Marriage and Marriage Markets
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Abstract
        This article reviews models of marriage, with special emphasis on how the sex ratio can help explain outcomes such as marriage formation, the intra-marriage distribution of consumption goods, labor supply, savings, type of relationship, divorce, and intermarriage. Economic models of marriage pioneered by Gary Becker are reviewed in the first section and then extended in the next section to incorporate the labor market for work-in-household approach of Grossbard. The following section discusses challenges in identifying exogenous variation in sex ratios and presents empirical evidence on the impact of sex ratios on labor supply, consumption, savings, and several other outcomes.

Keywords: marriage, sex ratio, work-in-household, labor supply, savings, consumption

Introduction

This chapter reviews models of marriage that can be used to explain outcomes such as marriage formation, the intra-marriage distribution of consumption goods, labor supply, savings, type of relationship (e.g. cohabitation versus marriage) and divorce. The idea that economists have something to contribute to the study of marriage formation and its impact on economic outcomes was first advanced by Gary Becker (1973, 1981). Becker used rational choice theory and models that had been applied in more conventional economics applications (that is, market-based) to understand individual marriage decisions. In his approach, rational decision-makers are motivated by gains from marriage, especially the benefits of specialization and exchange between spouses.[1] Other possible gains from marriage include opportunities to consume jointly and the ability to capture returns to scale.

In these models the sex ratio is one of the important factors that affects marriage market outcomes, consumption and savings, human capital and labor market outcomes. Although there is a biological basis for the sex composition of a population[2], sex ratio differences may occur for many other reasons, including war casualties, immigration that varies by gender, differences by gender in mortality or incarceration, and parental preferences for gender of children. Sex ratio differences in marriage markets can also arise even if the overall gender ratio is in balance if fertility rates are rising or falling and if women and men typically marry at different ages. Specific well-known examples of interest include male gender preference in China and India, sex ratio differences within the U.S. African-American population, gender imbalance in the U.S. by educational attainment, and the effect of the U.S. baby boom and baby bust. It is important to understand the consequences of these substantial swings in sex ratios.

I begin by reviewing Becker's (1981) supply and demand model and then discuss extensions of this model that incorporates work in household production in which spouses may have conflict about allocations (Grossbard, 1976). The next section of the chapter discusses challenges in identifying exogenous variation in sex ratios and summarizes empirical evidence on their impact on labor supply, consumption, savings, and other outcomes. A conclusion follows.

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[1] Examples given by Becker and others are typically phrased in terms of marriage between a man and a woman. However, the benefits of specialization can also apply to same-sex couples with different skills.

[2] At birth, there are typically 105 males born per 100 females. Due to higher age-specific mortality rates for males, the biologically-based sex ratio typically declines with age (WHO, 2017). See Schone, this volume, for a discussion of biological sex differences.

A Simple Becker-style Model of the Marriage Market

In the *Treatise on the Family*, Becker uses the phrase 'marriage market' metaphorically: it signifies that "the mating of human populations is highly systematic and structured" (Becker 1981, p. 39). Nevertheless, Becker presents two marriage-market models that use the market concept in a more literal sense and that are reminiscent of other applications of market analysis. Both models result in a market equilibrium with an equilibrium marriage rate (the quantity axis) and an equilibrium division of marital output (the price axis). The first model assumes that there is only one type of man and one type of woman. The second Marshallian market equilibrium model has multiple types of men and women participating in separate, but inter-related, marriage markets.

In this latter model, multiple marriage markets are composed of homogeneous women and homogeneous men with an equilibrium price and quantity in each market. Equilibrium depends on the number of participating men and women and on substitutability between various types of potential spouses across markets. Figure 1 models a market for a particular type of man M_i and a particular type of woman F_j. Following Becker, this represents the market for husbands, as men are on the supply side and women on the demand side; the roles could be reversed with no change in results. It is assumed that together a (M_i, F_j) couple can produce marital output Z_{ij}. This output is then divided into a portion that goes to the man (m_{ij}) and another that goes to the woman (f_{ij}), with $Z_{ij} = m_{ij} + f_{ij}$.[3] The vertical axis shows m_{ij}, men's share of the marital output. If men are single, their output is Z_{i0} and if women are single, their output is Z_{0j}. Women's demand for husbands is downward-sloping: the more output women F_j share with men M_i, (i.e. the higher the "price" of this type of husband), the less women are interested in marrying them rather than remaining single or marrying a man of a substitute type. The most a woman of this type is willing to 'pay' for creating a joint household with this type of man is the output they can produce together (Z_{ij}) minus what she could produce had she remained single (Z_{0j}). The more that women are willing to substitute between this kind of man and the other $(I − 1)$ types of men, the more elastic their demand for men M_i.

Men's supply is upward-sloping because the larger the share of marital output they get from this type of woman, the more men M_i are likely to switch from being single or marrying other types of women to marry women of type F_j. Men's supply starts at Z_{i0}, their output if they remain single.

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[3] This assumes that all goods are private goods, that is, there is no joint consumption. See Lam (1988) for a discussion of the model with public goods.

