Like Attract Like? A Structural Comparison of Homogamy Across Same-Sex and Different-Sex Households

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LIKE ATTRACT LIKE?
A STRUCTURAL COMPARISON OF HOMOGAMY ACROSS SAME-SEX AND DIFFERENT-SEX HOUSEHOLDS

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Abstract. In this paper, we extend the marriage market theory of Gary Becker to same-sex couples. Beckers's theory rationalizes the well-known phenomenon of homogamy among heterosexual couples: individuals mate with their likes because of complementarities in the household production function. However, asymmetries in the distributions of male and female characteristics set theoretical limits to assortativeness among heterosexual couples: men and women have to marry "up" or "down" according to the relative shortage of their characteristics among the populations of men and women. Yet, among homosexual couples, this limit does not exist as partners are drawn from the same population, and thus the theory of assortative mating boldly predicts that individuals will choose a partner with nearly identical characteristics. Empirical evidence suggests a very different picture: a robust stylized fact is that the correlation of characteristics is in fact weaker among the homosexual couples. In this paper, we build an equilibrium model of the same-sex marriage market which allows for straightforward identification of the gains to marriage. We estimate the model with recent ACS data on California and show that preferences for similar partners are much less relevant for homosexuals than for heterosexuals with respect to age, education and race. As regards labor market outcomes such as hourly wages and working hours, our results highlight that the process of specialization within the household mainly applies to heterosexual couples. Finally, we discuss a number of interesting estimated interactions, like the one between education and wage, and the one between education and Hispanic origins.

Keywords: sorting, matching, marriage market, homogamy, same-sex households, roommate problem.

JEL Classification: D1, C51, J12, J15.

Date: November 21, 2014. Galichon's research has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013) / ERC grant agreements no 313699 and 295298. Part of this research was conducted while Galichon was visiting MIT. The authors would like to thank Arnaud Dupuy for useful discussions.

1. Introduction

How individuals sort themselves into marriage has important implications for income distribution, labor supply, and inequality (Becker, 1973). Strong evidence shows that the rise in income inequality across households over the last fifty years is partly due to assortative mating, as individuals have been sorting into increasingly assortative marriages (Greenwood, Guner, Kocharkov, and Santos, 2014; Eika, Mogstad, and Zafar, 2014).

Individuals prefer to mate with their likes, although, because of asymmetries between the distributions of characteristics in male and female populations, homogamy cannot be perfect among heterosexual couples. In other words, heterosexuals cannot always find a "clone" of the opposite gender to match with. A large body of the literature has noticed that, up until recently, "men married down, women married up" due to the gender asymmetry in educational achievement that has only recently started to fade (Goldin, Katz, and Kuziemko, 2006). Gender asymmetries exist in other dimensions such as biological characteristics (windows of fertility[1], life expectancy, bio-metric characteristics), psychological traits, economic attributes (due to the gender wage gap), ethnic and racial characteristics (immigration is not symmetric across gender, see Weiss, Yi, and Zhang (2013)) or demographic characteristics (some countries, such as China, have very imbalanced gender ratios).

Homogamy has been famously rationalized by Becker's theory of positive assortative mating (PAM), arguably the simplest structural model of homogamy: men and women are characterized by some socio-economic "ability" index and the marriage market clears in order to match men with women that are as close as possible to them in terms of this index. The (strong) prediction of this model is that the rank of the husband's index in the men's population is the same as the wife's in the women's population. However, this does not imply that the partners' indices are identical: they would be so only if the distributions of

[1]Women's fertility rapidly declines with age, whereas men's fertility does not. Biologists and anthropologists argue that this dissymmetry could explain the well-documented preference of men for younger women (Hayes, 1995; Kenrick and Keefe, 1992). Low (2013) evaluates this young age premium for women and names it "reproductive capital," as it gives them an advantage on the marriage market over older women.

the indices were the same for both men and women's populations.

