Preliminary

Marriage Matching, Risk Sharing and Spousal Labor Supplies

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Abstract

The paper integrates marriage matching with the collective model of spousal labor supplies with public goods and full spousal risk sharing. This collective model of marriage matching generalizes Becker's transferable utilities model of the marriage market. The paper derives testable implications of how changes in marriage market conditions affect spousal labor supplies. In contrast to the sex ratio which is a partial measure, the model motivates a sufficient statistic for marriage market tightness for each marriage match. The empirical section of the paper tests for marriage market effects on spousal labor supplies using data from the 2000 US census. Changes in marriage market tightness often have large estimated effects on spousal labor supplies that is consistent with the theory. The magnitudes of the responses differ by race and gender.

1 Introduction

Thirty years ago, Becker (1973; 1974; summarized in his 1991 book) introduced his landmark transferable utilities model of the marriage market. A cornerstone of that model is that resource transfers between spouses are used to clear the marriage market. This model is important for two reasons. First, it recognizes that spouses may have divergent interests. Second, it proposes that the marriage market is a class of general equilibrium models.[1]

The subsequent literature developed in three directions. First, researchers have found empirical evidence that is supportive of Becker's assumption of divergent interests within the family. More specifically with respect to the marriage market, researchers have found that a higher sex ratio (ratio of men to women) will result in more resource transfers from husbands to wives.[2] Second, Chiappori and his collaborators have developed a framework, the "collective model", for estimating household members' preferences when members have divergent interests. A key feature of this framework is that it assumes efficient intrahousehold allocations. The intrahousehold allocation is what a social planner will choose if the planner's objective function is the weighted sum of household members' utilities where the weights reflect the bargaining power of each member. Researchers have also found empirical support for this model. Third, building on earlier research, Choo Siow (2006; hereafter CS) have developed an empirically tractable transferable utilities marriage matching model, where the marginal utility of income is assumed to be constant.

Building on the above three strands of literature, this paper has does three things. First, we build a collective model of marriage matching, by embedding the collective model within the marriage market. Our collective model of the household builds on the collective model of spousal labor supplies with public goods by Blundell, Chiappori and Meghir (2006; hereafter BCM). We add to that model efficient spousal risk sharing.

In the marriage market, individuals choose who to marry or to remain unmarried. The utility weights of husbands relative to their wives in the collective model are used to clear the marriage market. We show the existence of marriage market equilibrium. The transferable utilities marriage market model, e.g. Becker and CS, is a special case of our collective model of marriage matching.

Second, the model motivates a new empirical strategy for estimating the effects of changing marriage market conditions on spousal labor supplies. Consider $\{i, j\}$ marriages where type i men marry type j women. We have a data set with G^r type j wives from R different societies. A standard strategy is to regress female G's labor supply, H^r_{jG}, on the sex ratio, m^r_i/f^r_j, where m^r_i and

[1] The equivalence between transferable utilities models of the marriage market and Walrasian models are studied by Ostroy, Zame...

[2] E.g. Angrist 2002; Chiappori, Fortin, and Lacroix 2002; Francis 2005; Grossbard-Schechtman 1993; Seitz 2005, South and Trent.

f_j^r are the number of type i males and type j females in society r respectively:

$$\ln H_{jG}^r = \alpha_0 + \alpha_1 \ln \frac{m_i^r}{f_j^r} + u_{jG}^r,\ G = 1,.,G^r;\ r = 1,..,R \tag{1}$$

u_{jG}^r is the error term of the regression.

α_1 measures the elasticity of female labor supplies with respect to the sex ratio.

The main difficulty with the above empirical specification is that substitution effects are ignored. If the numbers of other types of men and women change, there is no way to predict their effect on mean $\ln H_{jG}^r$. The quantitative significance of substitution effects on marital matching have been well established (E.g. Angrist; Brandt, Siow and Vogel 2007, ...). Also, Angrist showed that the sex ratios of substitutes, i.e. $\{i', j\}$ sex ratios, also affect the labor supplies of type j women. The problems with adding the sex ratio of substitutes are two fold. First, it is not clear to the researcher who are better substitute spouses. Second, many of the own and "obvious" substitute sex ratios (such as adjacent ages) are highly collinear and therefore it is difficult to estimate each effect separately. So for empirical tractability, researchers have primarily restricted their empirical specifications to own sex ratios as in (1). But since spousal substitutes are quantitatively important, we like to find an empirical proxy for overall market conditions for each marital match.

We show that Seitz's (2005) measure of marriage market tightness in society r, $T_{ij}^r = \ln \mu_{i0}^r - \ln \mu_{0j}^r$, the log ratio of unmarried type i men to unmarried type j women, is a summary statistic for market conditions for $\{i, j\}$ couples in society r.[3] An increase in T_{ij}^r increases the bargaining power of wives in $\{i, j\}$ marriages in society r. Substitution effects in the marriage market are embedded in T_{ij}^r. Holding the sex ratio $\ln m_i^r / f_j^r$ constant, a change in the number of substitutes, $m_{i'}^r$ and or $f_{j'}^r$ will affect the number of unmarried $i's$ and $j's$ and thus T_{ij}^r.

Market tightness, T_{ij}^r, is an endogenous variable. It can be affected by changes in sex ratios, labor market conditions across societies. We will control for changes in sex ratios and labor market conditions directly in our estimating strategy.[4] Thus we will investigate the empirical regression model for type j wives in $\{i, j\}$ marriages:

$$\ln H_{ijG}^r = \beta_{ij} T_{ijGk}^r + z_{ij}^{r\prime} \beta_1 + v_{ijG}^r,\ G = 1,.,G^r;\ r = 1,..,R \tag{2}$$

H_{ijG}^r is the labor supply of wife G in an $\{i, j\}$ marriage in society r. $H_{ijG}^r \subset H_{jG}^r$.

v_{ijG}^r is the error term of the regression.

[3] This measure is similar to the Beveridge curve measure of labor market tightness: ratio of the number of vacancies to number of unemployed.

[4] If the demand for female labor is relatively low in society r, the sex ratio may respond and be high; thereby be negatively correlated with u_{ij}^{rk}. In this case, the OLS estimate of α_1 will not be consistent. This point is well known and labor economists often include wages and non-wage income as additional covariates.

z^r_{ij} is a vector of covariates which includes proxies for labor market conditions for type i and type j individuals, and other factors which may affect the marital output of $\{i, j\}$ marriages.

A theoretical objective of this paper is to motivate (2). The theory will also show that $\beta_{ij} < 0$. That is, when market tightness increases, and the bargaining power of wives in $\{i, j\}$ marriages increases, their labor supplies fall. Our theory will also suggest that (2) should be estimated using sex ratios as instruments.

The final objective of this paper is to estimate (2) with the 5% United States 2000 census where r is a state. Thus we will have 50 different societies.

A summary of the empirical results are as follows. After controlling for labor market conditions, state effects, individual characteristics, marriage market tightness is negatively (positively) correlated with wives' (husbands') labor supplies. Different dimension of labor supply, the labor force participation rate, usual hours of work per week and weeks worked per year, are affected. The magnitudes of the responses differ by race and gender. Often, the responses are quantitatively large. A one standard deviation increase in marriage market tightness often lead to more than a one quarter standard deviation decrease in wives' labor supplies in all dimensions. Husbands' responses are smaller and their responses are primarily in hours of work per week and secondarily in participation. Non-white spousal responses are larger than white spousal responses. Thus changes in marriage market tightness have quantitatively significant effects on intrahousehold reallocations in the direction predicted by our theory.

We also agument the results on spousal labor supplies with other measures of leisure consumption using time use data from the ATUS (?). The estimates using leisure consumption are consistent with the labor supplies results but they are less precisely estimated because we have much less observations.

The methodological objective of this paper is to provide a unified framework for interpreting reduced form estimates of marriage market conditions on spousal labor supplies. We do not establish identification of the structural parameters of our collective marriage matching model nor do we estimate any structural parameters. Our companion paper, CSSa, studies identification of our collective marriage matching model.

Often, empirical applications of the static collective model of spousal labor supplies ignore spousal risk sharing and public goods. We do not take a stand on how important these two concerns are. As will be discussed below, our reduced form results do not shed light on whethere is full spousal risk sharing in marriage or not. Rather we include risk sharing in our model to show that the reduced form implications that we test in this paper are robust to spousal risk sharing or otherwise. Similarly, we include public goods to show that our results are also robust to the extent of public goods in marriage. Thus we do not restrict our analysis to childless couples as usually done in the empirical static collective model literature. This difference is due primarily to the fact that we are estimating a reduced form relationship rather than the structural parameters that the empirical static collective model literature usually do. In CSSa, we will take a stand on these issues when we also estimate structural parameters.

Because our work is related to a large literature, it is convenient to postpone discussion of the literature until the end of the paper.

2 The model

Consider a society in which there are I types of men, $i = 1, .., I$, and J types of women, $j = 1, .., J$. All type i men have the same preferences and ex-ante opportunities; and all type j women also have the same preferences and ex-ante opportunities. That is, the type of an individual is defined by his or her preferences and ex-ante opportunities.

Let m_i be the number of type i men and f_j be the number of type j women. M and F are the vectors of the numbers of each type of men and women respectively.

The model is a two period model. In the first period, individuals choose whether to marry and who to marry if they marry. An $\{i, j\}$ marriage is a marriage between a type i man and a type j woman. At the time of their marital choices, wages and non-labor income for each marital choice are random variables.

After their marital choices, and in the second period, intrahousehold allocations are chosen after wages and non-labor income for each household are realized. We consider a static model of private and public consumption, and labor supply choices. The rationale for including public good consumption within marriage is to capture resources allocated to children, if any, in the marriage.[5]

For expositional simplicity, all individuals have positive hours of work. As will become clear in the development, it is straightforward to extend the model to allow other kinds of marriages such as ones where the wife does not work, or cohabitation rather than marriage.[6]

Let C_{ijgG} be the own consumption of wife G of type j matched to a type i husband g. K_{ijgG} is the amount of public good each of them consumes. H_{ijgG} is her labor supply.We normalize the total amount of time for each individual to 1. Her utility function is:

$$U_{ij}(C_{ijgG}, 1 - H_{ijgG}, K_{ijgG}, \varepsilon_{ijG}) = \widehat{Q}_{ij}(C_{ijgG}, 1 - H_{ijgG}, K_{ijgG}) + \Gamma_{ij} + \varepsilon_{ijG} \tag{3}$$

$\widehat{Q}_{ij}(.)$, her felicity function, depend on i, j which allows for differences in home production technologies across different marital matches. We will impose restrictions on $\widehat{Q}_{ij}(.)$ later. The invariant gain to an $\{i, j\}$ marriage for the woman, Γ_{ij}, shifts her utility according to the type of marriage and allows the model to fit the observed marriage matching patterns in the data. It may vary across different types of marriages within a society.[7] The important restriction is that Γ_{ij} does not affect her marginal utilities from consumption or labor supply.

[5] We will not formally model children in this paper.

[6] Choo and Siow 2006a extends CS to include cohabitation.

[7] In the empirical work, we allow $\widehat{Q}_{ij}(.)$ and Γ_{ij} to differ across societies as well.

Finally, we assume ε_{ijG} is a random variable that is realized before marital decisions are made. ε_{ijG} is independent of C_{ijgG}, H_{ijgG}, K_{ijgG} and also g. That is, it does not depend on the specific identity of the type i male. The independent realizations of this random variable across different women of type j in the same society will produce different marital choices for different type j women in period one. If a woman chooses not to marry, then $i = 0$.

The specification of a representative man's problem is similar to that of women. Let c_{ijgG} be the own consumption of man g of type i matched to a type j woman G. K_{ijgG} is his public good consumption. Denote his labor supply by h_{ijgG}. If he chooses not to marry, then $j = 0$. The utility function for males is described by:

$$u_{ij}(c_{ijgG}, 1 - h_{ijgG}, K_{ijgG}, \varepsilon_{ijg}) = \widehat{q}_{ij}(c_{ijgG}, 1 - h_{ijgG}, K_{ijgG}) + \gamma_{ij} + \varepsilon_{ijg}, \quad (4)$$

$\widehat{q}_{ij}(.)$, his felicity function, depends on i, j will allow the model to fit observed labor supply behavior for different types of marriages. We will impose restrictions on $\widehat{q}_{ij}(.)$ later. The invariant gain to an i, j marriage for the man, γ_{ij}, shifts his utility by i, j and allows the model to fit the observed marriage matching patterns in the data. It may vary across different types of marriages. The important restriction is that γ_{ij} does not affect his marginal utilities from consumption and labor supply.

Finally, we assume ε_{ijg} is a random variable that is realized before marital decisions are made. ε_{ijg} is independent of c_{ijgG}, h_{ijgG}, K_{ijgG} and G. The independent realizations of this random variable across different men of type i in the same society will produce different marital choices for different type i men in period one.

2.1 The collective model with efficient risk sharing

The objective of this section is to derive two results, both of which are relevant to the empirical work. First, we will show how efficient risk sharing affects the expected felicities of the spouses as bargaining power within the household changes. Second, we will impose restrictions such that the wife will on average work more and the husband will on average work less as the bargaining power of the husband increases.

We start first with intrahousehold allocation after the marriage decision has been made. Consider a particular husband g and his wife G in an $\{i, j\}$ marriage. Total non-labor family income is A_{ijgG} which is a random variable. The wage for the wife is also a random variable W_{ijgG} . The male's wage is another random variable w_{ijgG}. A_{ijgG}, W_{ijgG} and w_{ijgG} are realized in the second period, after the marriage decision.

The family budget constraint is:

$$c_{ijgG} + C_{ijgG} + K_{ijgG} \leq A_{ijgG} + W_{ijgG}H_{ijgG} + w_{ijgG}h_{ijgG} \quad (5)$$

Because wages and non-labor income, W_{ijgG}, w_{ijgG}, and A_{ijgG}, are random variables whose values are realized after marriage. In the second period, the spouses can share income risk in the first period.

The continuous joint distribution of A_{ijgG}, W_{ijgG} and w_{ijgG} with bounded support is characterized by the parameter vector Z. Z is known to individuals before their marriage decisions. Let $S_{ijgG} = \{W_{ijgG}, w_{ijgG}, A_{ijgG}\}$. Let $F(S_{ijgG}|Z)$ denote the cumulative multivariate wages and non-labor income distribution in the society.