All individual demands and supplies for these two types are aggregated at the marriage-market level and an equilibrium male share of marital output (m_{ij}) is obtained at the intersection of demand and supply, namely point e_0. Given that $Z_{ij} = m_{ij} + f_{ij}$, this equilibrium also implies the equilibrium price of women f_{ij}. At that equilibrium point, both men M_i and women F_j are more satisfied being with each other than being in a couple with a substitute of type k.

Factors affecting marriage market conditions—including sex ratios—influence the division of marital output and income and each spouse's access to consumer goods. Because changing sex ratios are reflected in shifts in the market demand or supply of potential mates, they impact the distribution of marital output between the spouses. The more men there are relative to women, (i.e. the higher the sex ratio), the more competition there will be among men and the higher will be women's share of marital output. A higher sex ratio is illustrated in Figure 1, by the shift from S_0 to S_1, representing an increase in the number of men in the marriage market. Men's equilibrium share of marital output decreases from e_0 to e_1, and the share of marital output obtained by women increases accordingly. The opposite occurs when there is an increased number of women, represented here by an increase in the demand; in that case, women's share of marital output will go down and men's will increase.

In the model with different types of men and women who are either substitutes or complements, changes in the sex ratio in one marriage market can also affect prices and access to marital output in other marriage markets. A higher aggregate sex ratio in the economy does not necessarily translate into a higher sex ratio in each (M_i, F_j) marriage market. For example, there may be an oversupply of men at the national level, but not in a particular sub-market (e.g., the college-educated or by race, religion, or ethnicity).

More generally, anything that shifts the supply or demand curve will affect marriage market equilibrium. For example, an improvement in women's non-marriage alternatives, due either to better labor market opportunities or more-accepting social views of single women, would shift their demand curve for husbands down (i.e., a decrease in the number of women willing to marry at any value of f_{ij}). This would decrease the proportion of men and women married and, more importantly, result in a transfer of some marital output from husbands to wives. This seems broadly consistent with recent demographic trends of a falling proportion of men and women married at a point in time and toward marriages that are more egalitarian. Another example is the rising acceptance of sexual activity outside of marriage, which plausibly improves outside options for both men and women. This would cause both supply and demand to decrease, thus providing a further impetus to

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falling proportions married; because both curves shift, the impact on the distribution of marital output is uncertain. See Hoffman and Averett (2016) for a further discussion of these issues.

Sex Ratios, Marriage Markets, and Work-In-Household

Grossbard (1976) modified Becker's marriage model framework by recognizing the possibility of in-marriage conflict regarding who does the household production and how individuals who work at household production are compensated. While this model contains many of the same elements as Becker's marriage market model, it models the wife and husband as separate agents making decisions regarding both production and consumption.[4] The model incorporates elements from labor and personnel economics, where firms and workers are typically considered as separate agents—before, during, and after employment. Even when there is a match between a worker and a firm and employment occurs, their diverging interests regarding the level of effort and compensation may lead to conflict. Firms are often concerned about low worker productivity due to principal-agent problems.

Similarly, in Grossbard (1976) spouses are separate agents who may have conflicting interests regarding household production, for example, the production of food and children. Consider a husband who prefers to delegate childrearing responsibilities to his wife and thinks his child needs more time with her mother than the wife is willing to spend. This creates a principal-agent problem. In the example given here, the husband is the principal who has "hired" his wife as his agent in childrearing (this, of course is only an example—the roles are completely reversible in principle, if not in practice).[5] In marriage, husbands and wives may also have conflicts regarding any jointly-consumed household-produced output, including happiness from joint children. The individual spouses may typically prefer to obtain more and/or better quality marital output, but may be unwilling to devote their own resources and efforts into the production process. Furthermore, production-related conflicts may occur regarding marital output that only benefits one spouse, but that is produced by the other.

To facilitate the application of labor market analysis to marital firms, Grossbard (1976) and Grossbard-Shechtman (1984) defined the concept of *Work-in-Household* (WIHO), which is a service that is of benefit to one spouse (for example, the wife) but involves an opportunity cost on the part

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[4] For more details see Grossbard-Shechtman (1993) and Grossbard (2015).

[5] Most economic models of the family only recognize principal-agent problems in the case of divorce, when children are under the custody of one parent (e.g. Weiss and Willis 1985). It follows from Grossbard (1976) that this problem is not limited to divorced parents.

of the spouse supplying the service (for example, the husband). Demand for WIHO is similar to the demand for labor and is downward-sloping. The more productive the WIHO-worker and the more valuable the product of WIHO to the (potential) beneficiary, the higher the demand. Supply of WIHO is similar to the supply of other types of labor: it is upward-sloping and shifts as a function of the characteristics of both worker and 'job' (in this case characteristics of the spouse or potential spouse). Multiple markets for various types of WIHO workers differentiated by education, ethnicity, age, etc. set WIHO prices within marriage based on demand and supply.

Representative markets for the WIHO of men and women of a particular type are presented in Figure 2. In each market, there is a market demand and a market supply, which are derived from individual supply and demand curves. Assuming heterosexual marriage, men are represented by the demand curve in the market for WIHO performed by women (f), and women are represented by the demand curve in the market for WIHO performed by men. Each demand is a downward-sloping function of Y, the quasi-wage per unit of WIHO. This wage measures how much a potential or actual spouse is willing to compensate a person for work that benefits him or her. Each WIHO supply curve is upward-sloping, because people are willing to produce more if they are paid more and because men can choose between different types of women and women can choose between different types of men. In equilibrium, the intersection of market D and S yields the equilibrium compensation, Y_m and Y_f, for WIHO received by a husband of type m or a wife of type f. These WIHO prices are reflected in the allocation of marital output.

