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Are There Increasing Returns to Scale in Marriage Markets?*

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Abstract

The goal of an individual searching for a marriage partner is typically to form a long-term relationship. Marital search is a complicated and costly activity, where opportunities typically arrive over time at uncertain intervals, each party has to evaluate each other's characteristics, and expectations play an important role. Given these features of marital search, a seminal paper by Mortensen (1988) has shown that the matching framework can be suited for the analysis of marriage markets and also raised the possibility of a thick market externality in these markets. We contribute to this literature by empirically investigating whether marriage markets are characterized by increasing, constant, or decreasing returns to scale. We focus on three societies—late medieval and early Renaissance Tuscany, China in the 1980s, and the United States in 2000—which are different in terms of population size, economic structure, sex ratios, marriage transfers, and the social norms governing marriage markets. Our main finding is that in all three societies, there is no evidence of increasing returns to scale in marriage markets, whereas the hypothesis of constant returns to scale cannot be rejected. The remarkably similar and precise estimates suggest that the number of eligibles (and potential contacts) in a marriage market is less important than economic factors, such as wealth levels and income dispersion, in affecting the marriage rate across different societies. The key message is that *where* individuals live, in large cities or small towns, have a minimal effect on their marriage rates.

JEL Classification: J12, J41

Keywords: marriage markets, matching, thick market externality, returns to scale, spousal search, endogeneity

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1 Introduction

On what basis people choose to get married? What factors affect the marriage rate in a given society? Are there some common fundamentals that influence marital search and marriage rates across diverse societies?

Moffitt (1992, p. 26) notes that most exits and entrances into welfare in the United States are associated with changes in family structure, and not with changes in labor market circumstances, and suggests that "a model of marital search would be a more accurate descriptor of AFDC entry and exit than a wage-search model of the type employed in the job-search literature." This fact alone highlights the paramount importance of family formation, structure, and dissolution, with marriage playing a central role.

Since Becker (1973)'s pioneering work, the marriage market has become a familiar toolbox in economics to address these questions. A seminal paper by Mortensen (1988), and subsequent work by Burdett and Coles (1997, 1999), Shimer and Smith (2000), and Smith (2006), have shown that search theory and the matching framework are best suited for the analysis of marriage markets.[1]

The goal of an individual searching for a marriage partner is typically to form a long-term relationship. Potential marriage partners understand that some individuals make better partners than others and, therefore, they search and may accept or reject marriage proposals until they find what they consider their best match.

Searching for a husband or wife, though, is a complicated and time consuming activity. To influence the arrival rate of potential partners, singles may go to cafes, join dancing clubs, or ask for the help of match-makers. Nevertheless, looking for a marriage partner is a complex task because each party has to evaluate each other's characteristics to decide whether it will be a great match. Hence, matching models assume that search is costly.

Also, expectations play an important role. If a single man believes that few, if any, women will find him an acceptable marriage partner, then he may accept the first opportunity that presents itself.

The key tool of matching models of search is the meeting function, which relates the number of meetings per unit of time as a function of the number of participating agents. When referring to the marriage market, $M(m, f)$ indicates the number of meetings between men and women as a function of the stock of eligible men and women. Upon a meeting, the couple has to decide whether to marry or not. If the couple decides to marry, they leave the marriage market. If they decide not to marry, they return to the marriage market and keep searching for potential spouses.

The meeting function can exhibit increasing (IRS), decreasing (DRS), or constant (CRS) returns to scale. With IRS, that is, if there is a thick market externality, the meeting rate in a city with, say, 20000 eligibles is proportionally higher than the meeting rate in a town with 2000 eligibles or a village with 200 eligibles. The opposite is true when the meeting function

[1] Search models, developed in the labor market literature by Diamond (1981), Mortensen (1982), and Pissarides (1984), have proved to be a useful tool in labor economics, industrial organization, finance, monetary theory, and the economics of the marriage market. See Rogerson, Shimer, and Wright (2005) for a recent survey of the search literature and matching framework applied to labor economics, which is the most relevant for the study of marriage markets.

displays DRS. With CRS, the meeting rate is independent of the number of eligibles.

The returns to scale parameter of the meeting function does not directly translate into returns to scale in the propensity to marry. An IRS meeting function will lead to an IRS marriage rate if the higher rate of meetings directly translates into a higher marriage rate.

However, other possibilities may be relevant. In a small village or town there may be more conformity behavior, more social pressure to get married, and more stigma toward those who remain unmarried, whereas in a city singles do not live in a close and tight community and, therefore, they may experience less pressure to get married.

Alternatively, in a small town an individual may get married sooner because he or she expects that there will not be many attractive partners. In contrast, in a large city with many possible marriage partners, one may become more picky, wait, and delay marriage in the hope of finding a better match.

Also, in a city there may be a lot of amenities and fun activities to enjoy, more possibilities to go to college and invest in education, and more opportunities to get high-paid jobs. Therefore, singles living in a city may feel less rushed to enter a marriage relationship given the combination of amenities, educational opportunities, and job options available compared to singles living in a village or a small town.

Each of these stories may generate a *marriage rate* in a city that is actually the same (CRS) or lower (DRS) compared to the one in a small town or village even if in a city, the arrival rate of potential partners and the probability of meetings/contacts are higher than the ones in a small town or village.

Starting from Mortensen (1988), many papers (e.g., Chiappori and Weiss 2000; Anderberg and Mongrain 2001; Gautier, Svarer, and Teulings 2007) raise the possibility of a thick market externality in marriage markets and assume IRS meeting functions and marriage rates. Other works, like Burdett and Coles (1997) and Choo and Siow (2006a, 2006b) assume CRS meeting functions and marriage rates.

Whether an increase in the stock of eligible men and women in a marriage market increases, leaves unaffected, or decreases the *marriage rate* is an empirical question.

The need to estimate returns to scale in marriage markets is also prompted by the fact that these returns to scale have significant behavioral and welfare consequences. Just to give an idea, consider the case of the United States in which the marriage rate has constantly declined in the past 150 years and the divorce rate has risen during the same time (inverting this trend only in the last quarter of the twentieth century) (Stevenson and Wolfers 2007). Since the 1970s, only about 65 percent of American adults are married at a given time (the rest are either single, divorced, or widowed), and, as a consequence, nearly one-sixth of households with children are headed by a single female.[2] This is a matter for concern as female-headed families are more likely to be below the poverty line and children from single-parent families are more likely than children from two-parent families to drop out of high school, to be idle, and to experience teen births and are less likely to go to college.[3]

Researchers have just begun to estimate the degree of returns to scale in marriage markets. Following the literature testing for agglomeration effects in labor markets, a first

[2] See Ayagari, Greenwood, and Guner (2000) that present a model that rationalizes these trends.

[3] McLanahan and Sandefur (1994).

approach is to use a city as the unit of observation and to regress the marriage rate in a city on the size of the marriage market in that city.[4] The coefficient on city size provides an estimate of the degree of returns to scale in marriage markets.

For marriage markets in the United States there seems to be evidence in support of IRS. For example, using the 1970, 1980 and 1990 U.S. censuses, Gould and Paserman (2003) find IRS in marriage rates when estimating a probit regression of the probability of marriage of an eligible woman on individual covariates including a measure of men's wage inequality and log population in the metropolitan area in which the woman resides.[5] Similarly, using the 1980 U.S. census, Drewianka (2003) finds IRS in marriage rates when regressing the propensity to marry for individuals of a particular gender on individual attributes and the sex ratio (ratio of eligible men to women) of the city in which the individual resides.

We contribute to this literature by estimating the degree of returns to scale in marriage markets in three societies—late medieval and early Renaissance Tuscany, China in 1982, and the United States in 2000. These societies are very different in terms of area and population size, economic structure, sex ratios, female labor participation, age gap between spouses, marriage payments and transfers (e.g., dowries versus brideprices versus no transfers at the time of marriage), fertility and mortality trends, and the social norms governing the marriage markets (e.g., divorce, arranged versus non-arranged marriages).

For the city of Florence and her dominions consisting of nearly twenty Tuscan towns and hundreds of villages in the countryside, data on socioeconomic characteristics come from both the 1427 Florentine Catasto, a census and property survey of about 60,000 Tuscan households, and a sample of 7,400 dowry (marriage) contracts, which we collected at the State Archives of Florence.

In late medieval and early Renaissance Tuscany, brides' families gave dowries to their daughters at the time of the marriage, brides brought these dowries to their grooms, and daughters were typically excluded from bequests. The sex ratio was biased (e.g., 118 men for 100 women in Florence), marriage was almost universal for women whereas a proportion of men remained unmarried, and there was an average 10-year gap in the age at first marriage for men and women (with most women marrying in their late teens). The labor force participation of women was limited. Fertility was positively correlated with wealth and high infant mortality characterized many couples. Divorce was extremely rare. The role of match-makers was important although arranged marriages were not the norm.