This analysis of the marriage market has attracted wide attention in the economic literature, in spite of its shortcomings. One shortcoming is that it only applies to heterosexual unions. However, in a growing number of countries, same-sex couples have gained legal recognition and the institutions of civil partnership and marriage no longer require that the partners must be of opposite sex. This official recognition is the result of several legal disputes and social activism by the gay and lesbian communities[2]. The issue of whether to recognize same-sex unions has long been a topical subject in many countries, since it challenges the traditional model of family. From both an economic and a legal point of view, the definition of what "family" means has relevant political implications as long as this term is present - and is generally central - in many modern Constitutions and legal systems. Consequently, family households benefit from a special attention of policy-makers. Therefore, a discussion of the issues related to the same-sex marriage - remarkably at policy level - requires a good understanding of similarities and differences in the household dynamics among same-sex and different-sex couples. Besides, it is important to remind that the legal recognition of same-sex couples is only one of many transformations that the institution of the family has gone through in the last decades (Stevenson and Wolfers, 2007; Stevenson, 2008). Finally, since more and more data on same-sex unions have been made available, the extension of the economic analysis of family to the homosexual population can now be taken to data.

Going back to Becker's theories, it is worthwhile noting that the previous considerations on asymmetries between men and women distributions only hold as long as each partner comes from a separate set according to his/her sex. On the same-sex marriage market, the two partners are drawn from the same population and the distributions of characteristics is the same for each of them. Hence, Becker's theory pushed to its limits implies that, in

[2]Public actions for homosexual rights acknowledgment are often considered to have started in 1969, in New York City. See Eskridge Jr (1993) and Sullivan (2009) for a detailed history and a full overview of the arguments in favor and against same-sex marriage.

this setting, partners should be exactly identical, i.e. each individual will choose to marry someone with identical characteristics.

In spite of such theoretical predictions, facts suggest a very different picture. Recent empirical results on the 1990 and 2000 American Census show that same-sex couples are in fact less likely than different-sex ones to exhibit positive assortativeness, at least with respect to a variety of non-labor traits, including racial and ethnic background, age and education (Jepsen and Jepsen, 2002; Schwartz and Graf, 2009). Studies on Norway, Sweden (Andersson, Noack, Seierstad, and Weedon-Fekjær, 2006) and Netherlands (Verbakel and Kalmijn, 2014) brought to similar findings. In order to explain this heterogeneity, the literature has suggested several possible reasons. A first consideration is that homosexuals might be forced to pick from a restricted pool because of their small numbers in the population (Harry, 1984; Kurdek and Schmitt, 1987; Andersson, Noack, Seierstad, and Weedon-Fekjær, 2006; Schwartz and Graf, 2009; Verbakel and Kalmijn, 2014), thus having a narrower choice when choosing their partner, resulting in a more sparse range of types. In addition, homosexuals have been found to be more likely to live in urban neighborhoods than heterosexuals, and since diversities in socio-economic traits are stronger in cities, it facilitates the crossing of racial and social boundaries (Black, Gates, Sanders, and Taylor, 2002; Rosenfeld and Kim, 2005; Black, Sanders, and Taylor, 2007). Other analysts argue that homosexuals may have different preferences than heterosexuals, as they tend to be less conventional than straight individuals. Some explanations in this regard point out that, since homosexuality is still considered in some traditional cultures as at odds with prevailing social norms, homosexuals might grow less inclined to passively accept social conventions, and consequently they would end up choosing their partner with fewer concerns about his/her background traits (Blumstein, Schwartz, et al., 1983; Meier, Hull, and Ortyl, 2009; Schwartz and Graf, 2009). Note that household location choice and social norms are strictly related: it has been reported that homosexuals often leave their town of origin and escape social pressure exerted by relatives and acquaintances and go living in larger cities reputed to be gay/lesbian-friendly (Rosenfeld and Kim, 2005). Analogously, homosexuals are aware that they have more probabilities of avoiding discrimination by achieving higher educational levels and orienting their professional choices toward congenial working environments (Blumstein, Schwartz, et al., 1983; Verbakel and Kalmijn, 2014). The detachment from the community of origin and the research for more open-minded surroundings have an influence both on values and social norms and on the heterogeneity of interpersonal ties.