Let $\mathbf{E}$ be the expectations operator. Following the collective model with full risk sharing, we pose the efficient risk sharing spousal arrangement as a planner solving the following problem:

$$\max_{\{C,c,H,h\}} \mathbf{E}(\widehat{Q}(C_{ijgG}, 1-H_{ijgG}, K_{ijgG})|Z) + p_{ij}\mathbf{E}(\widehat{q}(c_{ijgG}, 1-h_{ijgG}, K_{ijgG})|Z) \tag{P1}$$

subject to (5) for all S_{ijgG}

Problem (P1) is BCM with efficient risk sharing. In problem (P1), the planner chooses family consumption and labor supplies to maximize the weighted sum of the wife's and the husband's expected felicities subject to their family budget constraint. $p_{ij} \in R^+$ is the weight allocated to the husband's expected felicity. If $p_{ij} > 1$, the husband has more weight than the wife and vice versa. As in the collective model literature, p_{ij} depends on Z, marriage market conditions, and other factors affecting the gains to marriage in which the individuals live. Call p_{ij} the husband's power.

How the husband's power is determined in the marriage market is a central focus of this paper. However the determination of p_{ij} is not a concern of the social planner in solving in problem (P1). The planner takes p_{ij} as exogenous. When the intrahousehold allocation is the solution to problem (P1), the intrahousehold allocation is efficient.

Let $C_{ij}(p_{ij}, S_{ijgG})$, $H_{ij}(p_{ij}, S_{ijgG})$, $c_{ij}(p_{ij}, S_{ijgG})$, $h_{ij}(p_{ij}, S_{ijgG})$, $K_{ij}(p_{ij}, S_{ijgG})$ be the optimal intrahousehold allocation when state S_{ijgG} is realized. Let $\mathbf{Q}_{ij}(p_{ij}, Z)$ and $\mathbf{q}_{ij}(p_{ij}, Z)$ be the expected indirect felicities of the wife and the husband respectively before the state S_{ijgG} is realized:

$$\mathbf{Q}_{ij}(p_{ij}, Z) = \mathbf{E}(\widehat{Q}_{ij}(C_{ij}(p_{ij}, S_{ijgG}), 1-H_{ij}(p_{ij}, S_{ijgG}), K_{ij}(p_{ij}, S_{ijgG}))|Z)$$
$$\mathbf{q}_{ij}(p_{ij}, Z) = \mathbf{E}(\widehat{q}_{ij}(c_{ij}(p_{ij}, S_{ijgG}), 1-h_{ij}(p_{ij}, S_{ijgG}), K_{ij}(p_{ij}, S_{ijgG}))|Z)$$

Appendix 1 shows that the solution to problem (P1) implies:

Proposition 1 *The changes in spousal expected felicities as the husband's power, p_{ij}, increases satisfy:*

$$\frac{\partial \mathbf{Q}_{ij}(p_{ij}, Z)}{\partial p_{ij}} = -p_{ij}\frac{\partial \mathbf{q}_{ij}(p_{ij}, Z)}{\partial p_{ij}} < 0 \tag{6}$$

The wife's expected felicity falls and the husband's expected felicity increases as p_{ij} increases. (6) traces the redistribution of spousal expected felicities as the husband's power increases.

We will now study how spousal labor supplies change as husband's power changes. A necessary condition for solving problem P1 is that given realized wages and non-labor income, i.e. S_{ijgG}, the planner solves problem P2:

$$\max_{C_{ijgG}, c_{ijgG}, H_{ijgG}, h_{ijgG}, K_{ijgG}} \widehat{Q}_{ij}(C_{ijgG}, 1 - H_{ijgG}, K_{ijgG}) + p_{ij}\widehat{q}_{ij}(c_{ijgG}, 1 - h_{ijgG}, K_{ijgG}) \tag{P2}$$

subject to $c_{ijgG} + C_{ijgG} + K_{ijgG} \leq A_{ijgG} + W_{ijgG}H_{ijgG} + w_{ijgG}h_{ijgG}$

Problem P2 is a deterministic static maximization problem. We will assume that the felicity functions are weakly separable, that the objective function in problem P2 can be written as:

$$\widehat{Q}_{ij}(\Omega(C_{ijgG}, 1 - H_{ijgG}), K_{ijgG}) + p_{ij}\widehat{q}_{ij}(\omega(c_{ijgG}, 1 - h_{ijgG}), K_{ijgG}) \tag{7}$$

BCM first analyzed problem P2 in the general and weakly separable case and we build on their results. In general, it is difficult to determine analytically how spousal labor supplies respond to changes in p_{ij}. Appendix 2 shows that in the weakly separable case, by restricting leisure (with suitably defined individual private income) and the public good to be normal goods for each spouse,

Proposition 2 *The wife's labor supply is increasing in p_{ij} whereas the husband's labor supply is decreasing in the husband's power, p_{ij}:*

$$\frac{\partial H_{ijGg}}{\partial p_{ij}} > 0 \; \forall S_{ijgG} \tag{8}$$

$$\frac{\partial h_{ijGg}}{\partial p_{ij}} < 0 \; \forall S_{ijgG} \tag{9}$$

(8) and (9) are expected.

Problem P2 is a unitary model of the family faced with wages W_{ijgG}, w_{ijgG}, and non-labor income A_{ijgG}. Thus we cannot reject a unitary model of the family for $\{i, j\}$ couples in the same society, by observing their spousal labor supplies behavior if they share risk efficiently.[8] For example, spousal labor supplies will satisfy Slutsky symmetry.

For notational convenience, if woman G of type j remains unmarried, denote her expected indirect utility as $\mathbf{Q}_{0j}(p_{0j}, Z)$ where $p_{0j} = 0$ and $\widehat{q}_{0j} \equiv 0$. Similarly, if man g of type i remains unmarried, denote his expected indirect utility as $\mathbf{q}_{i0}(p_{i0}, Z)$ where $p_{i0} = 1$ and $\widehat{Q}_{i0} \equiv 0$.

[8] This point is well known. Hayashi, Altonji and Kotlikoff, Lich Tyler, Mazzacco, Ogaki.

3 Marriage decisions in the first period

In the first period, agents decide whether to marry and who to marry if they choose to marry. We will use the additive random utility model to model this choice.

Consider a particular woman G of type j. Recall that she can choose between I types of men and whether or not to marry. She can choose between $I+1$ choices. Let $p_{0j}=0$. Her expected utility in an $\{i,j\}$ marriage is:

$$\overline{V}(i,j,p_{ij},\varepsilon_{ijG}) = \mathbf{Q}_{ij}(p_{ij},Z) + \Gamma_{ij} + \varepsilon_{ijG},\ i=0,..I \tag{10}$$

Given the realizations of all the ε_{ijG}, she will choose the marital choice which maximizes her expected utility. Let $\underline{\varepsilon_{jG}} = [\varepsilon_{0jG},..,\varepsilon_{ijG},..,\varepsilon_{IjG}]$ and $\Omega(\underline{\varepsilon_{jG}})$ denote the joint density of $\underline{\varepsilon_{jG}}$. The expected utility from her optimal choice will satisfy:

$$V^*(\underline{\varepsilon_{jG}}) = \max[\overline{V}(0,j,p_{0j},\varepsilon_{0jG}),..,\overline{V}(i,j,p_{ij},\varepsilon_{ijG}),..] \tag{11}$$

The problem facing men in the first stage is analogous to that of women. Let $p_{i0}=0$. A man g of type i in an $\{i,j\}$ marriage, with ε_{ijg}, attains an expected utility of:

$$\overline{v}(i,j,p_{ij},\varepsilon_{ijg}) = \mathbf{q}_{ij}(p_{ij},Z) + \gamma_{ij} + \varepsilon_{ijg},\ j=0,..,J \tag{12}$$

Given the realizations of all the ε_{ijg}, he will choose the marital choice which maximizes his expected utility. He can choose between $J+1$ choices. Let $\underline{\varepsilon_{ig}} = [\varepsilon_{i0g},..,\varepsilon_{ijg},..]$ and $\omega(\underline{\varepsilon_{ig}})$ denote the joint density of $\underline{\varepsilon_{ig}}$. The expected utility from his optimal choice will satisfy:

$$v^*(\underline{\varepsilon_{ig}}) = \max[\overline{v}(i,0,p_{i0},\varepsilon_{i0g}),..\overline{v}(i,j,p_{ij},\varepsilon_{ijg})..] \tag{13}$$

4 The Marriage Market

Let p be the matrix of husband's powers where a typical element is p_{ij} for $i,j\geq 1$. Assume that the random vectors $\underline{\varepsilon_{jG}}$ and $\underline{\varepsilon_{ig}}$ are independent of p and Z. Let $\Phi_{ij}(p)$ denote the probability that a woman of type j will choose a spouse of type i, $i=0,..I$.

Since each woman of type j is solving the same spousal choice problem (11),

$$\Phi_{ij}(p) = \Pr(\varepsilon_{i'jG} - \varepsilon_{ijG} < \mathbf{Q}_{ij}(p_{ij},Z) + \Gamma_{ij} - \mathbf{Q}_{i'j}(p_{i'j},Z) - \Gamma_{i'j}\ \forall i' \neq i) \tag{14}$$

$$= \int_{\varepsilon_{ijG}=-\infty}^{\infty} \int_{\varepsilon_{0jG}=-\infty}^{\mathbf{R}(0,i,j,G,p,Z,)} .. \int_{\varepsilon_{IjG}=-\infty}^{\mathbf{R}(I,i,j,G,p,Z,)} \Omega(\underline{\varepsilon_{jG}}) d\varepsilon_{ijG} d\underline{\varepsilon_{\neq i,jG}}$$

where $\mathbf{R}(i',i,j,G,p,Z,) \equiv \mathbf{Q}_{ij}(p_{ij},Z) + \Gamma_{ij} - \mathbf{Q}_{i'j}(p_{i'j},Z) - \Gamma_{i'j} + \varepsilon_{ijG}$

When there are f_j number of type j women, the number of type j women who want to choose type i spouses, $i = 0, .., I$ is approximated by $\overline{\mu}_{ij}(p, f_j) = \Phi_{ij}(p) f_j$.

Using (14), for $i \geq 1$,

$$\frac{\partial \overline{\mu}_{ij}(p, f_j)}{\partial p_{i'j}} = f_j \frac{\partial \Phi_{ij}(p)}{\partial p_{i'j}} = \begin{cases} \leq 0, \ i' = i \\ \geq 0, \ i' \neq i \end{cases} \tag{15}$$

$\overline{\mu}_{ij}(p, f_j)$ is the demand function by type j women for type i husbands. (15) says that the demand function satisfies the weak gross substitute assumption. That is, the demand by type j women for type i husbands, $i \geq 1$, is weakly decreasing in p_{ij} and weakly increasing in $p_{i'j}$, $i' \neq i$. Such a result is expected. All other types of potential spouses, $i' \neq i$, are substitutes for type i spouses. When the bargaining power of type i spouses increase, demand for that type of spouse is expected to weakly fall and the demand for other types of spouses is expected to weakly increase.

Similarly, let $\phi_{ij}(p)$ denote the probability that a man of type i will choose a spouse of type j, $j = 0, ..J$. Since each man of type i is solving the same spousal choice problem (13),

$$\phi_{ij}(p) = \Pr(\varepsilon_{ij'g} - \varepsilon_{ijg} < \mathbf{q}_{ij}(p_{ij}, Z) + \gamma_{ij} - \mathbf{q}_{ij'}(p_{ij'}, Z) - \gamma_{ij'} \ \forall j' \neq j) \tag{16}$$
$$= \int_{\varepsilon_{ijg}=-\infty}^{\infty} \int_{\varepsilon_{i0G}=-\infty}^{\mathbf{r}(0,i,j,g,p,Z)} .. \int_{\varepsilon_{iJG}=-\infty}^{\mathbf{r}(J,i,j,g,p,Z)} \omega(\underline{\varepsilon_{ig}}) d\varepsilon_{ijg} d\underline{\varepsilon_{i,\neq jg}}$$

where $\mathbf{r}(j', i, j, g, p, Z) \equiv \mathbf{q}_{ij}(p_{ij}, Z) + \gamma_{ij} - \mathbf{q}_{ij'}(p_{ij'}, Z) - \gamma_{ij'} + \varepsilon_{ijg}$

When there are m_i number of type i men, the number of type i men who want to choose type j spouses, $j = 0, .., J$ is approximated by $\underline{\mu}_{ij}(p, m_i) = \phi_{ji}(p) m_i$.

Using (16), for $j \geq 1$,

$$\frac{\partial \underline{\mu}_{ij}(p, f_j)}{\partial p_{ij'}} = m_i \frac{\partial \phi_{ij}(p)}{\partial p_{ij'}} = \begin{cases} \geq 0, \ j' = j \\ \leq 0, \ j' \neq j \end{cases} \tag{17}$$

$\underline{\mu}_{ij}(p, m_i)$ is the demand function by type i men for type j wives. (17) says that the demand function satisfies the weak gross substitute assumption. The explanation is the same as that given above for the demand for husbands.

Marriage market clearing requires the supply of wives (husbands) to be equal to the demand (husbands) for wives for each type of marriage:

$$\underline{\mu}_{ij} = \overline{\mu}_{ij} = \mu_{ij} \ \forall \ \{i > 0, \ j > 0\} \tag{18}$$

There are feasibility constraints that the stocks of married and single agents of each gender and type cannot exceed the aggregate stocks of agents of each gender in the society:

$$f_j = \mu_{0j} + \sum_i \mu_{ij} \tag{19}$$

$$m_i = \mu_{i0} + \sum_j \mu_{ij} \tag{20}$$

We can now define a rational expectations equilibrium. There are two parts to the equilibrium, corresponding to the two stages at which decisions are made by the agents. The first corresponds to decisions made in the marriage market; the second to the intra-household allocation. In equilibrium, agents make marital status decisions optimally, the sharing rules clear each marriage market, and conditional on the sharing rules, agents choose consumption and labor supply optimally. Formally:

Definition 3 *A rational expectations equilibrium consists of a distribution of males and females across individual type, marital status, and type of marriage* $\{\hat{\mu}_{0j}, \hat{\mu}_{i0}, \hat{\mu}_{ij}\}$*, a set of decision rules for marriage, a set of decision rules for spousal consumption, leisure and public goods* $\{\hat{C}_{ijgG}, \hat{c}_{ijgG}, \hat{L}_{ijgG}, \hat{l}_{ijgG}, \widehat{K}_{ijgG}\}$*, and a matrix of husbands' powers* $\widehat{p}$ *such that:*

1. *Marriage decisions solve (11) and (13), obtaining* $\{V^*(\underline{\varepsilon_{jG}}), v^*(\underline{\varepsilon_{ig}})\}$*.*
2. *All marriage markets clear implying (18), (19), (20) hold;*
3. *For an* $\{i, j\}$ *marriage, the decision rules* $\{\hat{C}_{ijgG}, \hat{c}_{ijgG}, \hat{L}_{ijgG}, \hat{l}_{ijgG}, \widehat{K}_{ijgG}\}$ *solve (P1).*

Theorem 4 *A rational expectations equilibrium exists.*

Sketch of proof: We have already demonstrated (1) and (3). So what needs to be done is to show that there is a matrix of husbands' powers, $\widehat{p}$ which clears the marriage market. Consider a matrix of admissible husband's powers p. For every marriage market $\{i, j\}$ excluding $i = 0$ or $j = 0$, define the excess demand function for marriages by men:

$$E_{ij}(p) = \underline{\mu}_{ij}(p) - \overline{\mu}_{ij}(p) \tag{21}$$

The demand and supply functions, $\underline{\mu}_{ij}(p)$ and $\overline{\mu}_{ij}(p)$, for every marriage market $\{i, j\}$, satisfy the weak gross substitute property, (15) and (17). So the excess demand functions also satisfy the weak gross substitute property. Mas-Colell, Winston and Green (1995: p. 646, exercise 17.F.16^C) provide a proof of existence of market equilibrium when the excess demand functions satisfy the weak gross substitute property. For convenience, we reproduce their proof in our context in Appendix 3. Kelso and Crawford (1982) were the first to use the gross substitute property to demonstrate existence in matching models.