In the early 1980s, 20 percent of the Chinese population lived in urban areas. The 1982 census shows that marriage was nearly universal for women, divorce was rare, and a large number of newly married couples lived with their parents because there was no market in urban housing (housing was primarily allocated according to an individual's place of work). Arranged marriages and marriage transfers, such as brideprices or dowries, were not widespread among urban couples. Elderly parents were more likely to live with a married son than a married daughter.

Late medieval Tuscan and Chinese marriage markets until the mid-1980s share a feature

[4] Petrongolo and Pissarides (2001) present a survey of the empirical literature testing for agglomeration effects in labor markets and conclude that CRS is a reasonable description of the labor market data.

[5] When using fixed effects, the point estimate for log population becomes statistically insignificant.

that will play an important role in our empirical strategy later on: given that there was no migration prompted by marital search, the size of the marriage market in both societies can be taken as exogenous.

The United States, as described in the 2000 census, cannot be more different from late medieval Tuscany and contemporary China.[6] Parents do not give dowries to their daughters at the time of their marriage, brides do not bring dowries to grooms and, in general, there are no transfers at the time of marriage between spouses. Daughters share in the bequests together with their brothers and parents invest in the human capital of their children regardless of their gender. The sex ratio is not biased against women, the average gap in the age at first marriage for men and women is less than two years, and divorce and remarriage are common. Women's participation in the labor market is high, and low infant mortality coupled with the possibility of controlling fertility make the child-bearing role of women quite different from the one in the pre-modern world. Arranged marriages by parents are rarely heard of and marriage agencies and, recently, online dating, are more popular match-making mechanisms. Also, the existence of many ethnic, race, and religious groups, creates a potential segmentation of the marriage market.

The assumption that the size of the marriage market in the United States is exogenous, is clearly untenable. There is substantial evidence showing that in the United States (as well as in some European countries), individuals choose to locate in cities in order to engage in marital search or related activities.[7] To deal with this endogeneity problem, we instrument the size of the marriage market.

Our main finding is that in all three societies, there is no evidence of a thick market externality or IRS when looking at marriage rate and total gains to marriage regressions. More precisely, the hypothesis of CRS cannot be rejected for early Renaissance Tuscan and contemporary U.S. marriage markets. Chinese marriage markets do not display IRS or CRS, but the point estimates suggest a mild DRS.

How do we interpret these findings? From an *empirical* point of view, the remarkably similar and precise estimates of returns to scale parameters for these diverse societies, suggest that there is some common and fundamental mechanism at work that makes marital search across different societies similar despite societies may differ significantly in the norms and patterns that characterize their marriage markets.

The key message of our paper is that *where* individuals live, in large cities or small towns, have a minimal effect on their marriage rates. In particular, when looking at the United States, city size per se is not responsible for the recent decline of marriage rates.

If there is no thick market externality and the number of eligibles does not affect the marriage rate or the total gains to marriage, there may be other factors that influence

[6] We chose the 2000 census because compared to the earlier ones, it provides a larger sample.

[7] For example, Costa and Kahn (2000) argue that educated couples are more likely to live in cities because it is easier for both of them to find suitable jobs. Compton and Pollak (2004) suggest that cities are attractive to both married and single educated individuals, and that the higher observed rate of educated couples in cities relative to other types is partly because of the larger stock of educated eligibles in cities. Gautier, Svarer, and Teulings (2007) show that in Denmark, single educated individuals are more likely to migrate to cities and married educated couples are more likely to leave the cities. In Sweden, single women are more likely to migrate to cities (Edlund 2005).

marital search across societies. For example, we find that in late medieval Tuscany wealth seems to have had a negative impact on marriage rates, with men in wealthier and more commercial cities postponing their marriage or never getting married. In China in the early 1980s, the absence of a housing market and the difficulty of finding a house or an apartment for a newly wed couple might explain the lower marriage rate in large, more congested cities compared to smaller towns. Finally, in the U.S. marriage markets as described in the 2000 census, investing in education and income dispersion seem to have had a negative impact on both the male and female marriage rates.

From a *theoretical* point of view, an IRS meeting function seems a reasonable assumption when modeling marital search: if there are more eligibles in a given location, the arrival rate of potential partners and the number of potential contacts are higher. However, if the observed marriage rate is independent of the number of eligibles (as the three societies we considered seem to indicate), one can argue that encountering someone is not identical to marrying someone. In particular, the three stories suggested above (e.g., more conformity behavior or social pressure to get married in small towns and villages) can help writing richer matching models of marital search.

Lastly, even if one finds that the *marriage rate* in a city is independent of the number of eligibles, a thick market externality may still exist. The reason is that agents may react to a thick market externality, with faster arrivals of potential partners and/or more disperse match value distribution, by waiting for a better match rather than marrying earlier. In this case, the thick market externality generates higher *marital output* but not necessarily a higher marriage rate.[8] For the U.S. 2000 sample, we show that there is no evidence of a thick market externality even when one considers the quality of the marital match proxied by the fraction of young children who live with two parents, and the educational attainment of children within marriage (we do not use the divorce rate or marital tenure to proxy for marital quality because one can argue that married individuals in larger cities may also choose to break up more and rematch more and they still have higher average welfare).

The paper is organized as follows. Section 2 outlines our methodological approach. Section 3 describes the salient features of marriage markets in the three societies we consider. Sections 4, 5, and 6 present the estimation results for marriage rate, total gains to marriage, and marital output regressions, respectively. Section 7 concludes.

2 Methodology

Marriage Odds Ratio Regressions. Using a city as the unit of observation, let c denote city c, f denote type f women and m denote type m men. μ_f^c is the number of married women of type f in city c. n_f^c is the number of eligible women of type f in city c. μ_m^c is the number of married men of type m in city c. n_m^c is the number of eligible men of

[8] Addressing this issue is similar to what has been done in the labor markets literature. For example, Petrongolo and Pissarides (2005) show that the unemployment hazard is unaffected by scale effects. Scale effects lead to higher reservation wages and higher post-employment wages.

type m in city c. Consider the following cross-section log marriage odds ratio regressions:

$$\ln \frac{\mu_g^c}{n_g^c - \mu_g^c} = \pi_g + \alpha_g \ln n_g^c + u_g^c \qquad g = f, m \tag{1}$$

where u_g^c are the error terms of the regressions.

The marriage rate ($\frac{\mu_g^c}{n_g^c}$) is monotonically increasing in the marriage odds ratio $\left(\frac{\mu_g^c}{n_g^c - \mu_g^c}\right)$. The behavioral justification for studying the log odds ratio is that it can be derived from McFadden's (1974) random utility model where the choice is between marriage or otherwise.[9] Under McFadden's interpretation, the log odds ratio, that is the left-hand side of (1), measures the mean difference in utility of type g in city c from marrying versus not marrying.

Estimating the parameters α_f and α_m enables to assess the degree of returns to scale in marriage markets. Under CRS, $\alpha_f = \alpha_m = 0$. Under IRS, $\alpha_f > 0$ and $\alpha_m > 0$. Under DRS, $\alpha_f < 0$ and $\alpha_m < 0$.

To understand the empirical findings in the next sections, it is important to discuss orders of magnitude. In general, for any city, a doubling of its population is a very large change. Suppose that the initial marriage rate in city c, $\frac{\mu_g^c}{n_g^c}$, is 0.8. Then a doubling of the city's population will increase the marriage rate to 0.801 if $\alpha_g = 0.01$, and to 0.81 if $\alpha_g = 0.1$. In contrast, let the initial marriage rate in city c, $\frac{\mu_g^c}{n_g^c}$, be 0.5. Then a doubling of the city's population will increase the marriage rate to 0.5017 if $\alpha_g = 0.01$, and to 0.517 if $\alpha_g = 0.1$. This implies that population growth in a city will generate a more modest increase in the marriage rate if the initial marriage rate in that city is higher.

In general, the difficulty with estimating the above regressions by OLS is the potential endogeneity of n_m^c and n_f^c due to endogenous migration to cities to find marriage partners. In order to obtain consistent OLS estimates of α_f and α_m, one has to make an *a priori* argument that n_m^c and n_f^c are exogenous. Net migration across cities due to differences in labor market conditions and amenities is fine because migration unrelated to marital behavior generates exogenous variation in n_m^c and n_f^c across marriage markets, which is what one needs for OLS to be consistent. Otherwise, one has to find instruments for n_m^c and n_f^c.

A standard concern in regression inference is when a covariate, n_g^c in our case, appears on both the right- and left-hand sides of the equation. If this covariate is measured with error, then measurement error may cause a correlation between the covariate and the dependent variable causing the OLS estimate of α_g to be inconsistent. Since there is sampling error in observed n_g^c, the estimation strategy may have a potential problem. However, this is not a first order problem in our case because the marriage odds ratio is independent of the sampling error in n_g^c.[10] There is still the conventional problem of measurement error in observed n_g^c, with which we deal in two ways. First, we estimate population weighted

[9] This model is the workhorse model in the empirical discrete choice literature.