These prices, similar to equilibrium wages in labor markets, guide coordination and sorting, help resolve conflicts of interest, and thus contribute to cooperation and productivity in the household. For example, the conflict between men who want more mothering for their children than women choose to supply may be resolved by a transfer of marital income and/or consumption from fathers to mothers. Thus, fathers are "paying" mothers to do more household production than they had originally intended and women are compensated for increasing household production time.

Allocative efficiency is reached if quantity demanded equals quantity supplied at the market price. This holds for both labor markets and marriage markets, now defined as markets for WIHO. Contracts between workers and employers can help resolve principal-agent problems in labor markets. Similarly, in marriage markets contracts between spouses can resolve possible conflicts regarding compensation for work in household production benefiting the spouse (WIHO). Marriage institutions regulate (often informal) labor contracts between spouses in a manner similar to how employment institutions regulate labor contracts between workers and employers (see Grossbard-Shechtman and Lemennicier 1999), except that both quantities of labor (WIHO) and prices are

more difficult to observe and measure in the case of marriage markets. Another difference between commercial firms and marriage firms is that when it comes to conventional firms the distinction between the worker and the firm is clear, but in "marriage firms" that is not always clear: both spouses can possibly hire each other as household production workers.

An important prediction developed in Grossbard-Shechtman (1984) and Grossbard (2015) is that sex ratios will also affect individual labor supply outside the home through their effect on the price of WIHO. A higher sex ratio is represented in Figure 2 by the shift of the demand curve to D_1 in panel A and the shift to S_1 in panel B. As a result, the WIHO price for women's work increases, reflecting their relative scarcity and stronger bargaining position, while the WIHO price for men's work declines.[6] The increase in women's WIHO price translates into a higher value for time spent in WIHO relative to the labor market and as a result, leads to fewer hours of labor market work by wives.[7] Conversely, if sex ratios are lower, female WIHO workers will be more likely to work outside the home.

Sex ratios may affect individual savings of men and women in different stages in the life-cycle, for example, before, during, and after marriage (Grossbard 2015, Chapter 11)). Grossbard and Pereira (2010) integrate sex ratios into an overlapping-generations model with WIHO that assumes a traditional gender-based division of labor and in which WIHO workers are paid by their spouses for their work in household production. In this model, prior to marriage, young single men save in order to be able to afford to purchase women's WIHO as priced in marriage markets. In contrast, young women who hope to marry don't need to save as much as men, as they anticipate that after marriage they will not only earn their income from work in the labor force but will also get paid for their WIHO. After marriage, women may save to prepare themselves against the risk of losing that income, whereas married men may save less as a proportion of their income, relative to what they saved prior to marriage: they may have little personal disposable income left after making intra-marriage transfers to their wife. These gender differentials depend on the price of WIHO. The higher the intra-marriage transfers from husband to wife, the more divorce is likely to bring both married men and married women towards saving at the rates that singles save, for they would anticipate the likelihood of re-entering markets for WIHO. The higher the price of women's WIHO, due, for instance, to a higher sex ratio, the higher the savings rate among young single men (or their

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[6] This is consistent with the effect of an increase in the sex ratio in Becker's model which increases a wife's access to marital consumption goods and leisure.

[7] This assumes that WIHO workers respond to prices and have an upward-sloping supply function. Other motivations may be present, such as love, devotion, feelings of guilt or duty, but they are not expected to neutralize the role of prices.

families) preparing for marriage, but the lower the savings rate among married men. In contrast, a higher sex ratio leading to higher pay for women's WIHO is predicted to lead to lower savings among single women and higher savings among married women. The net effect of sex ratios on aggregate savings rates will depend on the relative size of these four effects on unmarried men and women and married men and women.

The inclusion of WIHO in marriage models also links changes in sex ratios to changes in marital status and family structure. Since higher sex ratios are associated with higher prices for female WIHO work, it follows that when sex ratios are higher, women are more likely to marry than remain single. If men and women differ in their preferences for divorce, sex ratios may also affect divorce rates: with higher sex ratios, women are more likely to get their divorce-related preferences fulfilled and men less so. In this context, sex ratios may also affect the likelihood that a woman is a single mother. Ekert-Jaffe and Grossbard (2008) show that there would be fewer single mothers where sex ratios are higher and, presumably, women are 'paid' better for doing the WIHO of raising the child of her male partner.