Our collective model of marriage matching shows that the transferable utilities model of the marriage market can be generalized to non-transferable utilities where the marginal utilities of consumption is not constant.

5 The logit spousal choice model

The rest of the paper concerns some empirical implications of the above model.

From here on, we will assume the logit random utility model, that ε_{ijG} and ε_{ijg} are i.i.d. extreme value random variables. In this case, McFadden (1974) showed that for every type of woman j, the relative demand for type i husbands is:

$$\ln \overline{\mu}_{ij} - \ln \mu_{0j} = (\Gamma_{ij} - \Gamma_{0j}) + \mathbf{Q}_{ij}(p_{ij}, Z) - \mathbf{Q}_{0j}(Z) \ , \quad i = 1, .., I \tag{22}$$

where $\overline{\mu}_{ij}$ is the number of $\{i, j\}$ marriages demanded by j type females and μ_{0j} is the number of type j females who choose to remain unmarried.

Similarly, for every type of man i, the relative demand for type j wives is:

$$\ln \underline{\mu}_{ij} - \ln \mu_{i0} = (\gamma_{ij} - \gamma_{i0}) + \overline{q}_{ij}(p_{ij}, Z) - \overline{q}_{i0}(Z), \quad j = 1, .., J, \tag{23}$$

where $\underline{\mu}_{ij}$ is the number of $\{i, j\}$ marriages supplied by j type males and μ_{i0} is the number of type i males who choose to remain unmarried.

6 Implications for reduced form labor supplies regressions

In our companion paper, CSSa, we show that there is no observable restriction marriage matching pattern in a single marriage market. CSSa shows what structural parameters are identified from estimating structural labor supplies equations and marriage matching patterns in at least two marriage markets. In this paper, we will focus on implications of the above theory in a reduced form labor supplies framework without estimating any structural parameter.

Let the equilibrium husband's power be $\{p_{ij}(\Gamma, \gamma, Z, M, F)\}$. Using market clearing, and subtracting relative supply, (22), from relative demand, (23):

$$\begin{aligned} T_{ij} = \ln \frac{\mu_{i0}}{\mu_{0j}} &= (\Gamma_{ij} - \Gamma_{0j}) + \mathbf{Q}_{ij}(p_{ij}, Z) - \mathbf{Q}_{0j}(Z) \\ &- ((\gamma_{ij} - \gamma_{i0}) + \mathbf{q}_{ij}(p_{ij}, Z) - \mathbf{q}_{i0}(Z)) \end{aligned} \tag{24}$$

T_{ij}, the log of the ratio of the number of unmarried type i men to unmarried type j women, is a measure of marriage market tightness or the net spousal gain of the wife relative to her husband. (24) says marriage market tightness increases when the number of unmarried type i men increases relative to the number of unmarried type j women.

(24) is a fundamental equilibrium relationship in the marriage market which is imposed by marriage market clearing. It is the basis of the empirical content of marriage matching on the collective model in this paper and CSSa. To see this, consider a change in ζ, an exogenous parameter.

Using (6) and (24),

$$\frac{\partial T_{ij}}{\partial \zeta} = \frac{\partial((\Gamma_{ij} - \Gamma_{0j}) - (\gamma_{ij} - \gamma_{i0}))}{\partial \zeta} + (\frac{\partial(\mathbf{Q}_{ij} - \mathbf{Q}_{0j}) - (\mathbf{q}_{ij} - \mathbf{q}_{i0})}{\partial Z})\frac{\partial Z}{\partial \zeta} - (1 + p_{ij})\frac{\partial \mathbf{q}_{ij}}{\partial p_{ij}}\frac{\partial p_{ij}}{\partial \zeta} \tag{25}$$

which may be rewritten as:

$$\frac{\partial p_{ij}}{\partial \zeta} = \rho_{ij}\frac{\partial((\Gamma_{ij} - \Gamma_{0j}) - (\gamma_{ij} - \gamma_{i0}))}{\partial \zeta} + \rho_{ij}\frac{\partial((\mathbf{Q}_{ij} - \mathbf{Q}_{0j}) - (\mathbf{q}_{ij} - \mathbf{q}_{i0}))}{\partial Z}\frac{\partial Z}{\partial \zeta} - \rho_{ij}\frac{\partial T_{ij}}{\partial \zeta} \tag{26}$$

$$\rho_{ij} \equiv [(1 + p_{ij})\frac{\partial \mathbf{q}_{ij}}{\partial p_{ij}}]^{-1} > 0$$

(26) says that, due to a change in ζ, the change in husband's power is observationally equal to three terms. The first term is proportional to the change in the relative spousal invariant gains. The second term is proportional to the change in the difference in expected spousal utilities (felicities) from a change in the wages and non-labor income distributions. The third term is proportional to the change in marriage market tightness. Since $\rho_{ij} > 0$, when T_{ij} increases, the husband's power will fall and vice versa.

T_{ij} and p_{ij} are both endogenous variables and simultaneously determined. So (26) is not a statement about the causal effect of T_{ij} on p_{ij}. We will now use proposition 2 and (26) to derive a testable implication of marriage matching on spousal labor supplies.

Let H^r_{ijG} be the hours of work of wife G in an $\{i, j\}$ marriage in society r. Consider the following reduced form labor supply regression:

$$\ln H^r_{ijG} = z^{r}_{ij}{}'\beta_1 + \beta_{ij}T^r_{ij} + u^r_{ijG},\ G = 1,..,G^r;\ ij = 1,..,\Psi^r;\ r = 1,..,R \tag{27}$$

z^r_{ij} is a vector which includes (1) proxies for the labor market and asset conditions of type i and type j individuals in society r, (2) society specific behavior which are independent of $\{i, j\}$ (r fixed effects), and (3) labor supplies effects that are common to $\{i, j\}$ marriages ($\{i, j\}$ fixed effects).

u^r_{ijk} is the error term in the regression.

Recall from section 2.1 that the labor supply of wife G married to husband g in an $\{i, j\}$ marriage in society r is $H_{ij}(p^r_{ij}, S^r_{ijgG})$. Using a log linear approximation,

$$\ln H^r_{ijgG} = \sigma_p p^r_{ij} + \sigma_S S^r_{ijgG} \tag{28}$$

Use (26) to derive a first order Taylor series approximation for p^r_{ij} and substitute into (28):

$$\ln H^r_{ijgG} = \sigma_{ij} + \sigma_p\rho_{ij}((\Gamma^r_{ij} - \Gamma^r_{0j}) - (\gamma^r_{ij} - \gamma^r_{0i}) + \frac{\partial((\mathbf{Q}_{ij} - \mathbf{Q}_{0j}) - (\mathbf{q}_{ij} - \mathbf{q}_{i0}))}{\partial Z} Z^r) \tag{29}$$

$$- \sigma_p\rho_{ij}T^r_{ij} + \sigma_S S^r_{ijgG}$$

σ_{ij} above contains all the zero order terms of the Taylor series expansion.

In (27), z^r_{ij} includes marital matches $\{i, j\}$ fixed effects, r fixed effects and labor market conditions that are $\{i, j, r\}$ specific. We assume that variations in z^r_{ij} are sufficient to capture variations in $(\Gamma^r_{ij} - \Gamma^r_{0j}) - (\gamma^r_{ij} - \gamma^r_{0j})$, and variations in $F(S^r_{ijgG}|Z^r)$ across societies. That is:

$$(\Gamma^r_{ij} - \Gamma^r_{0j}) - (\gamma^r_{ij} - \gamma^r_{i0}) = z^r_{ij}{}'\psi_\Gamma \tag{30}$$

$$Z^r = z^r_{ij}{}'\psi_Z \tag{31}$$

$$S^r_{ijgG} = z^r_{ij}{}'\psi_S + \varepsilon^r_{ijgG} \tag{32}$$

where ε^r_{ijgG} are the idiosyncratic wage and non-labor income variations across $\{i, i, r\}$ families, and are by definition uncorrelated with $\{i, j, r\}$ specific variables.

Substituting (30) through (32) into (29),

$$\ln H^r_{ijgG} = \sigma_{ij} + \sigma_p\rho_{ij}(z^r_{ij}{}'\psi_\Gamma + \frac{\partial((\mathbf{Q}_{ij} - \mathbf{Q}_{0j}) - (\mathbf{q}_{ij} - \mathbf{q}_{i0}))}{\partial Z} z^r_{ij}{}'\psi_Z) \tag{33}$$
$$- \sigma_p\rho_{ij}T^r_{ij} + \sigma_S z^r_{ij}{}'\psi_S + \varepsilon^r_{ijgG}$$

which reduces to (27).

Comparing the reduced from labor supply equation (27) with (33), $\beta_{ij} = -\sigma_p\rho_{ij}$ estimates the elasticity of mean hours of work of the wives in $\{i, j\}$ marriages with respect to marriage market tightness, holding z^r_{ij}, i.e. $\{i, j\}$ match production function, society wide differences, spousal invariant gains, labor market and non-labor income conditions, constant. β_{ij} is identified because there remains independent variation in T^r_{ij} due to differences in population supplies, M^r and F^r, across societies. Since $\rho^r_{ij} > 0$ and proposition 2 says that $\sigma_p > 0$, β_{ij} should be negative.

In the above regression, we have $\Psi^r \leq I \times J$ types of marriages. Because (26) must hold for every $\{I \times J\}$ marriages match and β_{ij} is match dependent, we do not need to include all marriages matches in our reduced form labor supply regression (27). The regression is valid for any subset of marital matches. For example, due to thin cell problems, we will focus only on own race marriages in the empirical analysis. The fact that there are cross race marriages, which we leave out in the empirical analysis, do not invalidate our statistical inference.

Similarly, consider the labor supply regression of the husband g in an $\{i, j\}$ marriage in society r,

$$\ln h^r_{ijg} = \alpha_{ij} T^r_{ij} + z^r_{ij}{}' \alpha_1 + v^r_{ijg},\ g = 1,..,g^r;\ ij = 1,..,\Psi^r;\ r = 1,..,R \tag{34}$$

h^r_{ijg} is the hours of work of the husband. v^r_{ijg} is the error term of the regression. Following the argument for the wife, we expect α_{ij} to be positive.

Thus the main test of our model is that, after controlling for variations in labor market and asset conditions of type i and type j individuals in society r, and variations in relative invariant gains, the wife's labor supply should be negatively correlated with market tightness whereas the husband's labor supply should be positively correlated with market tightness.

We will use the US 2000 census in the empirical work. We associate each state with a separate society. Our most general empirical specification of (27) and (34) include state effects, marital match $\{i, j\}$ effects, and state specific variables characterizing labor and non-labor earnings distributions of unmarried type i and j individuals. Identification of β_{ij} and α_{ij} is thus based on variation in tightness due to state and marital match interactions which is orthogonal to the variation in unmarried earnings distributions. Our identification strategy is equivalent to the difference in differences estimation of treatment effects using state and time panel data. Instead of the usual time variation, we use marital match $\{i, j\}$ variations. It is less restrictive than most existing empirical work on the effects of marriage market conditions on spousal labor supplies.[9]

Perhaps the main difficulty with our identification strategy is when there is variation in labor demand by state and individual types. Different types of individuals may migrate to high labor demand states and also work more in those states. This migration will lead to variations in the sex ratio and thus market tightness. If the increase in labor supplies, as a response to increased labor demand, is not captured by our variables characterizing the earnings distributions faced by these individuals, β_{ij} and α_{ij} will not be consistently estimated. Thus the reliability of our identification strategy depends on how well our labor market variables capture labor demand variations by state and individual types.[10] Classical labor supply theory, as assumed here, implies that wages and non-labor income are sufficient to characterize the labor market opportunities faced by individuals. We include measures of these variables.

There is another selection issue. If our observed matches do not accord with the matches as perceived by market participants, then the marriages in each observed match may contain mixtures of different unobserved marital matches. As labor market conditions and other exogenous variables change, the mix of unobserved marital matches used to construct observed market tightness and other variables may change. How these unobserved resorting affects our results is unclear. This problem is not unique to our paper. To the extent that changes in

[9] For example, Angrist uses individual types variation alone and CFL use across state variation alone to identify their sex ratio effects.

[10] Substantial endogenous migration will also invalidate most panel estimates of treatment effects which make use of state and time variation. This is a well known caveat of these studies.

exogenous variables change the composition of observed sex ratios, this problem affects all work this area.[11]

A secondary implication of our model is based on the observation that both β_{ij} and α_{ij} should depend on $\{i,j\}$, the marriage match. In otherwords, there should be interaction effects between spousal characteristics, $\{i,j\}$, and market tightness in the above reduced form spousal labor supplies regressions. For p^r_{ij} large, $(1+p^r_{ij})$ is large but $\frac{\partial \mathbf{q}_{ij}}{\partial p^r_{ij}}$ is likely to be small. So the effect of p^r_{ij} on ρ^r_{ij} is unclear. Thus although β_{ij} and α_{ij} may be proportional to ρ^r_{ij}, without further restrictions, their magnitudes are not informative on the magnitude of husband's power, p^r_{ij}.

T^r_{ij} is an endogenous variable. To the extent that it is correlated with labor supplies shocks, u^r_{ijk} and $v^r_{ijk'}$, we will use sex ratios to instrument for market tightness in the empirical work.

(27) and (34) do not include individual spousal wages or non-labor incomes as covariates. The theory implies that the labor supply responses to spousal wages should satisfy Slutsky symmetry. However, this restriction cannot be tested with census data, which is used here, because wages and non-labor income are measured with error and we do not have instruments for the idiosyncratic component of individual wages and non-labor income. Systematic components cannot be used as instruments to test Slutsky symmetry because the systematic components are known at the time of marriage, and therefore affect husband's power p^r_{ij}, and are also colinear with z^r_{ij}.[12]

Finally, in addition to spousal labor supplies, we will also consider other measures of spousal leisure to use as dependent variables in our reduced form regressions.