[10] Let $n_g^{c*} = n_g^c + u_g^c$ where n_g^{c*} is the measured population, n_g^c is the true population and u_g^c is the sampling error. As long as the marriage rate, r_g^c, is the same for the true population and sampling error, $\frac{\mu_g^{c*}}{n_g^{c*} - \mu_g^{c*}} = \frac{\mu_g^c}{n_g^c - \mu_g^c} = \frac{1}{r_g^c} - 1$.

regressions where smaller cities, which should suffer from more sampling error, have less weight. Second, our instrumental variables technique should alleviate the measurement error problem.

Total Gains to Marriage Regressions. Independent of the problem of endogeneity bias, μ_f^c and μ_m^c are not independent of each other. Because each heterosexual marriage consists of a man and a woman, the marriage rate of type m men must be related to the marriage rate of type f women if they marry each other. However, estimating (1) for men and women separately does not impose the restriction that α_f and α_m are related. Type f women can marry type m men, as well as other types of men, and type m men can marry type f women, as well as other types of women. These substitution possibilities make the relationship between α_f and α_m complicated. As Angrist (2004) and Choo and Siow (2006a) have shown, separate male and female marriage rate regressions can give conflicting results.

To deal with the above problem, we also estimate total gains to marriage regressions. Let the total gains to an $\{m, f\}$ marriage be π_{mf}:

$$\pi_{mf} = \ln \sqrt{\frac{\mu_{mf}^c}{\mu_{m0}^c} \frac{\mu_{mf}^c}{\mu_{f0}^c}} \tag{2}$$
$$\mu_{m0}^c = n_m^c - \mu_m^c;\ \mu_{f0}^c = n_f^c - \mu_f^c$$

where μ_{mf}^c is the number of $\{m, f\}$ marriages in city c. μ_{m0}^c and μ_{f0}^c are the numbers of type m men and type f women in city c who choose to remain unmarried, respectively.

Following Choo and Siow (2006a), who derive total gains to marriage by embedding McFadden's random utility model in a marriage market, we behaviorally interpret total gains to marriage as an average of the mean utilities of the two types of individuals married to each other relative to not marrying. That is, if the log marriage odds ratio $\frac{\mu_{mf}}{\mu_{m0}}$ $(\frac{\mu_{mf}}{\mu_{f0}})$ represents the mean utility that a type m man (type f woman) obtains from marrying a type f woman (type m man) relative to remaining unmarried, in (2) the total gain to a $\{m, f\}$ marriage is the average of the male and female log marriage odds ratios.

To estimate the degree of returns to scale in marriage markets, consider the following total gains to marriage regression:

$$\pi_{mf} = \ln \sqrt{\frac{\mu_{mf}^c}{\mu_{m0}^c} \frac{\mu_{mf}^c}{\mu_{f0}^c}} = \rho_{mf} + \alpha_{mf}(\frac{\ln n_m^c + \ln n_f^c}{2}) + v_{mf}^c \tag{3}$$

ρ_{mf} estimates the common total gains to a type m, f marriage across all cities. α_{mf} measures the degree of returns to scale ($\alpha_{mf} = 0$ for CRS, $\alpha_{mf} > 0$ for IRS, and $\alpha_{mf} < 0$ for DRS). v_{mf}^c is an error term, which allows for idiosyncratic deviations of total gains to marriage across different cities.[11]

[11] In the above specification, the coefficients on male and female populations are restricted to be the same, α_{mf}, which means that doubling the population will increase total gains to marriage by $2\alpha_{mf}$ percent. Given

Like in (1), n^c_m and n^c_f in (3) are potentially endogenous. If the idiosyncratic gain to marriage in city c, v^c_{mf}, is large, individuals may want to move to city c to find a marriage partner and, therefore, n^c_m and n^c_f may also be large, leading to an upward bias in the OLS estimate of α_{mf}. On the other hand, sampling error in the number of eligibles, n^c_m and n^c_f, may lead to a negative correlation between the covariate and total gains to marriage. This implies that the OLS estimate of α_{mf} will be biased downward. As discussed earlier, this sampling error is unlikely to be important. We will use OLS and also instrument for $(\ln n^c_m + \ln n^c_f)$ in (3).

Marital Output Regressions. Even if we find that the marriage rate or the total gains to marriage in a city are independent of the number of eligibles in that city, a thick market externality may still exist. The reason is that agents may react to a thick market externality, with faster arrivals of potential partners and/or a more disperse match value distribution, by waiting for a better match rather than marrying earlier. In this case, the thick market externality generates higher marital output but not necessarily a higher marriage rate. Because women have a finite amount of time to bear children, they may choose to marry in a narrow age window even if their pool of potential partners is poor. If the pool of partners increases, women may continue to marry in that age window but now they may be able to find better matches.

3 Marriage Markets in Three Diverse Societies

We estimate the returns to scale in marriage markets by considering three societies that are very diverse in terms of economic structure, population size, sex ratios, female labor participation, age gap between spouses, marriage payments and transfers (e.g., dowries versus brideprices versus no transfers at the time of marriage), fertility and mortality trends, and the social norms governing the marriage markets (e.g., divorce, arranged versus non-arranged marriages).

3.1 Tuscany, 1427

Late medieval and early Renaissance Tuscany was one of the most urban and commercial economies in Europe, with Florence being one of the most important trade and banking centers. The other Tuscan towns under Florentine rule were also commercial economies, though on a smaller scale. The rest of Tuscany consisted of hundreds of rural villages, with a mix of farmers, sharecroppers, fixed-rent tenants, and agricultural wage laborers.

In addition to having a mix of urban and rural marriage markets, the large variance in the size of Tuscan villages, towns, and cities enables to estimate the returns to scale in marital search. For example, the city of Florence had 9780 households, the town of Pisa 1740, and the rural villages in the Garfagnana district only 175 households.

that male and female populations across cities are highly collinear, if we allow for gender-specific population coefficients, multicollinearity results in unstable and implausible point estimates.

Tuscany is also blessed by the quantity and quality of data available, which enables to empirically estimate models and test hypotheses—something which is rare for pre-modern economies. The data on marital search and matching come from two primary sources.

We rely on the Florentine Catasto of 1427—one of the most impressive primary sources for the late medieval and early Renaissance period.[12] The Catasto is a census and property survey of about 60,000 households (roughly 260,000 people) with detailed information on all real property (houses in the city, farms and land holdings), business investments, loans, shares of the public debt, debts, occupations, and household demographics (number, gender, and age of children and other household members). The machine readable data file divides the Tuscan population into 29 distinct series. For the purpose of our study, each series is labeled as one "district," where each district corresponds to either a town or to the rural area (with many villages) surrounding a town.

We also exploit information on marriage matches from about 7,400 marriage and dowry contracts we collected at the States Archives of Florence. The bride's father (or other male relatives if the father was no longer alive) and the groom (and his father if alive) met in front of a notary, who drew up a marriage and dowry contract. The contract listed the names of the spouses, their places of residence, the amount of the dowry, and various clauses related to the payment of the dowry and its restitution in the event of the death of either of the two spouses.

Six features of marital behavior and marriage markets in medieval and early Renaissance Tuscany stand out.[13]

Tuscany was a virilocal society in which daughters left their natal households upon marriage and moved into their in-laws' households, whereas most married sons continued to live with, and work for, their parents. Divorce, although possible, was almost never an option in reality, which means that a marriage ended when one of the two spouses, or both, died.

Daughters were typically excluded from bequests. At the time of the marriage parents transferred wealth to their daughters through dowries, which mostly consisted of cash and movables, although houses, land holdings and shares in business partnerships were sometimes included. In turn, brides brought these dowries to their grooms, who could use and invest them. When the marriage ended, though, the dowry went back to the bride, who could remarry, live on her own, or go back to her natal family.[14]

[12] Faced with a fiscal crisis because of the protracted warfare against the duchy of Milan, in 1427 the Priors of the Florentine Republic instituted a new tax survey for all citizens of the city of Florence, the Tuscan towns, and hundreds of villages in her territories. Government officials and their staffs interviewed every head of household in Tuscany. The survey was completed within a few months. The machine readable data file Census and Property Survey of Florentine Dominions in the Province of Tuscany, 1427-1480 was prepared by David Herlihy and Christiane Klapisch-Zuber. The tax survey on which the Catasto data are based, and the documentary sources for the Catasto, are fully described in David Herlihy and Christiane Klapisch-Zuber (1978), *Les Toscans et leurs familles: Un étude du catasto Florentin de 1427* (English abridged edition: Tuscans and their Families: A Study of the Florentine Catasto of 1427. New Haven: Yale University Press, 1985).

[13] Botticini (1999), and Botticini and Siow (2003).

[14] See Botticini and Siow (2003) for a model of dowries that explains why dowries emerge and why they eventually disappeared in many modern and contemporary societies.

Sex ratios in the population were biased against women (Table 1). For example, in Florence there were 117 women for 100 men.[15]

[TABLE 1 HERE]

Women married in a very narrow age window, 15–25, whereas men married much later. There was an average 10-year gap between the ages at first marriage of men and women.

