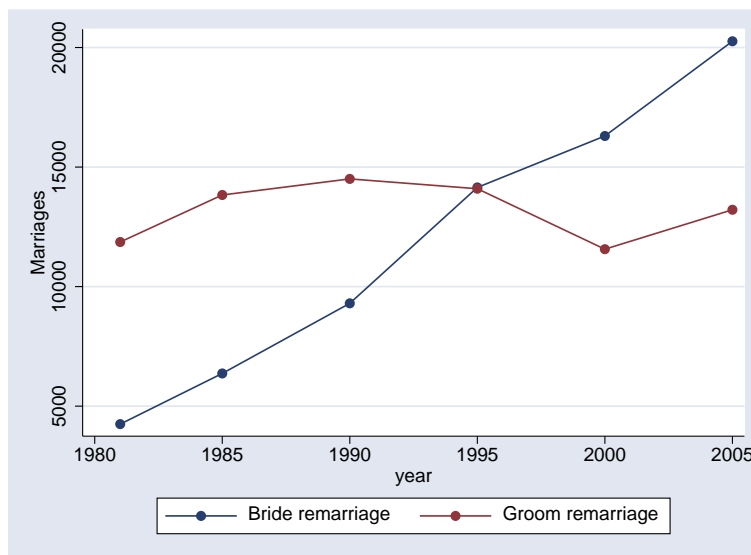
Source: 2009 Projected Population in Korea; Drawn from the website of Korean Statistical Information Service (<http://www.kosis.kr>).

Figure 4: Excess Single Men by Age, Various Census Years



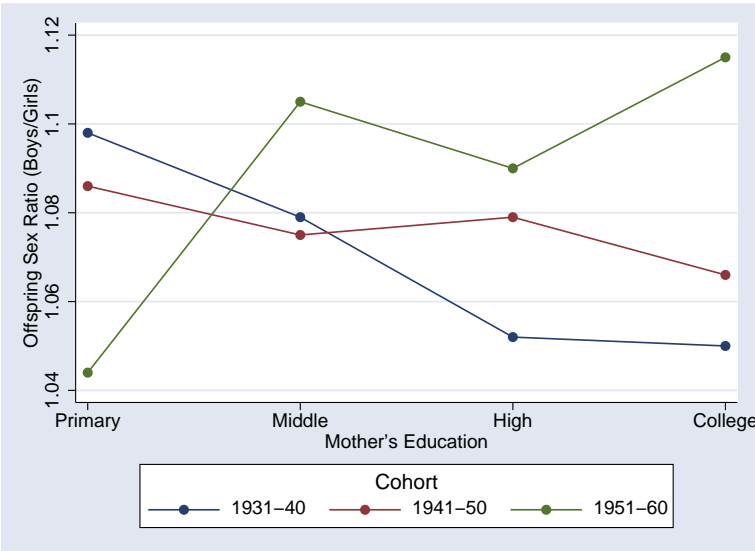
Source: 2% micro samples of the 1985, 1995 and 2005 Korean Censuses.

Figure 5: Number of marriages where one spouse was previously married, by year.