7 One period marriage without uncertainty

Most of literature on the collective model deals with a static model of intra-household allocations without uncertainty. That is, wages and non-labor income are known as of the time the individuals enter into the marriage. Our marriage matching framework can accommodate this case and our structural labor supply paper, CSSa, studies this case.

Let observed wages, non-labor income and labor supplies be equal to true

[11] For example, Angrist uses the sex ratio of immigrants as his measure of subsitutes which he argues was driven by immigration policy. Differences in immigration policies will change the quality of mix of immigrants.

[12] CFL did not include Z^r_{ij} as covariates. They used systematic characteristics of couples to instrument their wages and rejected Slutsky symmetry. Their rejection is consistent with the theory developed here. See the literature review for more discussion.

wages, non-labor income and labor supplies plus measurement error:

$$\widetilde{W}_{ij} = W_{ij} + \varepsilon_{ijgG}^{W\pi} \tag{35}$$

$$\widetilde{w}_{ij} = w_{ij} + \varepsilon_{ijgG}^{w\pi} \tag{36}$$

$$\widetilde{A}_{ij} = A_{ij} + \varepsilon_{ijgG}^{A\pi} \tag{37}$$

$$\widetilde{H}_{ij} = H_{ij} + \varepsilon_{ijgG}^{L\pi} \tag{38}$$

$$\widetilde{h}_{ij} = h_{ij} + \varepsilon_{ijgG}^{l\pi} \tag{39}$$

where $\widetilde{X}_{ij}$ is the observed values of X_{ij}. $\varepsilon_{ijgG}^{W\pi}$, $\varepsilon_{ijgG}^{w\pi}$, $\varepsilon_{ijgG}^{L\pi}$, $\varepsilon_{ijgG}^{l\pi}$and $\varepsilon_{ijgG}^{A\pi}$ are measurment errors which are uncorrelated with the true values. Marriages are still identified by $\{i, j, \pi\}$. Thus we can still use p_{ij}, the husband's power, to clear the marriage market. Given p_{ij}, instead of problem P1, the planner will now solve:

$$\max_{\{C_{ij}, c_{ij}, H_{ij}, h_{ij}\}} \widehat{Q}(C_{ij}, 1 - H_{ij}, K_{ij}) + p_{ij}\widehat{q}(c_{ij}, 1 - h_{ij}, K_{ij}) \tag{P1a}$$
$$\text{subject to } C_{ij} + c_{ij} + K_{ij} \leq A_{ij} + W_{ij}H_{ij} + w_{ij}h_{ij} \; \forall \; S_{ij}$$

(6), appropriately reinterpreted, continues to hold which is what is critical for marriage market clearing. Thus as long as we can identify the type of an individual and the marital matches that the individual can enter into, i.e. $\{i, j\}$, the empirical tests that we develop in this paper remain valid. Differences in observed spousal labor supplies across $\{i, j\}$ couples in the same society are interpreted as due to different realizations of measurement errors across these couples.

Thus the empirical results in this paper should be interpreted with care. *Even if our empirical results are consistent with our model predictions, they do not shed light on whether there is efficient risk sharing within the family or not.*

In our reduced form regressions, we do not include individual spousal wages as covariates. For every $\{i, j\}$ match, we observe labor income and labor supplies of multiple couples. Wages can be constructed by dividing labor income by hours of work. But measurement error in labor supplies and idiosyncratic labor supply shocks will induce variation in constructed wages as discussed above. Since risk sharing in marriage, measurement error in labor supplies, and idiosyncratic labor supply shocks are all salient factors in our data, and we do not have instruments for the idioysncratic components of wages, we do not use constructed wages in our reduced form labor supply estimates. Consequently, we do not take a stand on how much risk sharing there is in our data.

Put in another light, the reduced form implications that we test in this paper are independent of whether there is risk sharing or not. Similarly, our results are also independent of whether there are public goods in marriage or not.

8 Empirical results

8.1 Data

The data used in most of the analysis is drawn from the 2000 5% US census. We do additional analysis using time use data from the ATUS sample.

Table 1 contains the summary statistics of our base sample. It consists of approximately 747,000 married same race couples (whites (86%), blacks (8%) or hispanics (6%)).[13] We excluded mixed race couples to mitigate thin cells and also because we would need to present separate coefficients on market tightness for each type of mixed race couple.[14]

A type of individual is defined by their race, age and education. For each gender, there are four contiguous age categories (age_m and age_f of 5 years each). The youngest female and male age categories, category 1, are 25-29 and 27-31 respectively.[15] For each gender, there are two schooling categories: high school graduate (edu_HS_m and edu_HS_f: 66%) versus college graduate (4 years of college and above). So for each race and gender, there are 8 types of individuals. Since we are only considering same race marriages, there are potentially $64 \times 3 = 254$ types of marital matches for each society.

There is one common selection in the empirical collective labor supply literature that we do not do. Because we allow for public goods within marriage, we do not restrict our analysis to childless individuals or couples.

We define each state as a separate society. With 50 states, there are potentially $254 \times 50 = 12700$ cells across all marriage markets. However, the majority of these potential cells (marital match×state) have few or no observed marriage. To avoid thin cell problems, we delete a cell if the number of marriages in that cell is less than 5.[16] For most regressions, we have 2995 different cells (marital match×state), with 189 distinct marital matches. Most of the missing cells are due to non-white marriages, with large spousal age differences, in states with small populations. There are 750,000 same race couples in our sample before dropping the thin cell couples. After dropping the thin cell couples, about 3,000 couples, our base sample have about 747,000 couples. In other words, most of the thin cells that we dropped were empty.

Market tightness for marital type $\{i, j\}$ in state r is defined as the log of the ratio of the number of unmarried type i males to the number of unmarried type j females in state r.[17] Across individuals, mean market tightness for whites, blacks and hispanics (lmt_w, lmt_b, lmt_h) are 0.019, -0.028, -0.006

[13] If an individual chooses any hispanic label, they are classified as hispanic. Next is black and last is white. We do this to maximize the number of hispanics, and blacks.

[14] Market tightness for mixed race couples which include white spouses are very different from own race couples because there are so many more whites than other races in the data. So we would need to have separate coefficients on tightness for each mixed race couples.

[15] Men: 18%, 27%, 30% 25%.
Women: 17%, 27%, 31%, 25%.

[16] We have other minor selection rules.

[17] An individual is unmarried if he or she is currently not married in the census form (not code 1 or 2).

respectively. This means that there are approximately 2% more, 3% less and 1% less unmarried white, black and hispanic males than females respectively. Mean market tightness by cells are -0.0026, -0.39 and -0.12 for whites, blacks and hispanics respectively. So although there are some large differences across marital matches (particularly for blacks and hispanics), most individuals choose marital matches where market tightness are close to one.[18] Comparing means across cells, black males have the most bargaining power and white males have the least. There is also substantial variation in tightness across cells by racial groups. This variation in market tightness will help us in estimating the effect of tightness on spousal labor supplies.

We use 5 measures of log sex ratios. The most refined measure, lsr_ij, is the sex ratio measured at the cell level (log of the ratio of the number of males of type i to the number of females of type j in state r). There are also sex ratios by education matches and state (lsr_edu), age matches and state (lsr_age), and race and state (lsr_race). Finally, there is an overall sex ratio by state (lsr). For all measures, mean log sex ratios are slightly less than zero which implies that there are slightly more women than men. Again, the estimated standard deviations are large.[19] As expected, the narrower the definition of marital type leads to a larger standard deviation (0.45 for lsr_ij versus 0.04 for lsr).

We use three measures of spousal labor supplies. The first measure is whether the individual is in the labor force or not (lfs_m and lfs_f). Mean labor force participation rates for men and women are 0.94 and 0.73 respectively. Conditional on being in the labor force, our second measure is log usual hours worked per week (lnh_w_m and lnh_w_f). Mean usual hours worked for men and women were 45 and 29 hours respectively. Condititional on being in the labor force, the third measure is log weeks worked per year (lnwks_m and lnwks_f). Mean weeks worked per year for men and women were 48 and 36 weeks respectively.

In terms of characterizing the labor earnings and non-labor income of unmarried individuals, for each type of individual, we have three variables to characterize each type of earnings distribution. Conditional on positive annual labor earnings for a type of unmarried individual, we construct the mean and standard deviation of log annual labor earnings (wage and salary income). We also include the fraction of those type of individuals with zero labor earnings. We construct the analogous variables for non-labor earnings (total personal income minus wage and salary income).[20]

8.2 Determinants of market tightness

Table 2 presents estimates of market tightness. Each cell (state×marital match) is one observation. There are 2995 observations. This is our empirical estimate

[18] An explanation for the larger variation of market tightness across cells is that gender differences in labor demand may be large for some cells.

[19] As in the case for market tightness, treating each marital type (cell) as one observation, the standard deviations are at least twice as large.

[20] Fraction with non-positive non-labor income rather than zero non-labor income.

of $T(\Gamma^r, \gamma^r, Z^r, M^r, F^r)$.

Column 1 regresses market tightness on sex ratios. The estimates show that all measures of sex ratios affect market tightness even though we included the sex ratio by cell (lsr_ij) as a covariate. Put another way, substitution effects are central to marriage market behavior. Given the complex relationship between population supplies and marriage matching, we will not attempt to interpret the estimated relationship. The R^2 is 0.943 which says that sex ratios are major determinants of market tightness.

Column 2 add individual characteristics, race, age and education. As both the individual estimated coefficients and the F test shows, in addition to population supplies, an individual's race, age and education also affect market tightness. Using a reduced form interpretation, being non-white increases market tightness. Column 3 add state effects. Although the F test shows that state effects matter, their explanatory power is marginal.

Column 4 includes the earnings distributions of the unmarrieds, state and race effects. The F test shows that unmarried labor market conditions have significant explanatory power. Increasing (decreasing) unmarried female (male) mean log earnings increases market tightness, the ratio of unmarried males to unmarried females. This is consistent with the interpretation that an increase in the earnings of a type of individual increases their desirability in marriage. It is not consistent with the interpretation that an increase in unmarried mean earnings leading to a relative increase of that type of unmarrieds individuals alone.[21] Similarly, increasing the fraction of unmarried individuals without labor or non-labor income decreases the desirability of their type in marriage. These findings on the effects of unmarried earnings on market tightness is important for our empirical strategy because we are using unmarried earnings of a type of individual as a proxy for labor market conditions for both married and unmarried indviduals of that type. We use unmarried labor earnings rather than wages because the census does not have data on individual wages. To construct wages, we would need to divide labor earnings by hours of work. Since the model implies that unmarried earnings are unaffected by marriage market considerations, we decide to use unmarried labor earnings as proxies for labor market conditions. This proxy ameliorates the problem of having a proxy for hours of work on the right hand side when we do labor supply regressions in the next section.

Finally, column 5 includes every marital match (189) and states as fixed effects. We also included sex ratios and unmarried incomes as additional covariates. As shown in the point estimates and F tests, sex ratios and unmarried incomes continue to have explanatory power. Column 5 is a standard difference in differences regression using state and marital match effects. Identification of the sex ratio and unmarried income effects are through states and marital match interactions.

[21] Note that we are not holding the earnings of the married individuals constant.

8.3 Market tightness and wives' labor supplies

Table 3 presents linear probability estimates of the effects of market tightness on a wife's labor force participation status. lfs_f equals 1 if she participates and zero otherwise. As discussed in the methodology section, the impact of market tightness on spousal labor supply depends on marital match. We allow the effect of market tightness on spousal labor supply to depend on the race of the couple (lmt_w for whites, lmt_b for blacks and lmt_h for hispanics). The standard errors of all individual level regressions in this paper are clustered at the cell level.

Column 1 only includes market tightness interacted with race effects. The estimated coefficients on lmt_w and lmt_h are both positive and statistically different from zero. Superficially, the positive estimates are inconsistent with the theory. But as pointed out in the discussion on methodology, we need to hold other factors constant which is not done in column 1.

Our theory suggests the direction of the bias if we leave out relevant control variables. Consider leaving out a relevant control variable which induces a positive labor supply response from wives in a particular marital cell. This will make those marital matches more desirable for males which will increase market tightness. In this case, our estimated coefficients on tightness, which otherwise should be negative, are biased upwards. Including relevant control variables will allevatiate this bias.

Column 2 adds state effects. The F test shows that state effects have significant explanatory power in the regression. But adding state effects by themselves do not change the 'wrong' estimated signs on market tightness. If a variable affects spousal labor supplies, it should have an effect on market tightness. However, the state effects may affect female and male labor supplies in the same direction. For example, if labor demand is strong in that state, both men and women may work more. In this case, the state effects will matter in the spousal labor supply regressions. But there is no unambiguous effect of labor demand on marriage market tightness.

Column 3 adds individual type effects. The individual estimates and F tests show that both race, age and education effects are important in explaning variation in wives' labor force participation rates. What is more important is that the estimated signs of market tightness become significantly negative in accordance with the theory. The estimated elasticities of tightness range from -0.016 to -0.033. We will provide an economic interpretation of the quantitative magnitudes of these estimates. So column 3 provides the first evidence that adding individual effects affect our estimate of the tightness coefficients, consistent with the theory. The individual effects may have a direct impact in spousal labor supplies and indirect effects on market tightness. Adding individual effects allow husbands' characteristics to affect spousal labor supplies differently from wives' characteristics.

Column 4 includes unmarried earnings and states, but not individual race, age and education effects. This allows us to study the impact of controlling for labor market conditions alone. The F test shows that unmarried earnings have statistically significant explanatory power. The point estimates on tightness remain negative although the point estimate for hispanics is imprecisely estimated. The important point in column 4 is that by adding labor market conditions alone to the wives' labor force participation regression, we can change the estimated signs on the coefficients of tightness. Column 4 do not include any individual effect. To a first order, the estimated coefficients on tightness are similar to that in column 3. Thus, although state varying, the labor market condition variables are capturing a large part of the individual effects in column 3.

Column 5 includes unmarried earnings, race and state effects. The F tests show that unmarried earnings, race and state effects all have statistically significant explanatory power. The point estimates for white, black and hispanic tightness are negative and statistically significant at the 5% level.

Column 6 add marital type effects, state effects and unmarried earnings. The 189 marital type effects allow for spousal labor supplies to differ by marital matches, $\{i, j\}$. In other words, we allow different marital matches to have different marital technologies. The F test shows that unmarried earnings are quantititatively important for explaining lfs_f even when we include unrestricted marital match effects. The point estimates for hispanic and black tightness remain statistically different from zero at the 5% and 10% significance level respectively. The point estimate for white tightness is not statistically different from zero. The point estimates are qualitatively largely similar to that in columns, 3, 4 and 5. Columns 3, 4 and 5 are special cases of column 6. However due to the many more covariates, 182 martial match effects, the standard errors of the estimates on tightness are significantly larger than those in the previous three columns.