Marriage markets for spouses with different characteristics exist side by side. The higher the demand for an individual with particular characteristics for example, physical appearance, labor market success, race, religion, or ethnicity -- the more that individual is likely to get his or her first choice of partner. In some cases, intermarriage with a partner from a higher status group may be the preferred state, and the higher the price of the WIHO worker, the more that individual is likely to marry up (see Grossbard-Shechtman 1993).[8]

Similar models have been used to explain the impact of sex ratios on other outcomes for women. For example, low sex ratios would lead women to obtain more education: the more they expect to participate in the labor force, the more valuable additional education will be (Heer and Grossbard-Shechtman, 1981). Lower sex ratios, which reduce the probability of marriage for women and/or result in low compensation for WIHO, may also lead women to have fewer children. This framework also predicts that where sex ratios are lower, it is more likely that polygyny (men marrying multiple women) will be allowed (Grossbard 1980).[9] Otherwise, in societies where women have few options other than domestic production and reproduction, unmarried women or their

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[8] See Mansour and McKinnish, this volume, for a detailed discussion of marital sorting and heterogamy.
[9] For a detailed discussion of polygyny and polyandry in developing countries, see Anukriti and Dasgupta, this volume.

relatives may put political pressure on those supporting the institution of compulsory monogamy which makes it difficult for some women to have their own children.[10]

The greater the demand for WIHO workers with particular characteristics, the higher their price in marriage. In turn, this will affect all the outcomes discussed above—education, labor supply, type of relationship, intermarriage, etc. Furthermore, characteristics of those who demand WIHO will also affect the price of WIHO in a manner reminiscent of compensating differentials in labor markets. In the commercial sector, firms or industries with less desirable characteristics must pay more for the same workers relative to what employers in firms or industries with more desirable employers have to pay. Likewise, *ceteris paribus,* the less attractive the characteristics of those demanding WIHO, the more they must pay. To the extent that women are performing WIHO, then compensating differentials are what men with less desirable characteristics pay above   what men with more desirable characteristics pay. For men, compensating differentials will be expressed in extra pay for their WIHO, when married to less-desirable women. The idea of compensating differentials in marriage has many testable implications, including implications for labor supply, time spent doing WIHO, marriage versus cohabitation, ethnic intermarriage, and number of wives in a polygynous society.

Another testable prediction regarding women's labor supply, still assuming that women do the WIHO, is that women who are young relative to their husbands are likely to work less in the labor force. This assumes that their youth is a highly-valued trait and therefore these young women may receive a higher WIHO price than women older than their husbands (see Grossbard-Shechtman 1984). More generally, this prediction applies to individuals who are more attractive, younger, more educated, belong to race/ethnic/religious groups with higher status, or are otherwise viewed as 'more desirable' (Grossbard 2015).

Empirical Evidence on Sex Ratio Effects

Marriage markets, characterized by sex ratios in the theoretical models described above, are hypothesized to impact the likelihood of marriage, the quality of a spouse, the allocation of resources and consumption within marriage and a number of behavioral outcomes such as human

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[10] Grossbard (1980) also presents a rationale that helps explain why some societies have polyandry, an institution allowing marriages with multiple husbands. These are early examples of the "institutional economics of marriage." More on the economics of polygamy can be found in Grossbard (2016a).

capital accumulation, leisure, labor supply, saving, fertility and even crime. Confirming the existence and measuring the magnitude of these effects require empirical investigation.

Exogenous Variation in Sex Ratios

Empirical analyses of the impact of sex ratios on marriage and other outcomes must address the issue of possible endogeneity of marriage-market sex ratios. For example, it is difficult to determine whether the inverse association between the sex ratio and women's labor supply in studies based on cross-city variation such as Grossbard-Shechtman and Neideffer (1997) or Chiappori et al. (2002) is causal or whether it indicates that women migrated to cities with more job opportunities for women. The most reliable tests on how sex ratios affect a variety of outcomes are from studies using natural experiments that generate exogenous variation in sex ratios, so that the causal effects can be more confidently identified. Sex ratios in a population can vary for many reasons: preference for sons in some cultures in conjunction with the development of new technologies to ascertain a fetus's gender;[11] differential mortality by gender, especially following war; differential immigration by gender; and differences by gender in incarceration.

Fluctuations in sex ratios resulting from sex-selective fertility are often catalyzed by policies restricting overall fertility.[12] In China, the one-child policy was instituted in 1979 and, combined with a strong preference for sons, between 1988 and 2004 the sex ratio for young adults aged 16 to 25 rose from 1.02 to 1.06 (Edlund et al. 2013). Edlund et al (2013) also compute city-level sex ratios for individuals aged 18 to 45, assuming a two-year spousal age gap. This sex ratio, based on only one Census year and a wide range of ages, varied between 0.851 and 1.899, clearly indicating that gender-specific migration may play an important role in determining sex ratios by location.

Sex ratios also vary across ethnic, racial and religious groups. For example, studies have compared sex ratios among blacks and whites in the U.S. (e.g., Wilson 1989, Brien 1997). Sex ratios are far more balanced for whites than blacks because of differential mortality and incarceration. However, when geographical variation in the sex ratio is used to explain outcomes such as marriage rates or intra-household allocation, there is always the possibility of spurious correlation due to endogenous migration or unobserved differences rather than causal mechanisms. To circumvent this problem, researchers have relied on natural experiments to identify exogenous variation in sex ratios.

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[11] This appears to be especially true for China and India. For a detailed discussion of gender preferences and interactions with the One-child policy see Rose, this volume.

[12] See Portner, this volume, for a discussion of fertility issues in developing countries, and Lopoo and Raissian, this volume, on fertility policy in developed countries.

For example, Charles and Luoh (2010) used incarceration of men, and particularly African-American men, as an exogenous determinant of sex ratios in marriage markets. Their study compares blacks and whites in various age groups in U.S. counties to examine the impact of sex ratios on behavioral outcomes discussed below.