A part of these explanations has to do with individual preferences, whereas another part has to do with demographics, i.e. the distribution of characteristics in the population. The observed equilibrium matching patterns should be analyzed taking into account both categories. For instance, a large correlation in education may arise from individual tastes, as people find a partner with similar educational background desirable, or from demographics, as the observed population mostly consists of individuals with a high school diploma, which makes unions between partners with the same education statistically very likely. Nevertheless, it is also clear that the explanations listed in the former paragraph, while different in nature, are not mutually exhaustive, but all contribute to a better understanding of the equilibrium patterns.

In this paper, the focus is on individual preferences: we would like to compare the "preference for homogamy" across same-sex and different-sex households. In order to do so, we need a methodology to interpret the observation of matching patterns which disentangles preferences from demographics. This is achieved by a structural approach, which captures the preference parameters leading to equilibrium matching patterns that exhibit the closest fit with the patterns actually observed. This approach hence requires an equilibrium model of matching.

Still following Becker (1981), the economic literature has classically modeled the marriage market as a bipartite matching game with transferable utility. A couple consists of two partners coming each from a separate or identical subpopulation (respectively, in the case of heterosexual and homosexual unions). Both partners are characterized by vectors of attributes, such as education, wealth, age, physical attractiveness, etc. It is assumed that, when two partners with respective attributes x and y form a pair, they generate an affinity equal to $\Phi(x, y)$, which is shared endogenously between them. In the case of separate subpopulations (heterosexual marriage), it follows from landmark contribution of Choo and Siow (2006) that the affinity function Φ can easily be estimated based on matching patterns modulo a distributional assumption on unobservable variations in preferences, and was followed by a rich literature (Fox, 2010; Galichon and Salanié, 2014; Dupuy and Galichon, 2014; Chiappori, Salanié, and Weiss, 2011; Chiappori, Oreffice, and Quintana-Domeque, 2012, to cite a few). Dupuy and Galichon (2014) extended Choo and Siow's model to the case of continuous attributes and propose the convenient bilinear parameterization $\Phi(x, y) = x^{\top} Ay$, where A is a matrix called "affinity matrix" whose terms reflect the strength of assortativeness between two partners' attributes. However, the bipartite assumption is restrictive and does not allow to estimate the affinity on same-sex marriage markets, and, to the best of our knowledge, no such estimation procedure is proposed in the literature. This problem is addressed in the present paper, using the observation by Chiappori, Galichon, and Salanié (2012) that, when the population to be matched is large, the same-sex marriage problem or "unipartite matching problem" can be theoretically reformulated as a heterosexual matching problem or "bipartite matching problem". As a consequence, the empirical tools developed to perform estimation of preferences on the heterosexual marriage market, such as those cited above, can be adapted to estimate preferences on the homosexual marriage market.

There are a few papers that already deal with the issue of assortativeness among same-sex households, although none of them allows to draw conclusion on preference parameters. The most relevant benchmarks for the empirical results of this work are the aforementioned Jepsen and Jepsen (2002) and Schwartz and Graf (2009). Both papers make use of the American census data (1990 and 1990/2000 respectively) and their most important result is that members of different-sex cohabiting couples are more alike than those of same-sex ones with respect to non-labor market traits. The heterogeneity in assortativeness is measured in a Logit framework containing dedicated parameters for homogamy. In general, in a Logit framework individuals choose their best option among all possibilities. However, this fails to take into account the fact that matching takes place under scarcity constraint on the various characteristics. In this paper, we fully describe the equilibrium matching pattern in respect of market conditions. We estimate the true preference parameters for each type of couple (same-sex and different-sex ones): the following cross-comparison turns out to be very insightful for the understanding of heterogeneity in assortativeness.