In order to interpret the economic impact of the estimates, consider a one standard deviation increase in market tightness across cells by race. Comparative statics hold other factors and marital choices constant. So the exercise should be interpreted as moving a particular $\{i, j\}$ match from one society to another where market tightness is changed by one standard deviation.

As shown in table 1, the standard deviations of tightness across cells are 0.737, 1.22 and 1.05 for whites, blacks and hispanics respectively. Instead of choosing a particular point estimate, we will pool the estimates over the 4 specifications (columns 3, 4, 5 and 6). Using a pooled estimate of -0.02 for white tightness, a one standard deviation increase in tightness for whites will decrease white wives' labor force participation rate by $0.02 \times 0.737/0.11 = 0.13$ standard deviation. Using a pooled estimate of -0.04 for black tightness, a one standard deviation increase in tightness for blacks will decrease black wives' labor force participation rate by $0.04 \times 1.22/0.12 = 0.41$ standard deviation. Finally, using a pooled estimate of -0.03 for hispanic tightness, a one standard deviation increase in tightness for hispanics will decrease hispanic wives' labor force participation rate by $0.03 \times 1.05/0.14 = 0.23$ standard deviation.

As measures of the effect of marriage market conditions on spousal labor supplies, these are quantitatively large results because we are holding marital technologies and labor market conditions on labor supplies constant.

Across cells, mean tightness for whites, blacks and hispanics are -0.0026, -

0.39 and -0.12 suggests that black women have the least marriage market power, hispanic women have more and white women have the most. This ranking of market tightness by race is the same as the ranking of estimated responses of the wives' labor force participation rates by race to a one standard deviation increase in tightness across societies. Both rankings are consistent with our interpretation that black women have less marital power than hispanic women who in turn have less power than white women.

Table 4 presents OLS estimates of tightness on the log usual hours of work per week of wives. The number of observations is 21% smaller because we exclude wives who have zero hours of work. Column 1 includes only tightness measures by race. The estimated coefficient for whites is statistically significant and have the 'wrong' sign. Adding state controls in column 2 result in both white and hispanic tightness having statistically significant 'wrong' signs.

Column 3 add individual education, age and race controls. Now the estimated coefficient for white tightness is small and indistinguishable from zero. On the other hand, the estimated coefficients for black and hispanic tightness are negative and statistically significant, consistent with the theory. Column 4 includes labor market conditions and state controls. The estimates are qualitatively and quantitatively similar to that in column 3. So again, including labor market conditions by itself is sufficient to get the 'right' estimated signs on tightness.

Column 5 includes unmarried earnings, race and state effects. The F tests show that these factors all have statistically significant explanatory power. The point estimate for black and hispanic tightness are -0.027 and -0.017 respectively. The point estimate for white tightness is small and positive but imprecisely estimated.

Finally, column 6 includes unrestricted marital match effects, labor market conditions and state effects. Again, the F test shows that labor market conditions are quantitatively important in explaining variations in weekly hours of work. The estimated coefficients on white and black tightness are small and imprecisely estimated. The estimated coefficient on hispanic tightness is -0.039 and statistically different from zero at the 5% level. As in the previous table, the standard errors in column 6 are signficantly larger.

We pooled estimates across columns 3 to 6 for black tightness as -0.02, hispanic tightness as -0.019 and white tightness as not different from zero. Using the pooled estimate of -0.02, a one standard deviation increase in tightness for blacks will decrease black wives' usual hours of work per week by $0.02 \times 1.2/0.09 = 0.27$ standard deviation. Using a pooled estimate of -0.019, a one standard deviation increase in tightness for hispanics will decrease hispanic wives' usual hours of work per week by $0.019 \times 1.1/0.12 = 0.17$ standard deviation. A one standard deviation increase in tightness for whites has minimal effect on white wives' hours of work per week.

Although the two measures of wives' labor supplies are very different, the results in Table 4 are broadly consistent with that in Table 3. With no or only state controls, the estimated coefficients on tightness often have the 'wrong' sign (columns 1 and 2). With individual controls, and/or labor market conditions controls, the estimated coefficients on tightness have negative signs, consistent with our theory. For a one standard deviation increase in tightness, black wives respond the most, hispanic wives in the middle and whites wives respond the least.

Table 5 presents OLS estimates on tightness on log weeks worked per year of wives. The results are broadly similar to the previous two tables. With tightness alone, or adding state effects, the estimated effects of tightness have the 'wrong' signs (columns 1 and 2).

Adding an individual's race, age and education or labor market conditions result in negative estimated effects of tightness weeks worked (columns 3 and 4). Column 5 includes labor market conditions, race and state effects. The point estimates on tightness are significantly negative for all three races.

Column 6 includes marital matches, state effects and labor market conditions. Although the estimated coefficients on black and hispanic tightness remain negative, they are no longer precisely measured. More surprisingly, the estimated effect of white tightness is positive and significantly different from zero at the 10% significance level.

We pooled estimates across columns 3 to 6 for white tightness as -0.004, black tightness as -0.014 and hispanic tightness as -0.017. Using the pooled estimate of -0.004, a one standard deviation increase in tightness for whites will decrease white wives' weeks worked per year by $0.004 \times 1.2/0.095 = 0.05$ standard deviation. Using the pooled estimate of -0.014, a one standard deviation increase in tightness for blacks will decrease black wives' weeks worked per year by by $0.014 \times 1.2/0.13 = 0.13$ standard deviation. Using a pooled estimate of -0.017, a one standard deviation increase in tightness for hispanics will decrease hispanic wives' weeks worked per year by $0.017 \times 1.1/0.165 = 0.11$ standard deviation. Again the estimated response, as measured by standard deviations of weeks worked by race, is largest for black, middle for hispanic and lowest for white wives.

Market tightness is an endogenous variable which may cause consistency problems in our OLS regressions. As per the discussion above with left out covariates, positive unobserved wives' labor supply disturbances are likely to induce an increase in tightness and therefore an upward bias in our estimates of the tightness effect. Tables 3a, 4a and 5a estimates the same equations as Tables 3, 4 and 5 by instrumenting market tightness with sex ratios. The first stage regressions were presented in Table 2. Consider the estimates in Tables 3a, 4a and 5a. Almost all the point estimates on tightness in columns 3, 4 and 5 are more negative than their counterparts in Tables 3, 4 and 5. They are as precisely estimated. The only case where the IV estimates are less precisely estimated is in column 6. The imprecision is not due to weak instruments. As shown in column 5 in Table 2, sex ratios strongly affect tightness. Rather the problem is including sex ratios with so many other covariates. Table 9 shows the reduced form regression of spousal labor supplies on sex ratios holding marital matches, states and labor market conditions constant. The F tests show that sex ratios are often not statistically different from zero. The majority of the IV point estimates on tightness in column 6 are negative. But due to their large standard errors, little can be drawn from those estimates.

Leaving out relevant covariates and ignoring endogeneity of market tightness leads to upward bias in our estimates of the effects of tightness. Correcting the two problems by different techniques leads to the same qualitative result, more negative estimates of tightness on wives' labor supplies. With appropriate corrections, even though we use three different measures of spousal labor supplies, the estimated magnitudes, as measured in standard deviations of wives's labor supplies across marriage markets by race, follow the same ranking across the different specifications.

An increase in market tightness reduces the labor force participation rates of wives of all races. With usual hours of work per week, blacks and hispanics have consistent negative responses whereas whites have negligible responses. With weeks worked per year, all wives responded negatively although the magnitude of white wives responses were small. The magnitudes of the labor supplies responses ranged from -0.05 to -0.41 standard deviation, with most estimates around -0.2. A -0.2 standard deviation response to a one standard deviation change in marriage market condition is quantitatively large because we are holding marital technologies and labor market conditions on labor supplies constant.

8.4 Market tightness and husbands' labor supplies

Average husbands' labor force participation rate is 0.94. The standard deviation of the participation rate is correspondingly small, although it is larger for non-whites because their average participation rates are lower.

Table 6 provides linear probability estimates of the effect of tightness on a husband's labor force participation status (lfs_m). The columns have the same covariates as the wives' regressions. Column 1 includes tightness measures alone. The estimated coefficient for white tightness is -0.008 and is statistically different from zero, which is inconsistent with the theory. We expect an increase in tightness to increase husband's labor supply. Adding state effects in column 2 do not change the 'wrong' estimated sign.

In column 3, when we add race, education and age effects for husbands and wives, the statistically significant negative estimate disappears. Only the estimated coefficient on black tightness is significant at the 10% level. Column 4 includes labor market conditions and state effects. Here all the estimated coefficients on tightness are positive and statistically different from zero. Column 5 includes, labor market conditions, race and state effects. The white tightness coefficient becomes significantly negative, contrary to the theory. The black tighness coefficient remains significantly positive. The hispanic tightness coefficient is slightly negative but imprecisely estimated. Finally, column 6 includes labor market conditions, marital matches and state effects. Now the estimated white coefficient is significantly positive and the non-white coefficients are not different from zero.

Pooling the point estimates from columns 3 to 6, we obtain 0.005, 0.007 and 0.004 for white, black and hispanic tightness. Using the pooled estimates, a one standard deviation increase in tightness will increase white, black and hispanic participation rate by $0.005 \times 0.74/.035 = 0.11$, $0.007 \times 1.2/0.084 = 0.1$ and $0.004 \times 1.05/0.105 = 0.04$ standard deviations respectively. Measured in terms of standard deviations, the white husbands' response is largest which is completely opposite the result for white wives. The hispanic husbands' response is the smallest. In general, measured in terms of standard deviations, the husbands' responses are generally smaller than their wives. Perhaps this is not surprising since the labor force participation rate for husbands are so much larger.

Table 7 presents OLS estimates of tightness on husbands' log usual hours of work per week. As before, columns 1 and 2 have 'wrong' estimated signs for the effect of white tightness. In column 3, 4, and 5, the white coefficient is positive (column 4) or indistinguishable from zero. The estimates for black are all positive and statistically significant at the 5% level. The estimates for hispanics are also positive and significant at the 10% or lower. Finally, the estimates in column 6 are indistinguishable from zero.

Pooling the point estimates from columns 3 to 6, we obtain 0.002, 0.012 and 0.006 for white, black and hispanic tightness. Using the pooled estimates, a one standard deviation increase in tightness will increase white, black and hispanic usual hours per week by $0.002 \times 0.74/.07 = 0.02$, $0.012 \times 1.2/0.14 = 0.10$ and $0.006 \times 1.05/0.147 = 0.043$ standard deviations respectively. Measured in terms of standard deviations, the black husbands' response is largest. The white husbands' response is the smallest. As a whole, the results in Table 7 suggests that non-white husbands work marginally more hours per week as market tightness increases. The estimated response of white husbands is minimal.

Table 8 presents estimates of tightness on husbands' log weeks worked per year. Again, columns 1 and 2 have the 'wrong' estimated signs for the effect of white tightness. The point estimates in column 3 are indistinguishable from zero. The point estimates in column 4 have the right signs and are statistically different from zero at the 5% and 10% significance levels. Column 5 has the 'wrong' sign on white tightness and the other coefficients are not different from zero. The point estimates in column 6 are indistinguishable from zero. Except for the estimates in column 4, the evidence for the theory using husbands' weeks worked is at best mixed.

Pooling the point estimates from columns 3 to 6, we obtain -0.001, 0.006 and -0.0025 for white, black and hispanic tightness. Using the pooled estimates, a one standard deviation increase in tightness will increase white, black and hispanic weeks worked per year by $-0.001 \times 0.74/0.095 = -0.008$, $0.006 \times 1.2/0.11 = 0.06$ and $-0.0025 \times 1.05/0.11 = -0.024$ standard deviations respectively. Although the white and hispanic responses have the 'wrong' signs, the estimated responses are all quantitatively small. Thus we also conclude that, to a first order, husbands do not change their weeks worked per year in response to changes in marriage market conditions.

Table 6a, 7a and 8a estimates the same equations as Tables 6, 7 and 8 by instrumenting market tightness with sex ratios. Comparing Tables 6 and 6a, 7 and 7a, 8 and 8a, the estimates for the effects of tightness on husbands' labor supplies are similar. There is no systematic evidence that the IV estimates are larger or more precisely estimated. Thus the endogeneity of market tightness, as far as husbands' labor supplies are concerned, is not a serious concern.

In general, husbands' weeks worked per year responded least, if at all, to changes in marriage market tightness. The labor force participation rates of husbands, particularly among blacks, responded more to changes in marriage market tightness. Finally, non-white husbands usual hours of work per week are most responsive to changes in marriage market tightness.

Column 4 is an exception. Independent of the labor supply measure used, OLS or IV, Column 4, which controls for labor market conditions and state effects, consistently shows that an increase in tightness increases husbands' labor supplies for all racial groups.

Again except for column 4, the point estimates are less precisely estimated compared with those of their wives. The general loss of precision in estimating male labor supplies in response to covariates, and sex ratios in particular, is well known (E.g. Angrist).

Comparing by standard deviations of responses, the wives' labor supply responses to the same change in market tightness are larger than that of their husbands. Wives also respond in all dimensions of labor supplies whereas husbands primarily adjust their hours of work per week and secondarily their participation rates. For both husbands and wives, non-white responses are generally quantitatively larger than white responses.

An explanation for the lack of responsiveness in the weeks worked and to a lesser extent the participation margin for husbands is that these are prime working age males. Because the primarily role of these husbands within the marriage is to work, there is little room for adjustment of weeks worked or the participation margin in response to tightness variation. Put another way, the variation in weeks worked or participation among these husbands may be primarily due to involuntary layoffs, disability, schooling, or other non-leisure activities. These non-leisure variations in labor supplies are not within the scope of this theory.

The other striking empirical finding is the larger responses by non-whites' labor supplies to changes in market tightness. Table 2 shows that across cells, there is more variation in both labor supplies and tightness for non-whites than whites.

8.5 Alternative specifications

For husbands, because of the high labor force participation rates, we also estimated the husbands' labor force participation models by probit and intrumental probit regressions. The estimated results were not different from the OLS estimates.

For husbands, we also estimated one tightness coefficient for all races. The results were as expected, essentially an average of the three separate estimates by races. The results using a single coefficient reinforced the finding that husbands primarily adjust usual hours of work per week, then their labor force participation rate and least by weeks worked per year.

We deleted observations where usual hours of work exceeded 80 hours. Except for a tiny increase in precision, the estimates are unchanged.

We also estimate the effects of tightness on annual hours of work (weekly hours multiplied by weeks worked per year). The estimated effects are consistent with that presented here for the two labor supply measures considered separately.