Gender imbalances in mortality can also have a dramatic impact on sex ratios and provide exogenous variation. Abramitzky, Delavande, and Vasconcelos (2011) examine differences in marriage matching for cohorts in France differentially affected by casualties from World War I. Other studies have examined variations in sex ratios in marriage markets defined by ethnicity. Relying on patterns of marriage endogamy (marriage within ethnic group) and differences in immigration flows from various countries, Angrist (2002) examines the impact of sex ratios on outcomes for second- or third-generation migrants to the U.S.

Sex ratios in marriage markets may also vary by birth cohort, even if sex ratios at birth are balanced, when the number of births is trending either up or down. This imbalance arises because women typically marry men who are somewhat older than they are; in the U.S., the difference in median age at first marriage was approximately 2.5-3.0 years from 1890-1970 and 1.5-2.0 years since then (U.S. Census Bureau, 2016). For example, in the early 1950s in the U.S. there were more marriage-age men than women because of declining births following the Great Depression in 1929. Conversely, in the mid-1960s, when the first baby-boomers, born between 1944 and 1963, entered the marriage market, women were in oversupply. Heer and Grossbard-Shechtman (1981) calculated that in the U.S. in 1956 the sex ratio was balanced. By 1965, however, there were 11 fewer men for every 100 women ages 17 to 24, reflecting the increase in fertility in the mid-1930s.

Sex ratios from U.S. Census data for five-year age groups, assuming a two-year age difference at marriage and measuring sex ratios at ages 20-24 or 25-29 for the period 1916 to 1980 varied from .87 for women born in 1946-1950 and men born in 1944-1948, (a period of increasing fertility) to 1.07 for women born in 1971-1975 and men born in 1969-1973 (a period of declining fertility) (Grossbard-Shechtman and Neuman 2003). These fluctuations, resulting from an almost constant spousal age gap and large fluctuations in number of births, are substantial, larger even than the sex ratio changes observed in China and India resulting from gender-specific abortions, infanticide and adoptions abroad.

Sex Ratios, Consumption and Bargaining Power

Becker's marriage market model and related theories suggest that as women become scarcer in the marriage market relative to men, their bargaining power increases and they receive a larger share of the marital surplus. Chiappori, Fortin and Lacroix (2002) extend the bargaining power literature to expressly focus on the role played by sex ratios in increasing bargaining power as scarcity increases. In keeping with this model, economists have examined the effect of sex-ratios on 'assignable consumption', in other words, examining whether women obtain a greater share of marital output when sex ratios are higher. Examples of such assignable consumption items are tobacco and alcohol consumed primarily by men, and investments in children's human capital, which women typically favor.

Two studies using Chinese data present evidence that the sex ratio affects outcomes linked to household bargaining power. Using both cohort-based and cross-sectional data from mainland China, Porter (2016) finds that when sex ratios are higher, men consume less tobacco and alcohol and high sex ratios improve the health of sons. More specifically, the recent imbalanced sex ratio of 120, relative to the usual average sex ratio of 107, was associated with a 56% reduction in men's daily tobacco consumption and a 31% increase in boys' short-term health. Edlund et al (2013) show that when the sex ratio is higher, women have more authority in the household. They are more likely to participate in or make decisions about purchase of consumer durable goods and men spend more time in food preparation, washing clothes, and childcare. The effects are modest in magnitude: a 10% increase in the sex ratio (half a standard deviation) reduces the gender gap in household chores by approximately 13% and decisions about the purchase of durables by about 10%.

The effect of sex ratios effects on leisure among spouses in Taiwan was recently tested by Chang et al. (2016). They defined total work time as employment, commuting, and housework and compared three cohorts using cross-sectional data. As a reflection of increased bargaining power, the higher the sex ratio, the more leisure time women had and the higher husbands' share in total work time. More specifically, if the sex ratio increased by one standard deviation (0.1), the husbands' share in total work time increased by 0.0058, which is about 1 % of average total work time share. Similar effects are obtained if shopping and studying are reclassified as work, although the magnitudes of the effects are somewhat smaller, and the precision of the leisure share results is reduced for both husbands and wives. In addition, college-educated men in Taiwan were found to have experienced an even larger sex-ratio effect and do a substantially higher share of the total work within the couple than less educated men when faced with the same county-level sex ratio. This

finding suggests that the sex ratio is more binding in thinner markets or for populations not working near the physical maximum of work hours.

Sex Ratios and Savings

The impact of sex ratios on savings has been tested by Wei and Zhang (2011), who investigated recent changes in China's household savings as a function of China's increasingly high sex ratio. The sex ratio at birth in China climbed from 1.06 in 1980 to 1.27 in 2007, implying men outnumber women at age 25 or below by at least 30 million. They found that increases in sex ratios account for about half of the observed increase in Chinese household savings in recent years, as men compete for wives by saving to improve their position in the marriage market. Much of this savings takes the form of investment in real estate and financial investments. Horioka and Terada-Hagiwara (2016) estimated how household savings varied with sex ratios in India and Korea using time-series data for 1975–2010. They found that the sex ratio (unadjusted for differentials in age at marriage) had a negative impact on savings in India, where the bride's family tends to pay substantial dowries to the groom's family at marriage. In Korea, where, as in China, the groom's family has to bear a disproportionate share of marriage-related expenses including purchasing housing for the newlywed couple, the sex ratio had a positive impact on saving.