By the age of 25, marriage was almost universal among women: 84% of 18–27 years old women were married versus 52% of 22–32 years old men (Table 2). Given this pattern, in the regressions we consider men in the 22–32 and women in the 18–27 age groups, respectively.

[TABLE 2 HERE]

Unlike in contemporary China or the United States, there were no ethnic, race, or religious groups that could create segmentation in the marriage market. As the variance of assets per household indicates (Table 2), stratification in the early Renaissance Tuscan society occurred along other dimensions, foremost wealth and occupation.

Lastly, Tuscan people rarely moved to other towns or villages for the purpose of marriage. Table 3 illustrates the place of residence of the bride's and groom's families for the sample of dowry and marriage contracts we collected at the State Archives of Florence.

[TABLE 3 HERE]

From the thirteenth to the fifteenth century, the vast majority of urban grooms married urban brides, and vice versa, rural grooms mainly married rural brides. There were very few instances of an urban groom marrying a rural bride, or vice versa. Hence, the size of the marriage market in Tuscan towns and villages can be taken as exogenous, which will be important for the empirical strategy in the next section.

3.2 China, 1982

Data on Chinese marriage markets comes from the 1 percent random sample of the 1982 Population Census. The sample considers 1,002,691 person records and 242,718 household records living in cities or rural prefectures. We restrict our attention to the urban population living in 245 cities.

In the early 1980s, 20% of the Chinese population, nearly 200 million people, lived in urban areas.[16] About two thirds of the urban families were nuclear and one quarter were

[15] Historians have advanced various hypotheses to account for these biased sex ratios. Excluding widespread female infanticide, another possible explanation is differential care. For example, the Catasto itself and other primary sources, such as diaries and letters, show that Florentine families often sent their female babies to wet nurses in rural villages. Male babies were given to wet nurses living in Florence, where parents could monitor more easily their behavior. It then happened that the mortality rate of female babies was higher than the one of male babies.

[16] Davis and Harrell (1993) and Tang and Parish (2000) provide surveys of urban life in China.

stem families (3 generations or more). There were relatively few single-member households or joint-family households consisting of two or more married adult siblings.

Urban young adults primarily chose whom they wanted to marry. Marriage transfers, such as brideprices or dowries, were not widespread among urban brides and grooms.

Where the newly married couple would live was an important concern because there was no market in urban housing. Housing was primarily allocated by an individual's work place. In most cases, newly married couples lived with their parents for at least a few years. Elderly parents were more likely to live with a married son than a married daughter.

Like in late medieval Tuscany, divorce was rare in China in the 1980s.

Similarly to late medieval Tuscany, many studies have also documented the existence of a biased sex ratio (more men than women) in China (as well as in other Asian countries) to the extent of generating an academic and public debate on the "missing women" problem.[17] There is a growing literature (e.g., Porter 2008) that investigates the impact of the imbalanced sex ratios on Chinese marriage markets.

According to the 1982 census, by the age of 30, marriage was essentially universal for women: 97 percent of women in the 26–30 age group was married (Table 4). The average age at marriage was 25 for men and 23 for women.

[TABLE 4 HERE]

Given these patterns, the estimation in the next section considers men in the 24–28 and 29–33 age groups, and women in the 21–25 and 26–30 age groups (each age group has over 70,000 observations).

Until 1978, internal migration in China was strictly restricted: residents of cities had to live in the cities where they were born, whereas rural households were primarily confined to working in communal farming activities, and there were relatively few opportunities in the urban labor market for them. After 1978, at the same time when economic reforms in the countryside started being implemented, migration restrictions from rural to small– and medium–size cities began to be relaxed. Even though the pace of social and economic changes has been enormous since 1978, internal migration is still restricted in China.

At the time of the 1982 census, most residents had no choice about where they could live, and even if individuals wanted to migrate across cities for marital purpose, they could not do so.[18] Around 99% of the enumerated population was residing in and registered in the same location during the 1982 census collection period.

Only under two circumstances internal migration was relatively free. Individuals who got into institutions of higher education were allowed to move there. In 1982, though, few Chinese people had higher education. Alternatively, individuals could move to another city if a firm was willing to hire them. However, because there was no free market for labor, very few people moved for this reason in the 1980s.

[17] This literature is too vast to be summarized here. Lin and Luoh (2008), Oster, Chen, Yu, and Lin (2008) and Qian (2008) are very recent studies that also survey relevant previous works.

[18] Goldstein and Goldstein (1990), and Yang (1996a, 1996b).

Like for late medieval Tuscany, this limited internal migration in China makes the endogeneity problem not a issue when studying the effect of marriage market size on marriage rates.[19]

3.3 United States, 2000

The third society we consider are the United States. Data on marriage matches come from the 5 percent random sample of the 2000 census.[20] We chose the 2000 census instead of earlier ones because it provides a larger sample.

The sample considers 248 cities (or, more precisely, their standard metropolitan statistical areas, SMSA). The smallest city has 105,000 individuals, whereas the largest city has 9,700,000 individuals. Across cities, the average population is 810,787, which is consistent with the well-known fact that most cities in the United States have less than 1 million individuals.

Marital search and marriage markets in the United States present some striking differences with respect to the ones in late medieval Tuscany and contemporary China.

The United States are neither a virilocal nor a matrilocal society, but rather a neolocal society in which most newly married couples set up their own households, do not live with, and do not work for, their parents.

Unlike in late medieval Tuscany, American parents do not exclude their daughters from bequests but also do not give them dowries at the time of their marriage. Rather, U.S. households invest in their daughters' and sons' human capital, which in turn can affect the marital prospects of their children, once adults.

Neither dowries nor brideprices are exchanged among brides and grooms at the time of the marriage. Marriage payments and transfers are most likely to occur during either the marriage or at the time when the couple splits because of separation or divorce. Unlike in late medieval Tuscany or contemporary China, divorce and consequent remarriage are quite common in the United States. The divorce rate in the year 2000 was nearly 20 per 1000 couples.

There is no biased sex ratio in the U.S. marriage market: the young adult sex ratio is essentially one.

The existence of many ethnic, race, and religious groups creates the possibility of segmentation in the marriage market along these dimensions, and also allows for a possibly important role of social networks in marital search.

Universal marriage, especially among women, which was a distinctive feature of both late medieval Tuscany and contemporary China, does not characterize the United States (Table 5): a large fraction of both men and women remain single. Given the typical age at first marriage in the United States, we consider men in the 27–31 age group and women in the 25–29 age group. The mean marriage rates for these men and women are 0.485 and 0.508, respectively. There is also substantial variation in marriage rates across cities. One

[19] Au and Henderson (forthcoming) also exploited labor immobility across and into Chinese cities to study other agglomeration effects of cities.

[20] We use the sample weights to calculate our population counts.

standard deviation of the marriage rate exceeds 0.06, which is more than 10% of the mean marriage rate across cities.[21]

[TABLE 5 HERE]

Lastly, since there is unrestricted mobility in the United States and there is evidence that people move to cities to engage in marital search, the population in each city must be regarded as endogenous in the regressions.

4 Returns to Scale in Marriage Rate Regressions

Tables 6, 7, and 8 present log marriage odds ratio regressions at the city level with population weights for Tuscany in 1427, China in 1982, and the United States in 2000, respectively.

The *dependent variable* is the log of the number of married individuals divided by the number of unmarried individuals by gender and age. The *independent variable* is the log of the number of individuals in the same gender and age groups. The coefficient on this variable measures the degree of returns to scale. As these are log linear regressions, the point estimates are interpretable as elasticities.

For each society, the regressions also control for covariates. For Tuscany, the covariate is the wealth of the grooms' and brides' households. For China, the 1982 census does not provide information on family wealth but supplies information on educational attainment; therefore, the covariate is the percentage of men and women in a city, who attained more than primary education. For the United States, the regressions control for race, education, and family income.

Tuscany, 1427. Table 6 presents estimates of returns to scale parameters for men in the 22–32 and women in the 18–27 age groups, respectively.

[TABLE 6 HERE]

In column (2), the OLS point estimate for a_m is -0.037 with a standard error of 0.056 so one cannot reject the null hypothesis of CRS ($a_m = 0$) at the 10% significance level. That is, the number of eligible men in the 22-32 age group does not affect the probability of being married in that age group. Similarly, in column (6) the size of the marriage market does

[21] The mean total gains to marriage for men in the 27–31 age group married to women in the 25–29 age group is –0.567. One standard deviation is 0.278, which means that in most cities total gains to marriage are negative. A negative total gain to a specific marriage match is not unusual. It means that a marriage match that is imposed on a randomly chosen $\{m, f\}$ couple will generally be worse than having the couple remaining unmarried. Type m and type f individuals who choose to marry each other are not randomly drawn from the $\{m, f\}$ population. These couples, compared with other m and f individuals who do not choose to marry each other, have high idiosyncratic payoffs from marrying each other.

not seem to affect the probability for these women of getting married. The point estimate for a_f is -0.023 with a standard error of 0.120 so that we cannot reject the null hypothesis of CRS ($\alpha_f = 0$) at any reasonable significance level.