We were also worried about measurement error in constructing tightness and sex ratios due to thin cells. We deleted cells with less than 20 observations. This resulted in the deletion of about 100 cells. Using this smaller sample, the empirical results, both in terms of the point estimates and the estimated standard errors, are similar to that using the larger sample. Thus measurement error when constructing tightness or sex ratios due to thin cells is not a first order problem.

We also investigated tightness effects interacted with other individual characteristics. There is some evidence that spouses' labor supply responses to market tightness also differ by their husbands' education.

9 Literature review (incomplete)

As discussed in the introduction, our collective model of marriage matching integrates the collective model with marriage matching. Our collective model of the household builds on BCM. The collective model has a long history beginning with Chiappori (1988, 1992). A large body of empirical work tested the restrictions of the unitary model versus the collective model and consistently finds the restrictions implied by the unitary model are rejected while those implied by the collective model are not (a partial list includes Lundberg, 1988; Thomas, 1990; Fortin and Lacroix, 1997; Chiappori, Fortin, and Lacroix, 2002; and Duflo, 2003).

We add to BCM efficient spousal risk sharing. Efficient spousal risk sharing models have been discussed by....

The marriage matching model builds on the transferable utilities models of the marriage market, and in particular CS. Dagsvik have a closely related non-transferable utilities model of the marriage market.

Starting with Grossbard-Schectman (1984), there is a large empirical literature which studies the impact of sex ratios on spousal labor supplies. Grossbard-Schectman (1984) constructs a model where more favorable conditions in the marriage market improve the bargaining position of individuals within marriage. One implication of Grossbard-Schectman and related models that has been tested extensively in the literature is that, for example, an improvement in marriage market conditions for women translates into a greater allocation of household resources towards women, which has a direct income effect on labor supply. Tests of this hypothesis have received support in the literature (see among others, Becker, 1981; Grossbard-Schectman, 1984, 1993, 2000; Grossbard-Schectman and Granger, 1998; Chiappori, Fortin, and Lacroix, 2002; Seitz, 2004; Grossbard and Amuedo-Dorantes, 2007). Our empirical work considers the link between the sex ratio and both marriage and labor supply decisions in a general version of the collective model with matching.

Seitz (2004) first proposed the measure of marriage market tightness used in this paper. She constructs and estimates a dynamic model in which the sex ratio, marriage, and employment decisions are jointly determined. She finds that variation in the ratio of single men to single women across race can explain much of the black-white differences in marriage and employment in the US.

It is also convenient at this point to discuss empirical tests of the static collective model using spousal labor supplies such as CFL. In their paper, they estimate restricted spousal labor supplies models where the restrictions are derived from a static collective model. They instrument spousal wages, children, and nonlabor income with education, age, father's education, city size and religion. Different values of these instruments define different types of individuals in different regions. There is no instrument which captures the transitory component of wages.[22] Our interpretation of their empirical results is that they provide evidence of (1) efficient bargaining between different types of spouses and (2), spousal bargaining power depends on the type of marriage matches as we assume in this paper. Their empirical results are not informative about whether there is efficient risk sharing with the household as we suppose, or whether there is not as they supposed. In order to empirically distinguish between whether there is efficient risk sharing or not, one would need an instrument for transitory wage shocks when one estimates spousal labor supplies equations. As mentioned in Section 7, the results in this paper also do not shed light on whether there is efficient risk sharing or not. Our rationale for using the risk sharing interpretation as we do here is primarily for empirical convenience.

Our static formulation of the collective model in this section is also close to Del Boca and Flinn's formulation Instead of competitive marriage market clearing as we use in this paper, they use two different household allocation models and the deferred acceptance algorithm to construct a marriage market equilibrium. The difference in equilibrium constructions may not be significant in large marriage markets.[23] The empirically significant difference between their paper and ours is that, like CFL, they impose the restriction that the invariant gains to marriage and utilities from consumption and labor supply are the same for all types of marriages.[24] This restriction imposes restrictions on marriage matching patterns and spousal labor supplies in a single marriage market. We use the exactly opposite assumption: we do not impose any structure on invariant gains and utilities from consumption and labor supply across different types of marriages. Thus we do not impose any marriage matching and spousal labor supplies pattern in a single marriage market.

[22] Although age changes for an individual over time, the changes are deterministic.

[23] Dagsvik () has shown that when individuals' preferences over different spouses are characterized by McFadden's random utility model, using a non-transferable utility deferred acceptance algorithm to construct a large marriage market equilibrium results in a marriage matching function that is closely related to that discussed in this paper (See CS for further discussion).

[24] Their household production functions depend on the specific marital match which generates demand for different types of matches.

10 Appendix 1: Proof of proposition 1

Abstracting from i, j, g, G, the social planner solves:

$$\max_{\{C,c,H,h,K\}} \mathbf{E}(\widehat{Q}(C, 1-H, K|Z) + p\mathbf{E}(\widehat{q}(c, 1-h, K)|Z)$$

subject to, for each state S,

$$c + C + K \leq A + WH + wh \tag{40}$$

Let Z^* be the value of Z evaluated at the optimum. The first order conditions with respect to c, C, H, h, K and the multiplier λ for each state S are:

$$\widehat{Q}^*_C = \lambda \tag{41}$$
$$p\widehat{q}^*_c = \lambda \tag{42}$$
$$\widehat{Q}^*_{1-H} = \lambda W \tag{43}$$
$$p\widehat{q}^*_{1-h} = \lambda w \tag{44}$$
$$\widehat{Q}^*_K + p\widehat{q}^*_K = \lambda \tag{45}$$

Using the first order conditions, as p changes, for each state S,

$$\frac{\partial \widehat{Q}^*}{\partial p} = \lambda(C^*_p - WH^*_p + K^*_p) - p\widehat{q}^*_K K^*_p \tag{46}$$
$$\frac{\partial \widehat{q}^*}{\partial p} = \frac{\lambda}{p}(c^*_p - wh^*_p) + \widehat{q}^*_K K^*_p \tag{47}$$

which imply:

$$\frac{1}{p}\frac{\partial \widehat{Q}^*}{\partial p} + \frac{\partial \widehat{q}^*}{\partial p} = \frac{\lambda}{p}(c^*_p - wh^*_p + K^*_p + C^*_p - WH^*_p) \tag{48}$$

Since the budget constraint has to hold for every S,

$$c^*_p + C^*_p + K^*_p - wh^*_p - WH^*_p = 0$$
$$\Rightarrow \frac{\partial \widehat{Q}^*}{\partial p} = -p\frac{\partial \widehat{q}^*}{\partial p} \tag{49}$$

Since (49) holds for every state S, (6) obtains.

11 Appendix 2: Proof of $\frac{\partial \mathbf{E}H^*}{\partial p_{ij}} > 0$ and $\frac{\partial \mathbf{E}h^*}{\partial p_{ij}} < 0$

For an $\{i, j, G, g\}$ family, given realizations of wages and asset income, and taking p_{ij} as given, the planner solves a one period household maximization problem, P2. The objective of this appendix is to show that for any admissible realization of wages and asset income, and taking p_{ij} as fixed, labor supply of the wife will increase and labor supply of the husband will decrease as p_{ij} increases.

Ignoring the i, j, G, g subscripts, and assuming that realized wages and asset income are W, w and A, the planner's problem is:

$$\max_{C,L,c,l,K} \widehat{Q}(\Omega(C,L),K) + p\widehat{q}(\omega(c,l),K) \tag{50}$$

$$s.t.\ c + C + K + WL + wl \leq A + W + w = I \tag{51}$$

Given the weak separability between private goods and the public good in each spouse's utility function, let Y and y be the expenditure on the wife's and husband's private goods respectively. Then the wife will solve:

$$\max_{C,L} \widehat{Q}(\Omega(C,L),K) \tag{52}$$

$$s.t.\ C + WL \leq Y \tag{53}$$

Due to the weak separability, the optimal levels of private goods, C and L, only depend on W and Y, and are independent of K. We will assume that the optimal level of L is increasing in Y. The standard restriction on $\Omega(C,L)$, i.e. concavity and $\Omega_{LL} - \Omega_{CL} < 0$, that is leisure increases as Y increases, is sufficient. Solving (52) will result in an indirect utility:

$$\widetilde{Q}(Y,K) \tag{54}$$

The husband will solve:

$$\max_{c,l} \widehat{q}(\omega(c,l),K) \tag{55}$$

$$s.t.\ c + wl \leq y \tag{56}$$

Again, the optimal levels of private goods, c and l, only depend on w and y, and are independent of K. We will assume that the optimal level of l is increasing in y. The standard restriction on $\omega(c,l)$, i.e. concavity and $\omega_{ll} - \omega_{cl} < 0$, that is leisure increases as y increases, is sufficient. Solving (55) will result in an indirect utility:

$$\widetilde{q}(y,K) \tag{57}$$

All the above implications of (50) and (51) are known from BCM.

Assume that $\widetilde{q}(y,K)$ is increasing and quasi-concave, and $\widetilde{q}_{yK} > 0$.

So we can rewrite the planner's problem as:

$$\max_{Y,y,K} \widetilde{Q}(Y,K) + p\widetilde{q}(y,K) \tag{58}$$

$$s.t.\ Y + y + K \leq I \tag{59}$$

Let $\mathbf{Y} = -Y$. Then the planner's problem, (58) and (59), can be rewritten as:

$$\max_{\mathbf{Y},y} R(\mathbf{Y}, y, p) = \widetilde{Q}(-\mathbf{Y}, I - y + \mathbf{Y}) + p\widetilde{q}(y, I - y + \mathbf{Y}) \tag{60}$$

$R(\mathbf{Y}, y, p)$ is supermodular in $\mathbf{Y}, y, K$ and p if:

$$R_{\mathbf{Y}y} = \widetilde{Q}_{YK} - \widetilde{Q}_{KK} + p(\widetilde{q}_{Ky} - \widetilde{q}_{KK}) > 0 \tag{61}$$

$$R_{\mathbf{Y}p} = \widetilde{q}_K > 0 \tag{62}$$

$$R_{yp} = \widetilde{q}_y - \widetilde{q}_K > 0 \tag{63}$$

The first order condition to the planner's problem is:

$$-\widetilde{Q}_Y + \widetilde{Q}_K + p\widetilde{q}_K = 0 \tag{64}$$

$$-\widetilde{Q}_K + p(\widetilde{q}_y - \widetilde{q}_K) = 0 \tag{65}$$

(65) implies (63).

(61) and (62) are implied by the assumption that $\widetilde{Q}(Y, K)$ is increasing in both arguments and quasi-concave in K, and $\widetilde{Q}_{YK} > 0$. An economically meaningful interpretation is that K is a normal good. In terms of the planner's primitive objective function (50), a sufficient condition is $\widehat{Q}(\Omega(C, L), K) + p\widehat{q}(\omega(c, l), K) = \Omega(C, L)\widehat{\Omega}(K) + p\omega(c, l)\widehat{\omega}(K)$ for increasing concave functions $\widehat{\Omega}$ and $\widehat{\omega}$.

Since $R(\mathbf{Y}, y, p)$ is supermodular, using the monotone theorem of Milgrom and Shannon (1994), $\mathbf{Y}$ and y are both increasing in p, and thus Y is decreasing in p. Since L and l are increasing in Y and y respectively, L will decrease and l will increase as p increases. Thus H and h are increasing and decreasing in p respectively.

See BCM for other implications of the weakly separable collective model of spousal labor supplies with public goods.

11.1 Cobb-Douglas preferences

Let the preferences of the husband and the wife be:

$$\widehat{q}(c, l, K) = l^{\alpha_h} c^{1-\alpha_h} K^{\delta_h} \tag{66}$$

$$\widehat{Q}(C, L, K) = L^{\alpha_f} C^{1-\alpha_f} K^{\delta_f} \tag{67}$$

Then:

$$\omega(c, l) = l^{\alpha_h} c^{1-\alpha_h} \tag{68}$$

$$\widehat{\omega}(K) = K^{\delta_h} \tag{69}$$

$$\Omega(C, L) = L^{\alpha_f} C^{1-\alpha_f} \tag{70}$$

$$\widehat{\Omega}(K) = K^{\delta_f} \tag{71}$$

Given y and Y, optimal leisure will satisfy:

$$l^* = \frac{\alpha_h y}{w} \tag{72}$$

$$L^* = \frac{\alpha_f Y}{W} \tag{73}$$

l^* and L^* are increasing in y and Y respectively as required.
The indirect utilities are:

$$\widetilde{Q}(Y, K) = \alpha_f Y K^{\delta_f} \tag{74}$$

$$\widetilde{q}(y, K) = \alpha_h y K^{\delta_h} \tag{75}$$

for positive constants α_f and α_h. $R(\mathbf{Y}, y, p)$ is supermodular as required. Thus l^* will increase and L^* will decrease as p increases.

12 Appendix 3: Proof of existence of equilibrium

In the proof, we need:

$$E_{ij}(\underline{p}) > 0 \text{ as } \underline{p} \to \infty \tag{Condition A1}$$

$$E_{ij}(\underline{p}) < 0 \text{ as } \underline{p} \to 0 \tag{Condition A2}$$

That is, the utility functions q and Q must be such that as $\underline{p}$ approaches 0, men will not want to marry. And as $\underline{p}$ approaches ∞, women will not want to marry.

Let $\beta_{ij} = (1 + p_{ij})^{-1}$ where $\beta_{ij} \in [0, 1]$ is the utility weight of the wife in an $\{i, j\}$ marriage and $(1 - \beta_{ij})$ is the utility weight of the husband.

We know:

$$\frac{\partial \underline{\mu}_{ij}}{\partial p_{ij}} > 0 \tag{76}$$

$$\frac{\partial \underline{\mu}_{ij}}{\partial p_{ik}} < 0, \; k \neq j \tag{77}$$

$$\frac{\partial \underline{\mu}_{kl}(\beta)}{\partial p_{ij}} = 0; \; k \neq i, l \neq j \tag{78}$$

$$\frac{\partial \overline{\mu}_{ij}}{\partial p_{ij}} < 0 \tag{79}$$

$$\frac{\partial \overline{\mu}_{ij}}{\partial p_{kj}} > 0, \; k \neq i \tag{80}$$

$$\frac{\partial \overline{\mu}_{kl}(\beta)}{\partial p_{ij}} = 0; \; k \neq i, l \neq j \tag{81}$$

Let β be a matrix with typical element β_{ij} and the IxJ matrix function $E(\beta)$ be:

$$E(\beta) = \underline{\mu}(\beta) - \overline{\mu}(\beta) \tag{82}$$

An element of $E(\beta)$, $E_{ij}(\beta)$, is the excess demand for j type wives by i type men given β.

An equilibrium exists if there is a β^* such that $E(\beta^*) = 0$.