Du and Wei (2013) provided cross-country macro evidence based on data for 159 countries from 1990-2010. They found that the more sex ratios diverge from one, either positively or negatively, the higher the savings rates. Both Wei and Zhang (2011) and Du and Wei (2013) interpret their findings as evidence of a competitive savings motive: when there is an excess number of men in the marriage market, young men (or their parents) will compete more to find a wife and therefore save more.

Sex ratios and labor supply

From 1960 to 1975, the labor force participation rates of U.S. married women aged 20-24 rose dramatically from 31.7 percent to 57.0 percent. This increase coincided with the entry of the first baby-boom women, who were born shortly after WW II, into marriage and labor markets. This increase is consistent with marriage market analysis. The baby-boom women participated in marriage markets with low sex ratios for women compared to men a few years older (13 fewer men for every 100 women for the 5-year cohort born after WW II) and these low sex ratios may have pushed married women in the labor force. Later baby-boomers, who entered labor and marriage

markets in the late 1970s and early 1980s had more-balanced sex ratios, reflecting the decline in births after 1960. This coincided with the end of the big surge in young women's employment. Using data for 1965-1990 and controlling for other factors that changed over time, Grossbard-Shechtman and Granger (1998) showed that early baby-boom women experienced more rapid growth in labor supply than women born earlier or later. This was precisely the cohort with the lowest sex ratio.

A number of studies use variation in the sex ratio in marriage markets to examine the relationship between sex ratios and women's labor force participation or labor supply. Using data from married male and female respondents in the Panel Study of Income Dynamics combined with age- and race-specific sex-ratios from the Census, Chiappori, Fortin, and Lacroix (2002) estimate the impact of changing state-level sex ratios on hours worked by married women.[13] They find that as the sex ratio falls (as women become scarcer) wives' labor supply significantly increases. For example, they found that a one-percentage point increase in the sex ratio decreases wives' annual labor supply by over 17 hours at the same time it increases husbands' annual labor supply by 45 hours.

Also relying on sex ratio variation in marriage markets defined by age, Grossbard and Amuedo-Dorantes (2007) analyzed employment data over the period 1965-2005 for U.S. women aged 25 to 44 born between 1926 and 1980. Their examination of the impact of changes in the sex ratio on labor force participation suggests that that cohorts of women with lower sex ratios had above-average labor force participation, whereas cohorts of women with higher sex ratios—such as women born during the baby-bust after 1961—had below-average labor force participation.[14] An increase in the sex ratio of .10 was found to have the same effect on young women's labor force participation rate as two more additional years of schooling.

Both of the studies above acknowledge that relying solely on observed sex ratios by age and location may not fully address the concerns of endogeneity and many recent studies rely on natural experiments to provide evidence of a causal relationship. Angrist (2002) reports findings similar to those in the studies above that suggest a negative relationship between marriage market sex ratios and women's employment and labor supply. Relying on more plausibly exogenous variation in sex

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[13] Chiappori, Fortin and Lacroix (2002) use age-specific state-level sex ratios pegged to the actual age of an individual's spouse. They test robustness by constructing sex-ratios assuming a 2-year marriage age gap and a 2-5 year marriage age gap. They also include policy measures that are expected to alter intra-household bargaining power. In this context, they use a divorce law index that identifies shifts in divorce laws that favor women.
[14] The average is defined for the analytical sample.

ratios resulting from changes in the number of allowable immigrants to the U.S. by country of origin, he finds a large negative effect of sex ratios on female labor force participation among second- and third-generation immigrants. Similarly, within marriage markets defined by race, Charles and Luoh (2010) find an increase in African-American female labor force participation and labor supply hours as men of marriageable age became scarce due to changes in mandatory drug sentencing laws that dramatically increased incarceration of prime age African-American men.

Sex ratio analysis can lead to some predictions about U.S. women's future labor supply. Consider women between ages 30 and 54. Each year, some women age out of this age group and are replaced by millennials just turning 30. Millennials are characterized by more-balanced sex ratios than the older cohorts who were part of the baby-bust generation and faced high sex ratios. This change is, therefore, likely to increase the labor force participation of women aged 30-54. Recent data confirm this expectation (Grossbard (2016b).

Evidence from outside the US suggests a similar relationship. Teso (2016) has shown that sex ratios have also influenced labor force participation of African women. The enslavement of men in Africa led to a very low sex ratio, thereby pushing women into the labor force and changing the division of labor in society. Accordingly, the African ethnic groups that were more severely affected by the trans-Atlantic slave trade are today more likely to exhibit higher female labor force participation and more equal gender-role attitudes.