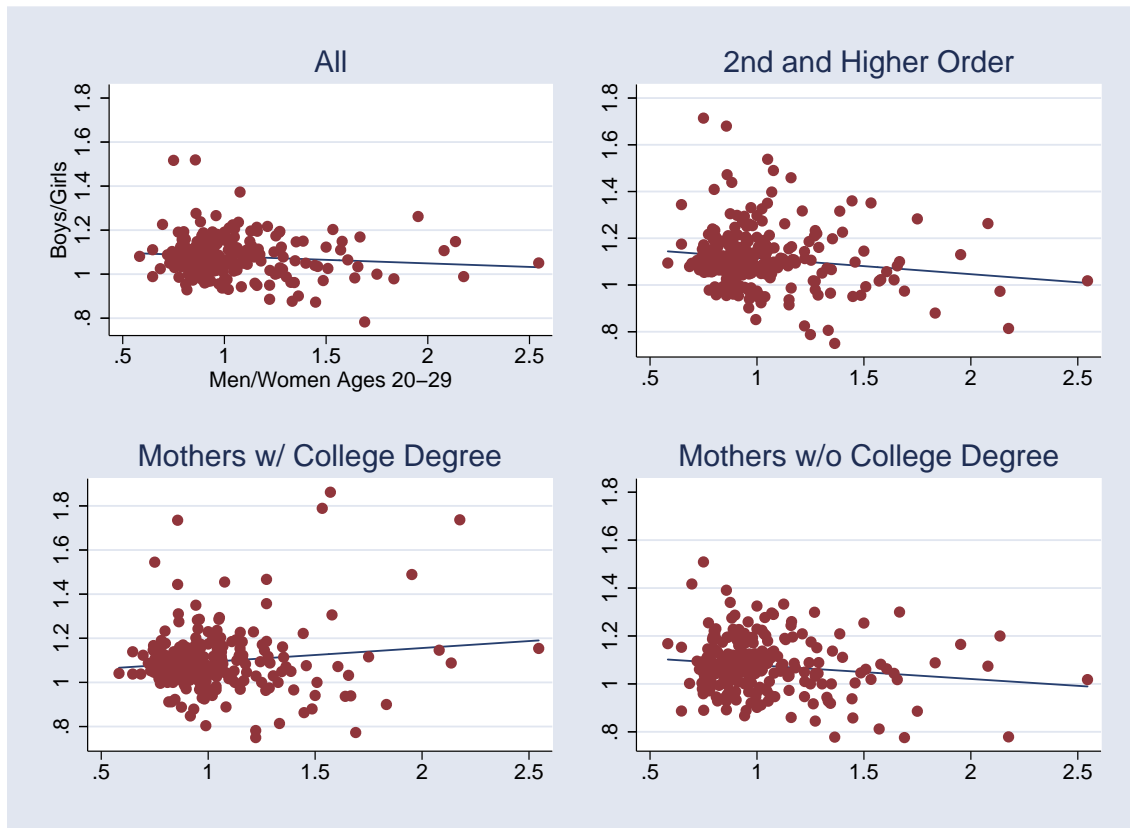
Source: Vital Statistics of Korea: Marriage and Divorce, each year; Drawn from the website of Korean Statistical Information Service (<http://www.kosis.kr>).

Figure 6: Offspring Sex Ratio Mothers 45 Years or Older, by Mother's Education and Cohort.



Source: 2% micro sample of the 2005 Korean Census.

Figure 7: County or District Sex Ratio at Birth by Adult Sex Ratio (20-29), 2005



Source: Micro sample of the 2005 Vital Statistics of Korea: Birth; and 2% micro sample of the 2005 Korean Census.

Note: County or district with 100 or more births (249 in total).