Interestingly, the point estimate for average log assets per adult in the district is -0.353 with a standard error of 0.089, which indicates that men in richer districts were more likely to remain unmarried (or to marry later). This is consistent with the pattern highlighted by historians: artisans, merchants, bankers, doctors and individuals engaged in other high-skill occupations often spent a certain number of years learning the skills required before starting their own businesses. Consequently, they often postponed getting married until they were established in their occupations.

Unlike for men, for women there is no discernible effect of average wealth in a given district on the odds of being married. One possible explanation is the differential fecundity of women and men, as pointed out in Siow (1998). Given that women have a finite amount of time to bear children, and given that in medieval times life expectancy was around 35-40 years, there was probably a strong pressure for young women to get married regardless of whether they belonged to poor or wealthy families.

Tuscan marriage markets were local and people did not move to other locations to engage in marital search. Hence, the size of the marriage market in each location can be taken as exogenous. To check for any potential endogeneity of city size and marriage market size, in columns (4) and (8) we instrument the log of the number of men in the 22–32 and of women in the 18–27 age groups with the log of total population in the district. The IV point estimates and standard errors are similar to the OLS ones, indicating that there is no evidence of endogenous mobility in a district for marital reasons, which is consistent with our prior.

We also run unweighted regressions and the results are quantitatively similar to those in Table 6. When looking at both OLS and IV, weighted or unweighted, male or female marriage odds ratio specifications, we cannot reject the hypothesis that $\alpha_m = \alpha_f = 0$, that is, the hypothesis of CRS for late medieval Tuscan marriage markets.

Because of the small number of districts (observations) and the relatively large standard errors, it is premature to reject modest IRS. For example, we cannot also reject the hypothesis that $\alpha_m = \alpha_f = 0.1$. From Table 2, the marriage rates for 22–32 year old men and 18–27 year old women were 0.518 and 0.838, respectively. Assuming the upper bound estimates $\alpha_m = \alpha_f = 0.1$ and using the orders of magnitude calculations in Section 2, a doubling of the population would increase the marriage rate by less than 4% and 2% for men and women, respectively. So, even in the most favorable case for IRS, the impact of marriage market size on the marriage rate would be very modest.

China, 1982. As shown in Table 7, marriage markets in China also do not show evidence of IRS when looking at marriage rates. Unlike for late medieval Tuscany, given the larger number of observations (cities) and the much smaller standard errors, the coefficients on the degree of returns to scale are estimated more precisely.

[TABLE 7 HERE]

Chinese marriage markets display mild DRS, that is, in larger cities with larger marriage markets and more eligibles who can meet and match, the marriage rate is actually slightly lower compared to the one in smaller cities.

More precisely, column (2) indicates that, when controlling for educational attainment, a 1% increase in the number of men in the 24–28 age group results in a 0.17% decrease in the number of marriages in that age group, and it is statistically significant at the 5 percent level. The estimated coefficient on log odds of education is negative, albeit not statistically different from zero. The results are similar for women in the 21–25 age group (column 6). Notice that for women, the estimated coefficient on education is negative and statistically significant—consistent with the hypothesis that educated women delay marriage.

The negative estimated elasticities on the size of the marriage market for both men and women suggest that there may be some delay in marriage in larger cities. To check for this possibility, column (4) runs the same log marriage odds ratio regression for men in the 34–38 age group (that is, 10 years older to the one in column [2]). The estimated elasticity, −0.181, is statistically different from zero at the 5% level. Similarly, the estimated elasticity on marriage market size for women in the 31–35 age group (column 8) is −0.020 and is not statistically different from zero. Although the standard error is reasonably small, here we cannot reject the hypothesis that $\alpha_f = 0.1$ at the 95% confidence interval. If $\alpha_f = 0.1$, a doubling of the number of eligible women in this age group will increase the marriage rate of these women by 2%. The point estimate for α_f suggests a much smaller increase, if any. Overall, the results in columns (4) and (8) suggest mild DRS and do not suggest any strong departure from CRS in long run male and female marriage rates.[22]

How can one interpret the finding that Chinese marriage markets seem to display mild DRS? One possibility is the problem for newly weds of finding an apartment or house where start their new families. In the 1980s, there was no housing market and the problem of finding a house for a new couple was particularly severe in large cities. So even though the number of eligibles and potential contacts in a large city was higher, the housing problem might have led young people in large cities delay their marriages, which in turn would explain the lower marriage rates in large cities in China.

United States, 2000. Also marriage markets in the United States do not display IRS (Table 8). Like for late medieval Tuscany, we cannot reject the hypothesis of CRS: the marriage rate in a given city does not seem to depend on the number of eligibles and potential contacts in that city. Given the larger number of cities (observations) and smaller standard errors compared to the ones for Tuscany, the coefficients on marriage market size for the United States are more precisely estimated.

[22] Restricted mobility in China until the 1980s means that the size of cities and their marriage markets can be taken as exogenous. However, to check for the possibility of endogenous migration to cities for marital purposes, we also ran IV population weighted regressions. The results are essentially the same. Thus, instrumenting the number of individuals by gender and age does not change the conclusion that there is minimal evidence of IRS in both short and long run marriage rates in China. A first approximation is that Chinese marriage markets are characterized by mild DRS. We have also run the equivalent unweighted regressions and the results do not change.

[TABLE 8 HERE]

We first focus on the marriage behavior of men in the 27–31 age group. Controlling for race, educational attainment, average income, and income dispersion, in column (2) the point estimate of the coefficient that measures the degree of returns to scale, α_m, is -0.028 with a standard error of 0.024. Hence, $\alpha_m = 0$ is in the confidence interval and we cannot reject CRS.

The negative sign of the coefficient on the variance of family income indicates that in cities with more income dispersion (and therefore, with a more dispersed quality of potential partners), men marry less, which is consistent with Gould and Paserman's observation that marriage is delayed when there is more heterogeneity in the marriage market.

Column (5) runs the same regression for women in the 25–29 age group, and the results are similar to the ones for men. Specifically, the point estimate of α_f is -0.010 with a standard error of 0.026, so that the hypothesis of CRS cannot be rejected at the 10% significance level. Also for women, the coefficient on the variance of family income is negative, which is consistent with the delay argument set forth by Gould and Paserman (2003).

For the United States there is the concern that singles move to cities to engage in marital search, and this may create a potential endogeneity problem. To deal with this problem, for each city we use the size of the cohort twenty years earlier as an instrument for the size of the same cohort in the year 2000. For example, when we analyze the marriage rate of 25–29 years old women in the 2000 census, we use the number of 5–9 years old women in the 1980 census in that city as an instrument for the number of 25–29 year old women in 2000. The assumption is that children (or their parents) do not choose the city in which to reside based on their marital prospects twenty years later. As indicated by the first stage IV regressions in Table A.1 in the Appendix, there is no problem of weak instruments (the coefficient on the size of the cohort 20 years earlier is close to 1).

Columns (3) and (6) in Table 8 show the second stage IV regressions for men and women, respectively. For men, the point estimate is -0.048 with a standard error of 0.028. The IV point estimate is slightly more negative than the OLS estimate.[23]

Both the OLS and IV estimates do not reject CRS. Given the standard errors, using a 95% confidence interval, the point estimate for α_m will not exceed 0.01, which means that even in the best case for IRS, the quantitative effect of the number of eligibles on the marriage rate is very modest. From Table 5, the mean marriage rate for men across cities is 0.485. Using the discussion of orders of magnitude in Section 2, a doubling of the population of a city will increase the marriage rate of men by less than half percent. Recall that there is substantial variation in marriage rates across cities (the standard deviation of marriage rates for men across cities is 0.063, which exceeds 10% of the mean marriage rate). The coefficients in columns (2) and (3) indicate that variation in the number of eligibles alone cannot explain the variation in male marriage rates across cities.

The findings for women (column 6) are similar to the ones for men. Both OLS and IV estimates of the returns to scale using male and female marriage odd ratios in Table

[23] As expected, the more negative IV estimate suggests that measurement error in the covariate is more important than having the number of individuals in both the right- and left-hand sides of the regression.

8 are consistent with each other: we cannot reject CRS when looking at marriage rates, that is, the variation in marriage market size alone in the United States cannot explain the variation in male and female marriage rates across cities.

Other factors seem more relevant in explaining the variation in the marriage rate. For example, the negative coefficient on the proportion of women with college education is consistent with Goldin and Katz (2002)'s argument that the diffusion of the pill increased the age of marriage and enabled women to invest in education and marry much later, without loosing out in the marriage market.