Assume that there exists a function $f(\beta) = \alpha E(\beta) + \beta$, $\alpha > 0$ which maps $[0,1]^{I*J} \to [0,1]^{I*J}$ and is non-decreasing in β. Tarsky's fixed point theorem says if a function $f(\beta)$ maps $[0,k]^N \to [0,k]^N$, $k > 0$, and is non-decreasing in β, there exists $\beta^* \in [0,k]^N$ such that $\beta^* = f(\beta^*)$. Let $f(\beta) = \alpha E(\beta) + \beta$, $k = 1$ and $N = I * J$, and apply Tarsky's theorem to get $\beta^* = \alpha E(\beta^*) + \beta^* \Rightarrow E(\beta^*) = 0$.

Thus the proof of existence reduces to showing $f(\beta)$ which has the required properties.

We know from (76) to (81) that:

$$\frac{\partial E_{ij}(\beta)}{\partial \beta_{ij}} < 0 \tag{83}$$

$$\frac{\partial E_{ik}(\beta)}{\partial \beta_{ij}} > 0 \tag{84}$$

$$\frac{\partial E_{kj}(\beta)}{\partial \beta_{ij}} > 0 \tag{85}$$

$$\frac{\partial E_{kl}(\beta)}{\partial \beta_{ij}} = 0;\ k \neq i, l \neq j \tag{86}$$

(83) to (86) imply that $E(\beta)$ satisfies the Weak Gross Substitutability (WGS) assumption.

We now show that the WGS property of $E(\beta)$ implies that we can construct $f(\beta)$, such that $f(\beta)$ maps $[0,1]^{I*J} \to [0,1]^{I*J}$ and is non-decreasing in β. The proof follows the solution to exercise 17.F.16^C of Mas-Colell, Whinston and Green given in their solution manual (Hara, Segal and Tadelis, 1996). N.B. Unlike them, we do not start with Gross Substitution, we begin from WGS, but it turns out to be sufficient for Tarsky's conditions.

For notational convenience, now onwards we'll treat the matrix function $E(\beta)$, as a vector function.

Let $N = I * J$ and 1_N be a $N \times 1$ vector of ones. $E(\beta) : [0,1]^N \to R^N$ is continuously differentiable and satisfies $E(0_N) >> 0_N$ and $E(1_N) << 0_N$ (Conditions A1 and A2).

For every $\beta \in [0,1]^N$ and any n, if $\beta_n = 0$, then $E_n(\beta) > 0$.

For every $\beta \in [0,1]^N$ and any n, if $\beta_n = 1$, then $E_n(\beta) < 0$.

If $\beta = \{0_N, 1_N\}$, the facts follow from Conditions A1 and A2. Otherwise, they are due to Conditions A1 and A2, and (83) to (86), i.e. WGS.

For each n, define $C_n = \{\beta \in [0,1]^N : E_n(\beta) \geq 0\}$ and $D_n = \{\beta \in [0,1]^N : E_n(\beta) \leq 0\}$.

Then $C_n \subset \{\beta \in [0,1]^N : \beta_n < 1\}$ and $D_n \subset \{\beta \in [0,1]^N : \beta_n > 0\}$.

Then by continuity, the following two minima, $_{ij}((1-\beta_n)/E_n(\beta) : \beta \in C_n)$ and $_{ij}(-\beta_n/E_n(\beta) : \beta \in D_n)$, exist and are positive. Let $\underline{\beta}_n > 0$ be smaller than those two minima. Then, for all $\alpha \in (0, \underline{\beta}_n)$ and any $\beta \in [0,1]^N$, we have $0 \leq \alpha E_n(\beta) + \beta_n \leq 1$.

For each n, define $L_n =_{ij} \{|\partial E_n(\beta)/\partial \beta_n| : \beta \in [0,1]^N\}$. Then, for all $\alpha \in (0, 1/L_n)$,

$$
\begin{aligned}
\frac{\partial(\alpha E_n(\beta) + \beta_n)}{\partial \beta_n} &= \alpha \frac{\partial E_n(\beta)}{\partial \beta_n} + 1 \geq -\alpha L_n + 1 > 0 \\
\frac{\partial(\alpha E_n(\beta) + \beta_n)}{\partial \beta_m} &= \alpha \frac{\partial E_n(\beta)}{\partial \beta_m} \geq 0; n \neq m, \text{ follows from (83) to (86).}
\end{aligned}
$$

Now let $K =_{ij} \{\underline{\beta}_1, .., \underline{\beta}_N, 1/L_1, .., 1/L_N\}$, choose $\alpha \in (0, K)$, then $f(\beta) = \alpha E(\beta) + \beta \in [0,1]^N$ and $\partial f(\beta)/\partial \beta_n \geq 0$ for every $\beta \in [0,1]^N$, and any n. Hence Tarsky's conditions are satisfied.

Table 1: Summary statistics

Individual observations

Variable	Obs	Mean	Std. Dev.	Min	Max
white	746908	.8562925	.3507932	0	1
black	746908	.0814654	.2735487	0	1
hispanic	746908	.0622421	.241595	0	1
age_m	746908	2.60135	1.048197	1	4
age_f	746908	2.640816	1.037335	1	4
edu_HS_m	746908	.6633964	.4725483	0	1
edu_HS_f	746908	.6652957	.4718873	0	1
lmt_w	746908	.01903	.4627821	-1.869631	2.27177
lmt_b	746908	-.0280272	.2506345	-3.60296	2.422626
lmt_h	746908	-.005826	.1774027	-2.879106	3.03591
lsr_ij	746908	-.0100798	.4476922	-2.764601	2.342305
lsr_age	746908	-.018646	.0853079	-.4813294	.455753
lsr_race	746908	-.0057381	.0626556	-.3377161	.4800958
lsr_edu	746908	-.018652	.4340826	-1.478899	1.442266
lsr	746908	-.0153439	.036479	-.1105111	.1578105
lfs_m	746908	.9412187	.2352151	0	1
lfs_f	746908	.7269281	.4455378	0	1
lnhrs_m	725299	7.691019	.3910135	0	8.546364
lnhrs_f	589361	7.253217	.79296	0	8.546364
lnh_w_m	725299	3.806601	.2331916	0	4.59512
lnh_w_f	589361	3.529625	.4474814	0	4.59512
lnwks_m	725299	3.884418	.2845084	0	3.951244
lnwks_f	589361	3.723591	.5345615	0	3.951244
m_mean_learn	746908	10.21445	.2885442	9.081255	10.98433
f_mean_learn	746908	9.941436	.3316821	8.290825	10.89547
m_earn_zero	746908	.1054286	.0596381	0	.4883721
f_earn_zero	746908	.1089577	.0561256	0	.3673469
m_sd_learn	746908	.8280522	.0841741	.2547058	1.857046
f_sd_learn	746908	.8427618	.0919874	.2222874	1.901179
m_mean_las~t	746888	7.426221	.3777734	4.493598	10.60162
f_mean_las~t	746888	7.508996	.4949416	4.877075	11.11245
m_sd_lasset	746781	2.038198	.1756193	.0330005	4.720074
f_sd_lasset	746872	1.851987	.2501231	.1246987	3.480812
m_asset_zero	746908	.6694445	.1204461	.2222222	1
f_asset_zero	746908	.5796434	.0905831	.183908	1

Cell means by race:

Variable	Cells	Mean	Std. Dev.	Min	Max
White					
lmt	1612	-.0025641	.7372727	-1.808126	2.27177
lfs_f	1612	.7477932	.1118168	.1818182	1
lfs_m	1612	.9589333	.0346237	.6	1
lnhrs_f	1583	7.23476	.1685743	6.037902	7.707701
lnhrs_m	1608	7.701237	.0704626	7.115595	7.935529
lnh_w_f	1583	3.516285	.1043758	2.881536	3.872241
lnh_w_m	1608	3.812955	.0438586	3.411621	4.079473
lnwks_f	1583	3.718474	.0949979	2.825608	3.951244
lnwks_m	1608	3.888281	.0448276	3.292703	3.951244
Black					
lmt	816	-.38937	1.21787	-3.412441	2.152944
lfs_f	816	.8000458	.1218876	.2	1
lfs_m	816	.8972384	.0847101	.4285714	1
lnhrs_f	770	7.380917	.1757796	6.47063	7.8484
lnhrs_m	806	7.592835	.1421132	6.655622	8.028186
lnh_w_f	770	3.630026	.0906155	3.200601	3.976723
lnh_w_m	806	3.754597	.0703003	3.366909	4.076942
lnwks_f	770	3.750891	.129734	3.058823	3.951244
lnwks_m	806	3.838238	.1100292	2.969893	3.951244
Hispanic					
lmt	567	-.1221349	1.050494	-2.879106	2.48425
lfs_f	567	.6402295	.1420297	0	1
lfs_m	567	.8510994	.1053707	.4	1
lnhrs_f	494	7.245783	.2233537	6.286896	7.730768
lnhrs_m	553	7.593462	.1471057	6.768757	8.023123
lnh_w_f	494	3.567683	.1163548	3.074066	3.849726
lnh_w_m	553	3.762296	.0844549	3.340286	4.082714
lnwks_f	494	3.6781	.1652286	2.901413	3.951244
lnwks_m	553	3.831167	.1090669	3.145307	3.951244

Table 2: Determinants of market tightness

	(1)	(2)	(3)	(4)	(5)
	lmt_a	lmt_a	lmt_a	lmt_a	lmt_a
ij SR	1.020				1.039
	(0.013)**				(0.023)**
Age SR	-1.245				-0.316
	(0.040)**				(0.049)**
Race SR	0.886				0.328
	(0.049)**				(0.062)**
Educ SR	0.165				0.004
	(0.017)**				(0.029)
SR	0.574				0.000
	(0.126)**				(0.000)
Black		-0.416	-0.419	-1.084	
		(0.019)**	(0.021)**	(0.040)**	
Hispanic		-0.115	-0.128	-0.440	
		(0.020)**	(0.023)**	(0.040)**	
M avg learn				-1.816	
				(0.093)**	
F avg learn				1.403	
				(0.071)**	
M zero earn				2.854	
				(0.295)**	
F zero earn				-3.372	
				(0.315)**	
M sd learn				-0.294	
				(0.126)*	
F sd learn				0.275	
				(0.131)*	
M avg lasset				0.051	
				(0.028)	
F avg lasset				0.099	
				(0.029)**	
M sd lasset				-0.067	
				(0.041)	
F sd lasset				0.138	
				(0.057)*	
m_asset_zero				0.976	
				(0.200)**	
f_asset_zero				1.042	
				(0.206)**	
Observations	2995	2995	2995	2976	2976
R-squared	0.943	0.822	0.830	0.804	0.983
i & j ages		0.00	0.00		
Race		0.00	0.00	0.00	
i & j edu		0.00	0.00		
States			0.00	0.00	0.00
Unmarried earn				0.00	0.05
martial match					0.00

Table 3: Effects of market tightness on labor force status of wives

	(1)	(2)	(3)	(4)	(5)	(6)
	lfs_f	lfs_f	lfs_f	lfs_f	lfs_f	lfs_f
lmt_w	0.087	0.086	-0.016	-0.014	-0.026	0.001
	(0.004)**	(0.003)**	(0.005)**	(0.004)**	(0.005)**	(0.004)
lmt_b	0.000	-0.001	-0.032	-0.049	-0.048	-0.024
	(0.005)	(0.005)	(0.004)**	(0.004)**	(0.005)**	(0.011)*
lmt_h	0.050	0.044	-0.033	-0.011	-0.030	-0.056
	(0.008)**	(0.005)**	(0.006)**	(0.006)	(0.006)**	(0.014)**
Black			0.052		-0.020	
			(0.003)**		(0.007)**	
hispanic			-0.079		-0.100	
			(0.006)**		(0.007)**	
Observations	746925	746925	746925	746769	746769	746769
R-squared	0.008	0.016	0.026	0.024	0.025	0.031
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 3a: Effects of market tightness on labor force status of wives [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lfs_f	lfs_f	lfs_f	lfs_f	lfs_f	lfs_f
lmt_w	0.100	0.100	-0.036	-0.019	-0.026	-0.004
	(0.004)**	(0.003)**	(0.006)**	(0.005)**	(0.006)**	(0.005)
lmt_b	0.008	0.010	-0.041	-0.045	-0.048	-0.014
	(0.005)	(0.005)	(0.004)**	(0.004)**	(0.005)**	(0.012)
lmt_h	0.042	0.039	-0.046	-0.019	-0.031	-0.060
	(0.006)**	(0.004)**	(0.006)**	(0.005)**	(0.006)**	(0.016)**
Black			0.047		-0.020	
			(0.004)**		(0.008)**	
Hispanic			-0.083		-0.100	
			(0.006)**		(0.007)**	
Observations	746925	746925	746925	746769	746769	746769
R-squared	0.008	0.016	0.026	0.024	0.025	0.031
States		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 4: Effects of market tightness on log hours per weeks of wives

	(1)	(2)	(3)	(4)	(5)	(6)
	lnh_w_f	lnh_w_f	lnh_w_f	lnh_w_f	lnh_w_f	lnh_w_f
lmt_w	0.074	0.073	0.006	0.006	0.008	0.002
	(0.004)**	(0.003)**	(0.005)	(0.004)	(0.005)	(0.006)
lmt_b	-0.031	-0.021	-0.026	-0.031	-0.027	0.009
	(0.006)**	(0.004)**	(0.003)**	(0.003)**	(0.004)**	(0.009)
lmt_h	0.011	0.012	-0.026	-0.019	-0.017	-0.039
	(0.006)	(0.004)**	(0.004)**	(0.004)**	(0.004)**	(0.015)**
Black			0.085		0.009	
			(0.004)**		(0.007)	
Hispanic			0.045		0.001	
			(0.005)**		(0.006)	
Observations	589374	589374	589374	589300	589300	589300
R-squared	0.006	0.016	0.022	0.023	0.023	0.027
States		0.00	0.00	0.00	0.00	0.00
Unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.29	
i & j ages			0.00			
i & j edu			0.00			

Table 4a: Effects of market tightness on log hours per week of wives [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lnh_w_f	lnh_w_f	lnh_w_f	lnh_w_f	lnh_w_f	lnh_w_f
lmt_w	0.074	0.074	-0.024	-0.004	-0.004	-0.003
	(0.004)**	(0.003)**	(0.007)**	(0.005)	(0.006)	(0.006)
lmt_b	-0.025	-0.019	-0.042	-0.033	-0.034	0.003
	(0.006)**	(0.005)**	(0.004)**	(0.003)**	(0.004)**	(0.010)
lmt_h	0.010	0.010	-0.043	-0.023	-0.023	-0.023
	(0.006)	(0.004)*	(0.005)**	(0.005)**	(0.005)**	(0.017)
Black			0.077		0.001	
			(0.004)**		(0.007)	
Hispanic			0.041		-0.003	
			(0.005)**		(0.006)	
Observations	589374	589374	589374	589300	589300	589300
R-squared	0.006	0.016	0.022	0.023	0.023	0.027
States		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.81	
i & j ages			0.00			
i & j edu			0.00			