The contributions of the present paper are twofold. On a methodological level, this paper is the first to propose a structural estimator of the matching affinity which applies to same-sex households, or, more generally, to instances of the unipartite matching problem. On an empirical level, we provide evidence through the means of a structural analysis that, as concerns non-labor market traits, the heterosexual population has a stronger preference for homogamy than the homosexual one. We give a detailed account of the differences in the pairwise complementarity (or substitutability) between characteristics such as age, race and education. Further, we also look at labor market traits such as hourly wages and working hours. Comparing assortativeness on labor market outcomes between homosexual and heterosexual couples allows us to infer different family dynamics and different household specialization processes. In addition, thanks to the detailed findings provided by the estimation of the affinity matrix, we are able to identify more subtle relationships among traits. In particular, we thoroughly discuss two cross-effects: the complementarity between wages and schooling and the substitutability between schooling and Hispanic origins. Finally, we briefly discuss the estimates of the mutually exhaustive affinity indices obtained through saliency analysis.

The rest of the paper is organized as follows. Section 2 will present the model and section 3 the estimation. We describe our data in section 4 and our results in section 5. Section 6 concludes.

2. The Model

In what follows, it is assumed that the full type of each individual, i.e. the complete set of all individual characteristics that matter for the marriage market (physical attributes, psychological traits, socio-economic variables, gender, sexual orientation, etc.), is fully observed by market participants. Each individual is characterized by a vector of observable characteristics $x \in \mathcal{X} = \mathbb{R}^K$, which constitutes his observable type. However, we allow for a certain degree of unobserved heterogeneity by assuming that agents experience unobserved variations in tastes that are not observable to the analyst, following Choo and Siow (2006). In this paper, types are assumed to be continuous, as in Dupuy and Galichon (2014), hereafter DG, and Menzel (2013). Assume that the distribution of characteristics x has a density function f with respect to the Lebesgue measure. Without loss of generality, the marginal distribution of the attributes is assumed to be centered, i.e. $\mathbb{E}[X] = 0$.

A *pair* is an ordered set of individuals, denoted $[x_1, x_2]$ where $x_1, x_2 \in \mathcal{X}$, in which the order of the partner matters, which implies that the pair $[x_1, x_2]$ will be distinguished from its inverse twin $[x_2, x_1]$. In empirical datasets, x_1 will often be denominated "head of the household" and x_2 "spouse of the head of the household," even though this denomination is completely arbitrary. A *couple* is an unordered set of individuals (x_1, x_2), so that the couple (x_1, x_2) coincides with the couple (x_2, x_1). A *matching* is the density of probability $\pi(x_1, x_2)$ of drawing a couple (x_1, x_2). One has $\pi(x_1, x_2) := \pi[x_1, x_2] + \pi[x_2, x_1]$, hence the symmetry condition $\pi(x_1, x_2) = \pi(x_2, x_1)$ holds. This symmetry constraint means that the position of the individual must not matter and thus that there are no predetermined "roles" within the couple.

We shall impose assumptions that will ensure that everyone is matched at equilibrium, hence the density of probability of type $x \in \mathcal{X}$ in the population is given by $\int_{\mathcal{X}} \pi(x, x')dx' = \int_{\mathcal{X}} \pi[x, x']\, dx' + \int_{\mathcal{X}} \pi[x', x]\, dx'$, where the right hand side counts the number of individuals of type x matched either as the head of household (first term), or as the spouse of the head (second term). Thus, we are led to define the set of feasible matchings for the unipartite problem as

$$\mathcal{M}^{sym}(f)=\left\{\pi\geq 0:\begin{pmatrix}\int_{\mathcal{X}}\pi(x,x')dx'=f(x)\ \forall x\in\mathcal{X}\\ \pi(x_1,x_2)=\pi(x_2,x_1)\ \forall x_1,x_2\in\mathcal{X}\end{pmatrix}\right\}$$

In contrast, in the classical bipartite problem, we try to match optimally two distinct populations (men and women) which are characterized by the same set of observable variables $\mathcal{X}$, and it is assumed that the distribution of the characteristics among the population of men has density f, while the density of the characteristics among the population of women is g. In this setting, the feasibility constraints take on the typical following form:

$$\mathcal{M}(f,g)=\left\{\pi\geq 0:\begin{pmatrix}\int_{\mathcal{X}}\pi(x,y)dy=f(x)\ \forall x\in\mathcal{X}\\ \int_{\mathcal{X}}\pi(x,y)dx=g\left(y\right)\ \forall y\in\mathcal{Y}\end{pmatrix}\right\}$$