Two caveats are in order. First, if in large cities individuals are more likely to divorce, using the number of *currently married* individuals may undercount the number of marriages in large cities and explain the absence of IRS. To check for this possibility, we also ran log marriage odds ratio regressions using *ever married* individuals instead of currently married individuals. There is no evidence for IRS but rather there is evidence for DRS, that is, marriage rates fall in larger cities when looking at ever married individuals. A possible interpretation is that in larger cities, there may be less stigma from getting divorced and not remarrying.

Second, to check for the issue of delay, that is, for the possibility that in large cities with a large pool of eligibles and potential contacts, individuals may wait and delay marriage, we also consider marriage odds ratio regressions for currently married individuals in older age groups: men age 37–41 and women age 35–39. The results are similar to the ones for the younger individuals: there is no evidence of IRS. There is some slight evidence of DRS and in most regressions, we cannot reject CRS. However, unlike for young women, who seem to wait when there is more dispersion in the pool of eligibles (measured by the variance of incomes), older women do not delay their marriages when faced with a more dispersed pool of potential partners, which is consistent with the differential fecundity argument between men and women mentioned earlier.

To sum up the findings from the marriage odds ratio regressions, we can conclude that, unlike Angrist (2004) and Choo and Siow (2006a), these regressions tell a consistent story: CRS cannot be rejected as a first approximation in U.S. contemporary marriage markets.[24]

5 Returns to Scale in Total Gains to Marriage Regressions

To impose marriage market clearing conditions on our estimation, in Table 9 we estimate total gains to marriage regressions (3) at the city level for late medieval Tuscany, China in 1982, and the United States in 2000.

[TABLE 9 HERE]

The *dependent variable* is the log of the number of marriages among men and women in the two age groups divided by the geometric mean of the number of unmarried men and

[24] Note that Angrist (2004) and Choo and Siow (2006a) ask substantively different questions unrelated to the issues discussed here.

women in the two age groups. The *independent variable* is the log of the geometric mean of the numbers of individuals in the two age groups. The coefficient α_{mf} measures the degree of returns to scale in marriage markets ($\alpha_{mf} = 0$ means CRS, $\alpha_{mf} > 0$ IRS, and $\alpha_{mf} > 0$ DRS, respectively). For each of the three societies, the regressions also control for a set of covariates related to wealth, income, education, race, etc.

For late medieval Tuscany, both the OLS and IV estimates cannot reject the hypothesis that $\alpha_{mf} = 0$ (CRS) at standard confidence intervals. We also run unweighted total gains to marriage regressions and obtain similar results. Whatever specification we run, we cannot reject the hypothesis of CRS. However, because of the small number of observations and the relatively large standard errors, it is premature to reject modest IRS. For example on a few occasions, we cannot also reject the hypothesis that $\alpha_{mf} = 0.2$ at the 5% confidence interval. If $\alpha_{mf} = 0.2$, a doubling of the population will increase total gains to marriage by $0.2 * \ln 2 = 0.139$, which is 27% of the standard deviation of total gains to marriage across districts. These estimates are the largest returns to scale estimates in this paper.

For China, both the OLS and IV estimates cannot reject DRS at the 5% level: in larger cities there seem to be lower total gains to marriage for these marriages.

For the United States, both the OLS and IV estimates cannot reject CRS, similarly to what we found for late medieval Tuscany. Although the IV point estimates are slightly larger than the OLS estimates, both sets of estimates tell the same story. Moreover, the standard errors in all the regressions are small and similar. The largest point estimate on $\frac{1}{2}(\ln n_m + \ln n_f)$ from column (4) is 0.011. Given a standard error of 0.013, the upper bound of the 95% confidence interval for α_{mf} is 0.037. Doubling the population will increase total gains to marriage by $\alpha_{mf} \ln 2 = 0.025$. From Table 5, the standard deviation of total gains to marriage across cities is 0.277. Using the 95% confidence interval upper bound estimate and the discussion of orders of magnitude in Section 2, a doubling of the population explains less than 10% of a standard deviation in total gains to marriage. Under the most favorable interpretation, there is a very slight evidence in favor of IRS.

Notice that although the size of the marriage market seems largely not to affect total gains to marriage, other factors do influence total gains to marriage in a city. In both columns (2) and (4), as can be anticipated from the increment in R^2, the P-values that all the other variables are different from zero are smaller than 0.001.

The results are robust to different specifications. For example, to control for the issue of delay in marriage in large cities, we also estimate total gains to marriage regressions for older individuals. The findings are the same: we cannot reject CRS. We also estimate total gains to marriage regressions where each observation gets the same weight. The results are not qualitatively different from the weighted regressions.

To sum up, when imposing marriage market clearing conditions and estimating total gains to marriage regressions, the number of eligibles and potential contacts in the marriage market do not seem to have any effect on the total gains to marriage. The thick market externality does not show up even in total gains to marriage regressions.

6 Returns to Scale in Marital Match Quality Regressions

Tables 8 and 9 indicate that when looking at marriage rates and total gains to marriage, CRS is a reasonable assumption for marriage markets in the United States.

However, a thick market externality may still exist in these marriage markets, in the sense that individuals in larger markets have faster arrival of potential matches and/or a more dispersed match value distribution to draw from. As is well known from the sequential search literature (e.g., Mortensen 1988), both these effects may lead to delayed marriages in larger markets, thus lowering observed marriage rates and marriage gains. Addressing this issue is similar to what has been done in the labor markets literature. For example, Petrongolo and Pissarides (2005) estimate a structural model of search and unemployment with scale effects. They show that the unemployment hazard is unaffected by scale effects. Scale effects lead to higher reservation wages and higher post-employment wages. This means that scale effects may show up in the quality of the match rather than in a higher matching rate.

Finding good measures of marital match quality is challenging. We do not use the divorce rate or marital tenure to proxy for marital match quality because married individuals in larger cities may also choose to break up more, rematch more, and still have higher average welfare.

Alternatively, one can reasonably argue that a major reason why individuals marry is to have children. Therefore, using the number of children and their "quality" (proxied by education) can be reasonable proxies for the quality of the marital match. More precisely, we use (i) the proportion of children age 1–6, who live with two parents in a city, and (ii) the educational attainment of 16-year old children of married parents.

Table 10 presents population weighted regressions of the ln(proportion of children 1–6 who live with two parents in a given city) on ln(population in a given city) and covariates.

[TABLE 10 HERE]

Controlling in column (3) for the proportions of black and white men and women in the 27–31 and 25–29 age groups, respectively, for the proportions of those individuals with college degree, and adding regional dummies, the estimated coefficient on city size is negative, -0.015, at the 5% significance level, which is consistent with the negative slope for the largest cities when plotting log(proportion of children age 1–6 who live with two parents) against log(population) in that city.

Weighting the observations by population size gives increasing weight to larger cities, and therefore, this negative slope is driven by very few observations. When we rerun the regressions treating all observations equally, the estimated coefficients on log population are not significantly different from zero at the 5% significance level in all specifications. Hence, delay in marriage does not seem to increase average marital match quality as proxied by the proportion of children age 1–6, who live with two parents. If anything, there is some evidence that the largest cities reduce marital match quality.

A possible objection to using the proportions of children age 1–6 living with two parents as a proxy for average marital match quality is another endogeneity problem: if married individuals leave a city (for example, when they have children, they decide to move to the suburbs), then cities may be left with unmarried individuals who are still hoping to marry. If there are IRS, larger cities with their higher *actual* marriage rates, may not have higher *observed* marriage rates if married individuals leave the cities at a higher rate than unmarried individuals. Since we use the metropolitan definition of a city (SMSA), which includes the nearby suburbs, this endogeneity problem of leaving the city after marriage should not be a first order problem for the regressions in Table 10.

The second proxy for the quality of marital match is the educational attainment of 16-year old children of married parents in a given city. Age 16 is chosen because most of these children are still living with their parents and a non-trivial proportion of them is behind their birth cohort in terms of attained years of schooling. This proxy does not suffer of the endogeneity problem described above: by looking at the educational attainment of 16-year old children, we are basically comparing the average marital match quality of couples in small cities, who did not leave the city after marriage, with the average marital match quality of couples in large cities, who did not leave the city after marriage. Table 11 presents the results of two regressions.

[TABLE 11 HERE]

In column (1), the number of years of education of 16-year old children with married parents in a city is regressed on the log population of that city, father's age, mother's age, father's years of schooling, mother's years of schooling, and dummy variables for father's and mother's races. The point estimate indicates that, controlling for parents' education, a 1% increase in the population size of a city decreases the years of schooling of a 16-year old by 0.004 years. However, the standard error, which is clustered by city, shows that the point estimate is not statistically different from zero at the 10% significance level.

Column (2) reports the results of a linear probability model where the dependent variable is equal to 1 if the 16 year-old child of a couple attained the median years of education of 16-year old children in his or her state, and 0 otherwise. The estimated coefficient on log population is 0.012 but again the standard error, which is clustered by city, indicates that the point estimate is not statistically different from zero at the 10% significance level.

The two regressions lead to similar conclusions. Marital match output, as proxied by the educational attainment of 16-year old children, does not rise with city size. Also, regardless of which proxy for marital match quality is used, this evidence on marital output is unlikely to be affected by the out-migration of married couples from the city.