Additional sex ratio effects

Sex ratios can help explain racial differences in marriage rates. Wilson (1989) emphasized low sex ratios as a key factor in the declining marriage rate among U.S. blacks. He focused not on sex ratios *per se*, but on the number of marriageable men relative to the number of women, where "marriageable" meant that a male was employed.[15] Using Census data, he showed that changes in marriage rates by broad region of the country were related to the corresponding regional changes in this ratio. Brien (1997) found that racial differences in the timing of marriage were related to state-level differences in sex ratios, more so than to local-level sex ratio differences. Using this definition of marriage markets, Brien's results suggest that variation in race-specific sex ratios in the market for 'marriageable' men, defined by education and/or employment, explain a substantial portion of the

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[15] Wilson computed the Male Marriageable Pool Index (MMPI), defined as the number of employed men in an age x race cell divided by the corresponding number of women in that age x race cell. The ratios were well below 1, were lower for blacks than whites, and fell sharply for blacks between 1970 and 1990.

black-white gap in women's marriage rates. Charles and Luoh (2010) found that lower sex ratios in marriage markets defined by race, age, and location, due to higher incarceration rates, were associated with lower marriage probabilities. Specifically, they find that a one standard deviation increase in incarceration rates reduced the probability of marriage for an African-American woman by 5 percent. Exploiting exogenous changes in sex ratios among immigrant groups due to variation in immigration policy that varied by country of origin, Angrist (2002) found that high sex ratios had a large positive effect on the likelihood of marriage for women and a slight positive effect on the marriage rates of second-generation men.

There is also evidence that sex ratio imbalance leads individuals to move across marriage markets. Chiswick and Houseworth (2011) examine the effect of sex ratios on ethnic intermarriage and found that in the US, the more members of the other gender from the same region of origin are available in a particular location, the less likely it is that an individual will intermarry. Evidence of marrying up or down in terms of education is also evidence of movement across marriage markets.[16] Using variation in the supply of potential husbands due to World War I casualties in France, Abramitzky, Delavande and Vasconcelos (2011) found that when men were scarcer, they improved their position in the marriage market by marrying older women of higher social class. Further support for this notion is provided by Charles and Luoh (2010), who find that a decrease in the sex ratio due to male incarceration increases the probability that black women marry spouses with low levels of education.

Furthermore, cohort changes in sex ratios have been linked to changes in fertility. Heer and Grossbard-Shechtman (1981) attribute part of the decline in marital fertility that occurred in the late 1960s to the decline in the sex ratio associated with the entry of the first post-World War II women into dating and marriage markets. As sex ratios dropped dramatically, women opted out of the "first marriage, then children" model and without pressure for extra fertility on the part of men, overall fertility dropped Bitler and Schmidt (2012) show that states with larger shares of men aged 19-25 who were drafted during the Vietnam Conflict experienced sharper decreases in birth rates for women aged 15-29. Their preferred estimate indicates that an additional man drafted in a state per 100 men in this age group leads to a 1.6 percent decrease in the birth rate for women under 30. The gradual phase out of the draft in the early 1970s was associated with an increase in the birth rate of between 3.9 to 4.7 percent. In the U.S., it thus seems that sex ratios and fertility have moved in the

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[16] See Mansour and McKinnish, this volume, for a detailed discussion of marital sorting and gains to marriage.

same direction. In contrast, Francis (2011) documented that as sex ratios rose in Taiwan, the total number of children in a family decreased, in apparent contradiction with the US time trend.[17] It could be that these diverging results for the US and Taiwan are due to the larger proportion of married mothers in Taiwan. With higher sex ratios, married women in Taiwan may have been better able to actualize their preferences for small families. In addition, Francis (2011) found that a ten-point increase in the marriage market sex ratio led to a 0.06 increase in the fraction of female children in a family. It is possible that this effect is the result of fewer selective abortions and infanticide of females: women's higher intra-household bargaining power associated with higher sex ratios may have led them to protect their female fetuses and infants more proactively.

The entry of the first post WW II baby-boomers—the lowest sex-ratio generation—into marriage markets in the late 1960s and 1970s also led to large increases in women's college attendance in the U.S. (Heer and Grossbard-Shechtman 1981; Grossbard-Shechtman 1993). Charles and Luoh's (2010) finding of a positive association between the incarceration rate and the fraction of women with any college is consistent with a negative association between cohort-based sex ratio and women's education. There is evidence of similar effects outside of the U.S. Edlund et al. (2013) found that in Chinese cities with higher sex ratios, women are less likely to obtain additional education.

Evidence from China also indicates that sex ratios affect investments in children. Porter (2016) showed that when sex ratios are higher, sons are healthier. The causality may be as follows: when sex ratios are higher, married women have more bargaining power relative to that of husbands and since mothers often control the use of the household's resources, they prefer to invest more in their sons' health capital. Francis (2011) also documented that sex ratios were positively related to children's years of education, especially for boys in Taiwan.

Sex ratios also may be related to male crime rates. Edlund et al. (2013) linked sex ratios to crime rates in China. Using data for 30 Chinese provinces in the period 1988 to 2004, they found that men in cohorts with a higher sex ratio at birth were more likely to engage in crime. Their results were sensitive to the inclusion of a province time trend, which suggests that the findings may be partially driven by migration of men to certain cities that have higher crime rates and not solely capturing sex ratio effects. In the US, the decline in the crime rate in the 1990s could reflect the high

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[17] Francis (2011) constructed sex ratio measures using the number of men aged 15–39, excluding mainlanders in the military, divided by the number of women aged 15–39, then multiplied by 100. He did not include mainlanders enlisted in the Taiwanese military because the government did not permit them to marry. He defined the sex ratio at the regional level based on five standard geographic regions for the period 1950 to 1984

sex ratios in marriage markets at that time, due to the falling fertility of the early 1970s.[18] Increased competition among men for relatively scarce women due to high sex ratios may thus be related to crime rates in different ways in different cultures. When women are in a better bargaining position in marriage markets, they may incentivize men towards a reduction in their criminal activities (which is consistent with US findings), rather than encourage men to accumulate more assets by illegal means (which is consistent with Chinese findings).