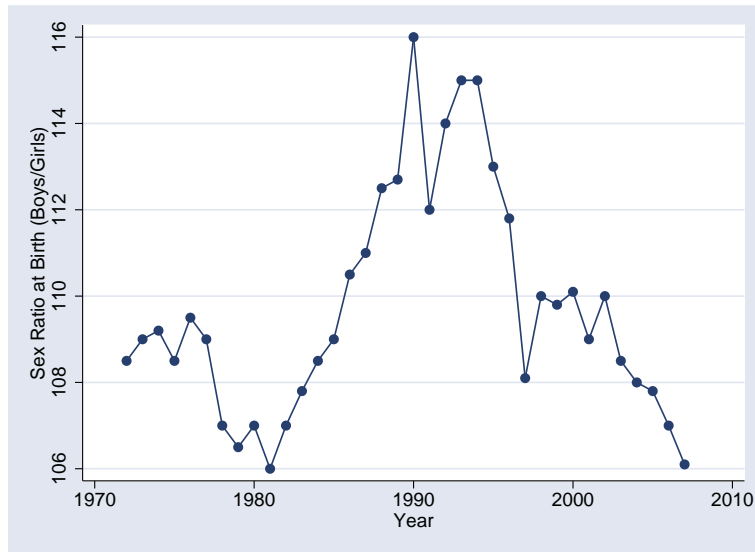
## Appendix

Table A-1: Completed fertility by maternal education and cohort

Birth Year	Parental Education			
	Primary or less	Middle	High	College or higher
1931-1940	4.339	3.604	3.215	2.919
1941-1950	3.456	2.811	2.547	2.326
1951-1960	2.551	2.199	2.017	1.928

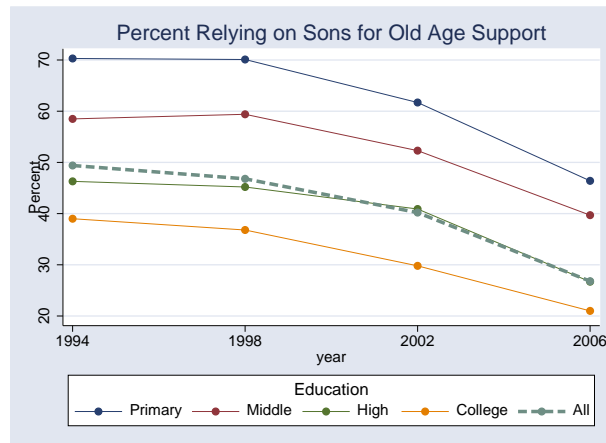
Source: Korean 2005 Census, 2% micro sample.