Interestingly, the estimated coefficients on the interaction between the parents' years of schooling are positive and significantly different from zero at the 5% level. So there is evidence of gains in marital match quality, as proxied by educational attainment of the children, by matching by education of the parents.

7 Concluding Remarks

The empirical results on marriage rates and total gains to marriage from our three data sets and different empirical methods are consistent with each other. Given the widely different circumstances of the three societies in terms of geography, time periods, social norms governing the marriage markets, population size, and sex ratios, the similar estimates for returns to scale parameters for the three societies are remarkable.

CRS is a reasonable approximation for late medieval Tuscan and U.S. marriage markets. Using a 95% confidence interval upper bound estimate for the degree of returns to scale parameters, there is mild evidence for IRS in some specifications. However, even in the most favorable cases, the quantitative effect of the number of eligibles on marriage rates or marriage gains is very small. Also, there is more evidence in favor of DRS in Chinese marriage markets.

For the U.S. marriage markets, we also investigated whether the thick market externality may show up in the average quality of the marital match, proxied by either the proportion of children in the 1–6 age group, who live with two parents, and the educational attainment of 16 year-old children living with two parents. There is no evidence of IRS even when looking at marital output instead of the marriage rate.

These findings suggest that a matching function with CRS seems best suitable to describe search in matching models of the marriage market. One rationale for assuming CRS is that, given individual characteristics, marriage within a narrow age window is a compelling experience for most individuals. This customary narrow age window of marriage adjusts due to income inequality (as also found by Gould and Paserman), educational attainment, and other factors. Exogenous population variation does not seem to be one of these factors.

TABLE 1

Sex Ratios, Tuscany 1427

	City	Rural
Florence	117.6	108.9
Pisa	112.3	106.9
Pistoia	102.7	112.7
Arezzo	108.1	106.2
Prato	105.7	115.5
Volterra	108.3	118.3
Cortona	97.3	108.9
Montepulciano	110.7	—
Colle	117.8	—
San Gimignano	113.3	121.5
Castiglione Fiorentino	104.2	114.1
Pescia	112.5	104.7

Source: Data from David Herlihy and Christiane Klapisch-Zuber, Les Toscans, p. 472.
The sex ratio is equal to $\frac{\text{number of men}}{\text{number of women}}$x100. "Rural" refers to the many rural villages surrounding the given town.

TABLE 2

Marriage Patterns, Tuscany 1427

	Mean	Standard deviation	Number of observations
Male marriage rate (men age 22–32)	0.518	—	22179
Male marriage rate (men age 30–39)	0.749	—	15427
Female marriage rate (age 18–27)	0.838	—	18961
Female marriage rate (age 25–34)	0.926	—	16135
Assets per household[a, b]	263.9	1534.0	61328
Assets per adult individual[c]	119.1	627.5	58225

Source: 1427 Florentine Catasto.
[a] Assets per household refer to the household's total wealth (in gold florins) as given in the 1427 Florentine census. This was equal to the present discounted value (at 7 percent interest rate) of the income from houses, land holdings, commercial partnerships, plus loans to private individuals and shares of the public debt, minus household's total debt.
[b] For men, household wealth refers to either their own wealth (if their parents were no longer alive), or to the wealth of the natal household in which they kept living even after marriage. In contrast, as brides moved into their grooms' households upon marriage, in the 1427 census their wealth is identified with the wealth of their husbands' households. Given the high degree of positive assortative matching in marriage, using the husband's wealth instead of the natal household's wealth for married women is not a major concern.
[c] Assets per adult individual = $\frac{\text{household's total wealth}}{\text{number of adult individuals in the household}}$ where an adult individual is one who is 19 or older.

TABLE 3

Marriages by Type of Match, Medieval Tuscany

	Years		
	1260–1299	1340–1360	1420–1435
Urban groom – urban bride	17.9	31.7	44.7
Rural groom – rural bride	74.1	61.0	49.7
Urban groom – rural bride	5.7	2.7	3.6
Rural groom – urban bride	2.3	4.7	0.1
Number of marriage contracts	475	2955	3721

Source: State Archives of Florence, Notarile Antecosimiano, 794 volumes of notarial deeds.
Note: The numbers are the percentages of marriages by type of match.

TABLE 4

Marriage Patterns, China 1982

	Mean	Number of observations
Proportion of married men (age 24–28)	0.582	87696
Proportion of married men (age 29–33)	0.903	66938
Proportion of married women (age 21–25)	0.456	72143
Proportion of married women (age 26–30)	0.965	75382
Proportion of men who completed primary school	0.968	154634
Proportion of women who completed primary school	0.917	147525
Number of cities		245

Source: 1982 Census of China (1% random sample of the population).

TABLE 5

MARRIAGE PATTERNS, UNITED STATES 2000

	Mean	Standard deviation	Observations (no. of cities)
City population	810787.1	1278090	248
	Men (age 27–31), women (age 25–29)		
Male marriage rate	0.484	0.063	248
Female marriage rate	0.507	0.069	248
Log male marriage odds ratio	0.061	0.258	248
Log female marriage odds ratio	0.032	0.283	248
Total gains to marriage	–0.567	0.277	248
	Men (age 27–31)		
Married men	13501.24	20702.69	248
Total number of men	29899.75	50690.39	248
Fraction of white non-Hispanic men	0.695	0.169	248
Fraction of black non-Hispanic men	0.110	0.094	247
Fraction of Hispanic men	0.137	0.156	245
Fraction of men with college education	0.250	0.092	248
Mean family income of married men	10703	0.175	248
Variance, family income of married men	0.923	0.556	248
	Women (age 25–29)		
Married women	13272.79	20430.38	248
Total number of women	28417.72	48995.97	248
Fraction of white non-Hispanic women	0.686	0.176	248
Fraction of black non-Hispanic women	0.125	0.113	241
Fraction of Hispanic women	0.130	0.157	245
Fraction of women with college education	0.282	0.097	248
Mean family income of married women	10682	0.168	248
Variance, family income of married women	0.971	0.602	248

Source: U.S. 2000 Census (5% random sample of the population).
College education means a B.A., Master, or PhD degree.

TABLE 6

Marriage Odds Ratio Regressions, Tuscany 1427

	Dependent Variable = $\ln \frac{\mu}{n-\mu}$			
	Men 22–32	Men 22–32	Men 22–32	Men 22–32
	OLS (1)	OLS (2)	OLS (3)	OLS (4)
ln(men 22–32)	–0.035	–0.037	0.007	–0.015
	(0.153)	(0.056)	(0.141)	(0.061)
ln(assets per adult)		–0.353		–0.353
		(0.089)		(0.090)
Instrument			ln(population)	ln(population)
R-squared	0.00	0.55	—	—
Number of districts	29	29	29	29
	Women 18–27	Women 18–27	Women 18–27	Women 18–27
	OLS (5)	OLS (6)	IV (7)	IV (8)
ln(women 18–27)	–0.038	–0.023	0.024	0.030
	(0.107)	(0.120)	(0.118)	(0.132)
ln(assets per adult)		0.102		0.102
		(0.183)		(0.189)
Instrument			ln(population)	ln(population)
R-squared	0.00	0.02	—	—
Number of districts	29	29	29	29

Source: 1427 Florentine Catasto.

Note: regressions weighted by district population with robust standard errors in parentheses.

μ = number of currently married individuals. n = total number of inviduals.

Men 22–32 = number of men in the 22–32 age group.

Women 18–27 = number of women in the 18–27 age group.

ln (assets) = log (household's total wealth). See Table 2's footnote for the definition of total wealth.

ln (assets per adult) = log ($\frac{\text{household's total wealth}}{\text{number of adult individuals in the household}}$).

TABLE 7

Marriage Odds Ratio Regressions (OLS), China 1982

	Dependent Variable = $\ln \frac{\mu}{n-\mu}$			
	Men 24–28	Men 24–28	Men 34–38	Men 34–38
	(1)	(2)	(3)	(4)
ln (men 24–28)	–0.226	–0.165		
	(0.092)	(0.057)		
ln (men 34–38)			–0.103	–0.181
			(0.060)	(0.059)
P_m > primary education		–0.115		0.205
		(0.106)		(0.112)
R-squared	0.160	0.184	0.028	0.087
Number of cities	243	243	217	217
	Women 21–25	Women 21–25	Women 31–35	Women 31–35
	(5)	(6)	(7)	(8)
ln (women 21–25)	–0.351	–0.170		
	(0.067)	(0.041)		
ln (women 31–35)			–0.243	–0.020
			(0.099)	(0.066)
P_f > primary education		–0.320		–0.474
		(0.046)		(0.065)
R-squared	0.378	0.600	0.108	0.423
Number of cities	243	240	203	203

Source: 1982 Census of China (1% random sample of the population).
Note: regressions weighted by city population with robust standard errors in parentheses.
ln (men 24–28) = log (number of men in the 24–28 age group).
ln (men 34–38) = log (number of men in the 34–38 age group).
ln (women 21–25) = log (number of women in the 21–25 age group).
ln (women 31–35) = log (number of women in the 31–35 age group).
P_m = log odds ratio of men age 24–28 (in column 2) and age 34–38 (in column 4), who have completed primary education in a given city.
P_f = log odds ratio of women age 21–25 (in column 6) and age 31–35 (in column 8), who have completed primary education in a given city.