Conclusion

Analytical tools that economists routinely apply to understand the determinants of traditional outcomes such as wages and labor supply can also be used to understand how marriage markets affect personal access to consumption goods, individual savings, leisure time, and labor supply. The same tools also shed light on choice of living arrangements, including choice between marriage, cohabitation, and co-parenting, fertility, and investments in own and children's human capital. In both the Becker and WIHO models, the sex ratio has important effects on the relative position of men and women in marriage markets. When the sex ratio is high, women obtain a higher equilibrium share of marital output in the Becker model and receive a higher price for their household work time in a WIHO model.

This chapter has focused on one important variable reflecting marriage market conditions: the sex ratio. By affecting demand and supply in marriage markets, sex ratios can have an impact on numerous outcomes, including consumption, labor supply, savings and crime. I reviewed evidence on sex ratio effects, with an emphasis on studies that establish causality. There is widespread evidence for many parts of the world that sex ratios have important effects on savings, labor supply and consumption and a variety of other outcomes.

If sex ratios influence marriage market conditions and a number of important outcomes related to these conditions then it is plausible that factors other than sex ratios could have an impact on marriage market conditions and the same outcomes. Among these factors are personal characteristics related to success in dating and marriage. To the extent that individuals with traits that are relatively valued in marriage markets can obtain a higher price for their WIHO (if they supply it) or can get away with paying less for their partner's WIHO (if they are on the demand side)

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[18] An alternative explanation of the decrease in the crime rate, advanced by Donohue and Levitt (2001), is that the legalization of abortion in the early 1970s led to a large reduction in births among lower-income women. They argue that the aborted births may have been disproportionately persons with a higher probability of committing a crime.

then these traits are expected to affect labor supply, consumption, savings and the other outcomes covered in this chapter (Grossbard 2015). For example, there is some evidence that individuals with higher body-weight work more hours in the labor force than their counterparts with average weight (Oreffice and Quintana-Domeque 2012). This could reflect their lower value in marriage markets.

Furthermore, unmeasured characteristics could be positively associated with the likelihood that an individual becomes part of a couple (married or not), and at the same time these same characteristics could affect the individual's bargaining power in marriage and prior to marriage: if an unmeasured characteristic affects demand for WIHO then it will push up both the quantity (likelihood of marriage) and the price of WIHO. Consequently, given that such price influences individual bargaining power in marriage (current or future), the unmeasured trait is likely to affect the outcomes of interest. It may therefore be worthwhile to estimate predicted likelihood of (inter)marriage and individual outcomes simultaneously, as in the case of a study of savings among single women in Japan by Kureishi and Wakabayashi (2013) and of time that individuals spend in household production (Grossbard, Gimenez-Nadal and Molina 2014).

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Figure 1. A Becker-Style Model of the Marriage Market

Husband's share of
marital output (m_{ij})

$Z_{ij} - Z_{0j}$

S_0

S_1

e_0
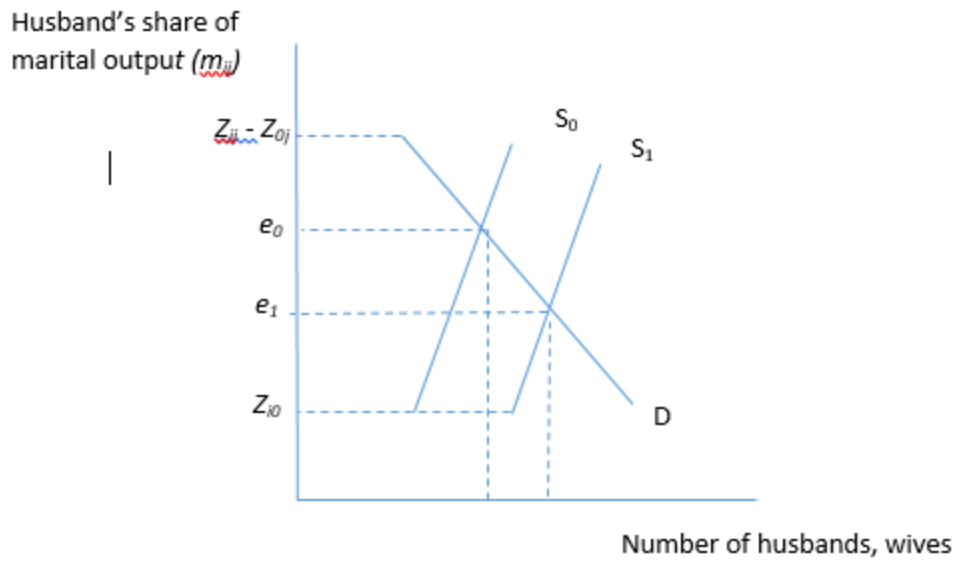
e_1

Z_{i0}

D

Number of husbands, wives

Figure 2. Markets for WIHO Supplied By Woman of Type F and Men of Type M