Figure A-1: Sex Ratio at birth by year

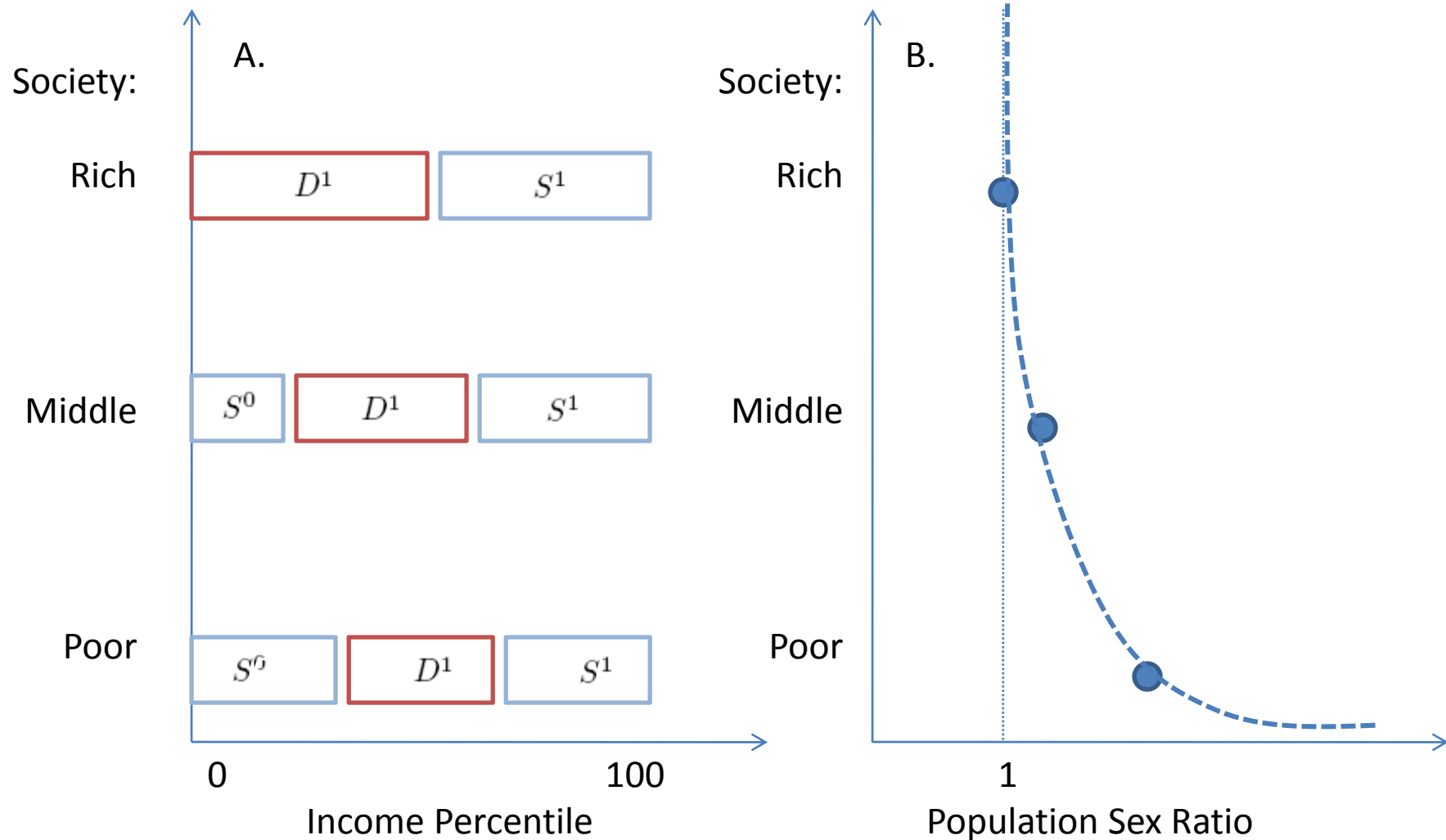


Source: Goodkind [1996] and [http://atlas.ngii.go.kr/english/explanation/social\\_3\\_1.jsp](http://atlas.ngii.go.kr/english/explanation/social_3_1.jsp)

Figure A-2: Reliance on Sons for Old Age Support, by Year and Education.



Source: Korean Statistical Office, Korean Social Statistics for each year.



Panel A shows the cross sectional relationship between offspring maleness in a poor, middle and rich society respectively.  
 Panel B shows the population sex ratio in these three stylized societies.

Figure A-3.

Table 1  
Results of OLS Regressions: Correlates of County/District Sex Ratios

Variable	Mean	(1) Overall sex ratio (Mean=1.081)		(2) Sex ratio of 2 <sup>nd</sup> or higher- order children (Mean=1.114)		(3) Sex ratio of children born to mothers with college education (Mean=1.094)		(4) Sex ratio of children born to low-educated mothers without college education (Mean=1.077)	
		Parameter	P-value	Parameter	P-value	Parameter	P-value	Parameter	P-value
Intercept		1.0125	<.0001	1.1260	<.0001	1.1537	<.0001	0.9270	<.0001
Sex ratio of population 20 to 29	1.020	-0.0450	0.0284	-0.0939	0.0023	0.0470	0.1646	-0.0721	0.0063
Proportion of Christians	0.254	-0.1920	0.0032	-0.3178	0.0011	-0.1388	0.1936	-0.2595	0.0019
Log of average earnings	5.209	0.0312	0.1829	0.0315	0.3673	-0.0139	0.7196	0.0555	0.0656
		R-square = 0.0456 F-value = 3.90 (P-value = 0.0095)		R-square = 0.0638 F-value = 5.56 (P-value = 0.0010)		R-square = 0.0252 F-value = 2.11 (P-value = 0.0991)		R-square = 0.0602 F-value = 5.23 (P-value = 0.0016)	

Note: The number of observations is 249.

Source: Measures of sex ratios (dependent variables) were computed from the 2005 Vital Statistics for Birth and Death; the sex ratio of the population aged 20 to 29 and the proportion of the resident whose religion is Christianity (either Protestant or Catholic) from the 2005 Population and Housing Census; and the average earnings from the 2005 Industrial and Occupational Employment Structure Survey.