TABLE 8—Marriage Odds Ratio Regressions, United States 2000

	Dependent Variable $= \ln \frac{\mu}{n-\mu}$					
	Men 27–31	Men 27–31	Men 27–31	Women 25–29	Women 25–29	Women 25–29
	OLS	OLS	IV	OLS	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
ln(men 27–31)	–0.133	–0.028	–0.048			
	(0.021)	(0.024)	(0.028)			
$\frac{\text{White men (27–31)}}{\text{Men (27–31)}}$		0.511	0.472			
		(0.189)	(0.198)			
$\frac{\text{Black men (27–31)}}{\text{Men (27–31)}}$		0.079	0.100			
		(0.216)	(0.220)			
$\frac{\text{Men (27–31), college}}{\text{Men (27–31)}}$		–2.071	–1.990			
		(0.338)	(0.359)			
Mean family income		–0.127	–0.113			
		(0.114)	(0.112)			
Variance family income		–0.062	–0.062			
		(0.027)	(0.027)			
ln(women 25–29)				–0.166	–0.010	–0.021
				(0.030)	(0.026)	(0.030)
$\frac{\text{White women (25–29)}}{\text{Women (25–29)}}$					0.671	0.618
					(0.129)	(0.139)
$\frac{\text{Black women (25–29)}}{\text{Women (25–29)}}$					–0.514	–0.481
					(0.206)	(0.209)
$\frac{\text{Women (25–29), college}}{\text{Women (25–29)}}$					–2.166	–2.129
					(0.298)	(0.310)
Mean family income					–0.622	–0.533
					(0.171)	(0.173)
Variance family income					–0.123	–0.111
					(0.032)	(0.031)
Instruments			$\ln(\text{men}^{1980}_{7-11})$			$\ln(\text{women}^{1980}_{5-9})$
R-squared	0.19	0.53	—	0.53	0.66	—
Number of cities	248	247	247	248	241	241

Note: Regressions weighted by city population with robust standard errors in parentheses.
$\mu =$ number of currently married individuals. $n =$ total number of inviduals.
Men 27–31 = number of men age 27–31. Women 25–29 = number of women age 25–29.
Men (27–31), college = number of men age 27–31 with college degree. Women (25–29), college = number of women age 25–29 with college degree. College education = B.A., Master, or PhD degree. Men^{1980}_{7-11} = number of men who were 7–11 years old in 1980. $\text{Women}^{1980}_{5-9}$ = number of women who were 5–9 in 1980.

TABLE 9

TOTAL GAINS TO MARRIAGE REGRESSIONS

	Dependent Variable = π_{mf} $= \ln \mu_{mf} - \frac{1}{2}\left(\ln \ \mu_{m0} + \ln \ \mu_{f0}\right)$			
	OLS	OLS	IV	IV
	(1)	(2)	(3)	(4)
	Tuscany, 1427			
$\frac{1}{2}\left(\ln \ n_m + \ln \ n_f\right)$	–0.012	–0.027	0.021	0.009
	(0.131)	(0.092)	(0.132)	(0.100)
R-squared	0.00	0.13	—	—
Number of districts	29	29	29	29
	China, 1982			
$\frac{1}{2}\left(\ln \ n_m + \ln \ n_f\right)$	–0.270	-0.143	–0.139	–0.127
	(0.080)	(0.045)	(0.033)	(0.032)
R-squared	0.300	0.429	—	—
Number of cities	243	240	243	240
	United States, 2000			
$\frac{1}{2}\left(\ln \ n_m + \ln \ n_f\right)$	–0.047	0.010	–0.045	0.011
	(0.010)	(0.011)	(0.011)	(0.013)
R-squared	0.126	0.539	—	—
Number of cities	248	241	248	241
Other covariates	No	Yes	No	Yes

Sources: For Tuscany, 1427 Florentine Catasto. For China: 1982 Census (1% random sample of the population). For the United States: 2000 Census (5% random sample of the population).

Note: regressions weighted by district/city population with robust standard errors in parentheses. μ_{mf} = number of marriages between men and women in a given age group, μ_{m0} = number of unmarried men in a given age group, μ_{f0} = number of unmarried women in a given age group, n_m = total number of men in a given age group, n_f = total number of women in a given age group. For Tuscany: men in the 22–32 and women in the 18-27 age groups. For China: men in the 24–28 and women in the 21–25 age groups. For the United States: men in the 27–31 and women in the 25–29 age groups.

Columns (2) and (4) control for the following covariates: for Tuscany log (household's total wealth per adult individual). For China, the log odds ratio of men and women in the relevant age groups, who have completed primary education in a given city. For the United States: mean family income, variance of family income, the percentage of men and women who have college education, the percentage of white and black men and women in the relevant age groups

In Columns (3) and (4) the instruments for the size of the district/city are as follows: for Tuscany and China, the log (total population in a given district/city). For the United States: the number of men who were 7–11 years old in 1980, and the number of women who were 5–9 in 1980.

TABLE 10–Marital Output Regressions, United States 2000

	Dependent Variable = $\ln\left(\frac{\text{No. of children (age 1-6) living with two parents}}{\text{No of children (age 1-6)}}\right)$		
	(1)	(2)	(3)
ln(city population)	–0.016	–0.015	–0.015
	(0.010)	(0.009)	(0.006)
Race and education controls	No	Yes	Yes
Region dummies	No	No	Yes
R-squared	0.04	0.45	0.55
Number of cities	248	241	241

Source: U.S. 2000 Census (5% random sample of the population).
Note: robust standard errors in parentheses.

TABLE 11—Marital Output Regressions, United States 2000

	Dependent Variable	
	Years of education of 16-year old children of married couples	Dummy = 1 if 16-year old children attained median education by state
	(1)	(2)
ln(city population)	–0.004	0.012
	(0.014)	(0.016)
Boy dummy	–0.144	–0.053
	(0.011)	(0.005)
Father's age	0.002	0.000
	(0.002)	(0.001)
Mother's age	0.010	0.002
	(0.002)	(0.001)
Father's education	0.018	0.006
	(0.007)	(0.003)
Mother's education	0.021	0.006
	(0.008)	(0.002)
F x M education	0.119	0.042
	(0.047)	(0.020)
Race dummies	yes	yes
Observations	81772	82021

Source: U.S. 2000 Census (5% random sample of the population).
Note: standard errors clustered by city in parentheses.
Median education refers to the median years of education of 16-year old children in the state where the city is located.
Father (mother)'s education = father (mother)'s years of schooling.
F x M education = $\frac{\text{father's years of schooling x mother's years of schooling}}{100}$.
Race dummies are eight dummy variables that control for the race of the married couple. The left out category is (father white, mother white).

TABLE A.1

MARRIAGE REGRESSIONS (1ST STAGE IV), UNITED STATES 2000

	DEPENDENT VARIABLE	
	ln (men 27–31)	ln (women 25–29)
	(1)	(2)
ln $(\text{men}^{1980}_{7-11})$	0.930	
	(0.041)	
$\frac{\text{White men (27–31)}}{\text{Men (27–31)}}$	–1.056	
	(0.233)	
$\frac{\text{Black men (27–31)}}{\text{Men (27–31)}}$	–0.621	
	(0.352)	
$\frac{\text{Men (27–31), college}}{\text{Men (27–31)}}$	1.204	
	(0.486)	
Mean family income, married men 27–31	0.218	
	(0.350)	
Variance family income, married men 27–31	–0.139	
	(0.087)	
ln $(\text{women}^{1980}_{5-9})$		0.968
		(0.037)
$\frac{\text{White women (25–29)}}{\text{Women (25–29)}}$		–0.806
		(0.286)
$\frac{\text{Black women (25–29)}}{\text{Women (25–29)}}$		–0.390
		(0.320)
$\frac{\text{Women (25–29), college}}{\text{Women (25–29)}}$		0.945
		(0.454)
Mean family income, married women 25–29		0.134
		(0.292)
Variance family income, married women 25–29		–0.066
		(0.093)
R-squared	0.90	0.91
Number of cities	247	241

Source: U.S. 2000 census.
Note: regressions weighted by city population with robust standard errors in parentheses.
ln (men 27–31) = log (number of men in the 27–31 age group).
ln (women 25–29) = log (number of women in the 25–29 age group).
ln $(\text{men}^{1980}_{7-11})$ = log (number of men who were 7–11 years old in 1980).
ln $(\text{women}^{1980}_{5-9})$ = log (number of women who were 5–9 years old in 1980).
College education = B.A., Master, or PhD degree.

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