Table 5: Effects of market tightness on log annual weeks of wives

	(1)	(2)	(3)	(4)	(5)	(6)
	lnwks_f	lnwks_f	lnwks_f	lnwks_f	lnwks_f	lnwks_f
lmt_w	0.036	0.037	-0.003	-0.006	-0.020	0.012
	(0.002)**	(0.002)**	(0.005)	(0.004)	(0.004)**	(0.005)*
lmt_b	0.002	0.004	-0.010	-0.014	-0.026	-0.014
	(0.004)	(0.004)	(0.004)*	(0.004)**	(0.005)**	(0.012)
lmt_h	0.012	0.012	-0.017	-0.008	-0.020	-0.020
	(0.006)*	(0.005)*	(0.005)**	(0.005)	(0.005)**	(0.017)
Black			0.018		-0.039	
			(0.003)**		(0.007)**	
Hispanic			-0.025		-0.050	
			(0.005)**		(0.007)**	
Observations	589374	589374	589374	589300	589300	589300
R-squared	0.001	0.004	0.006	0.005	0.006	0.008
States		0.00	0.00	0.00	0.00	0.00
Unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 5a: Effects of market tightness on log annual weeks of wives [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lnwks_f	lnwks_f	lnwks_f	lnwks_f	lnwks_f	lnwks_f
lmt_w	0.040	0.041	-0.024	-0.017	-0.035	0.006
	(0.003)**	(0.002)**	(0.006)**	(0.004)**	(0.006)**	(0.006)
lmt_b	0.006	0.008	-0.019	-0.015	-0.031	-0.004
	(0.004)	(0.004)*	(0.004)**	(0.004)**	(0.005)**	(0.013)
lmt_h	0.012	0.012	-0.028	-0.013	-0.025	-0.011
	(0.006)*	(0.005)*	(0.006)**	(0.006)*	(0.006)**	(0.021)
Black			0.013		-0.048	
			(0.004)**		(0.007)**	
Hispanic			-0.028		-0.054	
			(0.005)**		(0.007)**	
Observations	589374	589374	589374	589300	589300	589300
R-squared	0.001	0.003	0.006	0.005	0.006	0.008
States		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 6: Effects of market tightness on labor force status of husbands

	(1)	(2)	(3)	(4)	(5)	(6)
	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m
lmt_w	-0.008	-0.008	0.001	0.010	-0.005	0.005
	(0.001)**	(0.001)**	(0.002)	(0.002)**	(0.001)**	(0.002)**
lmt_b	0.029	0.027	0.004	0.013	0.006	0.008
	(0.004)**	(0.003)**	(0.002)*	(0.002)**	(0.002)**	(0.007)
lmt_h	0.013	0.011	-0.002	0.016	-0.003	0.003
	(0.007)	(0.006)	(0.003)	(0.004)**	(0.003)	(0.010)
Black			-0.070		-0.035	
			(0.002)**		(0.003)**	
Hispanic			-0.106		-0.088	
			(0.002)**		(0.003)**	
Observations	746925	746925	746925	746769	746769	746769
R-squared	0.001	0.004	0.025	0.022	0.026	0.027
States		0.00	0.00	0.00	0.00	0.00
Unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 6a: Effects of market tightness on labor force status of husbands [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m
lmt_w	-0.007	-0.007	0.001	0.005	-0.007	0.002
	(0.001)**	(0.002)**	(0.002)	(0.002)**	(0.002)**	(0.002)
lmt_b	0.031	0.031	0.005	0.015	0.006	0.015
	(0.004)**	(0.003)**	(0.002)*	(0.002)**	(0.002)**	(0.008)
lmt_h	0.009	0.008	-0.002	0.011	-0.004	-0.006
	(0.006)	(0.005)	(0.003)	(0.004)**	(0.003)	(0.011)
Black			-0.069		-0.036	
			(0.002)**		(0.003)**	
Hispanic			-0.106		-0.088	
			(0.002)**		(0.003)**	
Observations	746925	746925	746925	746769	746769	746769
R-squared	0.001	0.004	0.025	0.021	0.026	0.027
States		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 7: Effects of market tightness on log hours per weeks of husbands

	(1)	(2)	(3)	(4)	(5)	(6)
	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m
lmt_w	-0.017	-0.017	0.000	0.012	-0.001	-0.002
	(0.001)**	(0.001)**	(0.002)	(0.002)**	(0.002)	(0.002)
lmt_b	0.024	0.025	0.007	0.022	0.009	0.010
	(0.003)**	(0.003)**	(0.002)**	(0.002)**	(0.002)**	(0.007)
lmt_h	0.004	0.004	0.004	0.013	0.004	0.005
	(0.004)	(0.004)	(0.002)*	(0.003)**	(0.002)*	(0.008)
Black			-0.064		-0.037	
			(0.002)**		(0.003)**	
Hispanic			-0.052		-0.033	
			(0.002)**		(0.002)**	
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.002	0.004	0.016	0.016	0.017	0.017
States		0.00	0.00	0.00	0.00	0.00
Unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 7a: Effects of market tightness on log hours per week of husbands [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m
lmt_w	-0.014	-0.014	0.003	0.011	-0.003	-0.002
	(0.001)**	(0.001)**	(0.002)	(0.002)**	(0.002)	(0.002)
lmt_b	0.024	0.025	0.008	0.021	0.007	0.013
	(0.003)**	(0.003)**	(0.002)**	(0.002)**	(0.002)**	(0.008)
lmt_h	0.004	0.004	0.006	0.013	0.003	0.007
	(0.004)	(0.004)	(0.002)**	(0.003)**	(0.002)	(0.010)
Black			-0.064		-0.039	
			(0.002)**		(0.003)**	
hispanic			-0.052		-0.034	
			(0.002)**		(0.002)**	
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.002	0.004	0.016	0.016	0.017	0.017
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 8: Effects of market tightness on log annual weeks of husbands

	(1)	(2)	(3)	(4)	(5)	(6)
	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m
lmt_w	-0.009	-0.009	-0.002	0.007	-0.007	0.001
	(0.001)**	(0.001)**	(0.002)	(0.002)**	(0.002)**	(0.002)
lmt_b	0.020	0.021	0.004	0.015	0.001	0.004
	(0.003)**	(0.003)**	(0.002)	(0.002)**	(0.002)	(0.010)
lmt_h	0.004	0.003	-0.001	0.007	-0.003	-0.013
	(0.004)	(0.003)	(0.003)	(0.003)*	(0.003)	(0.011)
Black			-0.054		-0.041	
			(0.002)**		(0.003)**	
Hispanic			-0.049		-0.040	
			(0.002)**		(0.003)**	
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.000	0.002	0.007	0.006	0.007	0.008
States		0.00	0.00	0.00	0.00	0.00
Unmarried earn				0.00	0.00	0.00
martial match						0.00
Race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 8a: Effects of market tightness on log annual weeks of husbands [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m
lmt_w	-0.008	-0.007	-0.001	0.007	-0.007	-0.000
	(0.001)**	(0.001)**	(0.002)	(0.002)**	(0.002)**	(0.002)
lmt_b	0.021	0.022	0.005	0.015	0.002	0.009
	(0.003)**	(0.003)**	(0.002)*	(0.002)**	(0.002)	(0.011)
lmt_h	0.005	0.004	0.001	0.009	-0.002	-0.007
	(0.004)	(0.003)	(0.003)	(0.003)**	(0.003)	(0.012)
Black			-0.053		-0.040	
			(0.002)**		(0.003)**	
Hispanic			-0.048		-0.039	
			(0.002)**		(0.003)**	
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.000	0.002	0.007	0.006	0.007	0.008
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Table 9: Sex ratios and labor supplies with labor market conditions, marital matches and state effects

	(1)	(2)	(3)	(4)
	lfs_f	lnh_w_f	lnwks_f	lfs_m
ij SR	-0.029	-0.004	0.004	0.004
	(0.008)**	(0.010)	(0.011)	(0.005)
Age SR	0.065	0.028	0.044	0.003
	(0.018)**	(0.023)	(0.023)	(0.009)
Race SR	-0.139	0.001	-0.049	0.032
	(0.031)**	(0.029)	(0.035)	(0.018)
Educ SR	0.037	-0.002	0.000	-0.004
	(0.011)**	(0.013)	(0.014)	(0.006)
Observations	746769	589300	589300	746769
R-squared	0.031	0.027	0.008	0.027
sex ratios	0.00	0.70	0.10	0.27
States	0.00	0.00	0.00	0.00
Unmarried earn	0.00	0.00	0.00	0.00
martial match	0.00	0.00	0.00	0.00

Effects of market tightness on labor force status of husbands

	(1)	(2)	(3)	(4)	(5)	(6)
	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m
lmt	0.001	0.000	0.001	0.012	-0.001	0.005
	(0.001)	(0.001)	(0.002)	(0.002)**	(0.001)	(0.002)**
black			-0.070		-0.037	
			(0.002)**		(0.003)**	
hispanic			-0.106		-0.087	
			(0.002)**		(0.003)**	
HS M			-0.028			
			(0.002)**			
HS F			-0.011			
			(0.001)**			
Observations	746925	746925	746925	746769	746769	746769
R-squared	0.000	0.003	0.025	0.022	0.025	0.027
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Effects of market tightness on labor force status of husbands [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m
lmt	0.002	0.002	0.002	0.011	-0.002	0.003
	(0.001)	(0.001)	(0.002)	(0.002)**	(0.002)	(0.002)
black			-0.070		-0.037	
			(0.002)**		(0.003)**	
hispanic			-0.106		-0.087	
			(0.002)**		(0.003)**	
HS M			-0.029			
			(0.002)**			
HS F			-0.011			
			(0.002)**			
Observations	746925	746925	746925	746769	746769	746769
R-squared		0.003	0.025	0.022	0.025	0.027
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Effects of market tightness on labor force status of husbands (probit)

	(1)	(2)	(3)	(4)	(5)
	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m
lmt	0.008	0.003	0.023	0.066	0.013
	(0.012)	(0.012)	(0.012)	(0.012)**	(0.010)
black			-0.465		-0.144
			(0.010)**		(0.018)**
hispanic			-0.616		-0.420
			(0.011)**		(0.013)**
HS M			-0.312		
			(0.016)**		
HS F			-0.107		
			(0.013)**		
Observations	746925	746925	746925	746769	746769
states		0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00
race			0.00		0.00
i & j ages			0.00		
i & j edu			0.00		

Effects of market tightness on labor force status of husbands [IV probit]

	(1)	(2)	(3)	(4)	(5)
	lfs_m lmt	lfs_m lmt	lfs_m lmt	lfs_m lmt	lfs_m lmt
lmt	0.020	0.018	0.035	0.053	0.011
	(0.013)	(0.012)	(0.012)**	(0.012)**	(0.011)
black			-0.459		-0.146
			(0.011)**		(0.019)**
hispanic			-0.613		-0.421
			(0.011)**		(0.014)**
HS M			-0.327		
			(0.016)**		
HS F			-0.095		
			(0.014)**		
Observations	746925	746925	746925	746769	746769
states		0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00
race			0.00		0.00
i & j ages			0.00		
i & j edu			0.00		

Effects of market tightness on log hours per weeks of husbands

	(1)	(2)	(3)	(4)	(5)	(6)
	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m
lmt	-0.007	-0.007	0.004	0.016	0.003	-0.000
	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.001)*	(0.002)
black			-0.065		-0.038	
			(0.002)**		(0.003)**	
hispanic			-0.052		-0.032	
			(0.002)**		(0.002)**	
HS M			-0.036			
			(0.002)**			
HS F			-0.001			
			(0.002)			
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.000	0.003	0.016	0.016	0.017	0.017
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Effects of market tightness on log hours per week of husbands [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m	lnh_w_m
lmt	-0.005	-0.005	0.006	0.015	0.002	-0.000
	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.002)	(0.002)
black			-0.064		-0.039	
			(0.002)**		(0.003)**	
hispanic			-0.052		-0.033	
			(0.002)**		(0.002)**	
HS M			-0.038			
			(0.002)**			
HS F			0.001			
			(0.002)			
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.000	0.003	0.016	0.016	0.017	0.017
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Effects of market tightness on log annual weeks of husbands

	(1)	(2)	(3)	(4)	(5)	(6)
	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m
lmt	-0.002	-0.002	0.001	0.010	-0.004	0.000
	(0.001)*	(0.001)	(0.002)	(0.002)**	(0.002)*	(0.002)
black			-0.054		-0.042	
			(0.002)**		(0.003)**	
hispanic			-0.048		-0.039	
			(0.002)**		(0.003)**	
HS M			-0.014			
			(0.002)**			
HS F			0.000			
			(0.002)			
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.000	0.002	0.007	0.006	0.007	0.008
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Effects of market tightness on log annual weeks of husbands [IV]

	(1)	(2)	(3)	(4)	(5)	(6)
	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m	lnwks_m
lmt	-0.001	-0.000	0.003	0.011	-0.002	0.000
	(0.001)	(0.001)	(0.002)	(0.002)**	(0.002)	(0.002)
black			-0.054		-0.040	
			(0.002)**		(0.003)**	
hispanic			-0.048		-0.038	
			(0.002)**		(0.003)**	
HS M			-0.016			
			(0.002)**			
HS F			0.002			
			(0.002)			
Observations	725315	725315	725315	725177	725177	725177
R-squared	0.000	0.002	0.007	0.006	0.007	0.008
states		0.00	0.00	0.00	0.00	0.00
unmarried earn				0.00	0.00	0.00
martial match						0.00
race			0.00		0.00	
i & j ages			0.00			
i & j edu			0.00			

Effects of market tightness on labor force status of husbands (probit)

	(6)	(7)	(8)	(9)	(10)
	lfs_m	lfs_m	lfs_m	lfs_m	lfs_m
lmt					
lmt_w	-0.081	-0.014	0.042	-0.042	0.048
	(0.013)**	(0.017)	(0.016)**	(0.014)**	(0.020)*
lmt_b	0.195	0.040	0.072	0.059	0.053
	(0.021)**	(0.013)**	(0.013)**	(0.012)**	(0.045)
lmt_h	0.074	0.003	0.091	0.005	0.011
	(0.039)	(0.014)	(0.023)**	(0.013)	(0.043)
black		-0.463		-0.141	
		(0.010)**		(0.018)**	
hispanic		-0.621		-0.432	
		(0.011)**		(0.014)**	
HS M					
HS F					
Observations	746925	746925	746769	746769	746685
states	0.00	0.00	0.00	0.00	0.00
unmarried earn			0.00	0.00	0.00
martial match					0.00
race		0.00		0.00	
i & j ages		0.00			
i & j edu		0.00			

F tests