Hence, $\pi\in\mathcal{M}^{sym}(f)$ if and only if $\pi\in\mathcal{M}(f,f)$ and $\pi\left(x_1,x_2\right)=\pi\left(x_2,x_1\right)$. Thus the feasibility set in the unipartite problem and in the bipartite problem differ only by the additional symmetry constraint in the unipartite problem.

We now model matching affinities as in DG. It is assumed that a given individual x_1 does not have access to the whole population, but only to a set of acquaintances $\{z_k^x : k\in\mathbb{Z}_+\}$, which is described below. An individual of type x matched to an individual of type x' enjoys a surplus which is the sum of three terms:

- the systematic part of the pre-transfer matching affinity enjoyed by x from her match with x', denoted $\alpha\left(x,x'\right)$.
- the equilibrium utility transfer from x' to x, denoted $\tau\left(x,x'\right)$. This quantity can be either positive or negative; we assume utility is fully transferable, hence feasibility imposes $\tau\left(x,x'\right)+\tau\left(x',x\right)=0$.
- a "sympathy shock" $\left(\sigma/2\right)\varepsilon^x$, which is stochastic conditional on x and x', and whose value is $-\infty$ if x is not acquainted with an individual x'. The quantity $\sigma/2$ is simply a scaling factor. More precisely, the set of acquaintances is an infinite countable random subset of $\mathcal{X}$; it is such that $\left(z_k^x,\varepsilon_k^x\right)$ are the points of a Poisson process on $\mathcal{X}\times\mathbb{R}$ of intensity $dz\times e^{-\varepsilon}d\varepsilon$.

It is assumed that utility of unmatched individuals is $-\infty$ for all types, so that every market participant is matched at equilibrium. Hence, the individual maximization program of x is

$$\max_{k\in\mathbb{Z}_+} \alpha\left(x, z_k^x\right) + \tau\left(x, z_k^x\right) + \frac{\sigma}{2}\varepsilon_k^x, \tag{2.1}$$

where the utility of matching with acquaintance k yields a total surplus which is the sum of three terms, the systematic pre-transfer affinity, the transfer, and the sympathy shock. Define the systematic quantity of surplus at equilibrium U by

$$U\left(x, x'\right) = \alpha\left(x, x'\right) + \tau\left(x, x'\right)$$

thus $\Phi\left(x, x'\right) := \alpha\left(x, x'\right) + \alpha\left(x', x\right) = U\left(x, x'\right) + U\left(x', x\right)$ is the systematic part of the joint affinity between x and x'. Note that Φ is symmetric by definition, but α has no reason to be symmetric. Mathematically speaking, Φ is (twice) the symmetric part of α. As it is classical in the literature on the estimation of matching models with transferable utility, the primitive object of our investigations will be the joint affinity Φ rather than the individual pre-transfer affinity α; indeed, without observations on the transfers, Φ is identified but α is not. In other words, if we estimate that there is a high level of joint affinity in the (x, x') relationship, we will not be able to determine if this is due to the fact that "x likes x'" or "x' likes x". We will only be able to estimate that there is a high affinity between x and x'.

An individual of type x hence maximizes $U\left(x, z_k^x\right) + (\sigma/2)\,\varepsilon_k^x$ over the set of his acquaintances, which are indexed by k. It follows from the continuous logit theory (initially set forth by Dagsvik (1994), see an exposition in DG) that the conditional probability density of an individual of type x of matching with a partner of type x' is:

$$\pi(x'|x) = \exp\frac{U(x, x') - a\left(x\right)}{\sigma/2} \tag{2.2}$$

where

$$a(x) = \frac{\sigma}{2}\log\int_{\mathcal{X}} \frac{1}{f(x)}\exp\frac{U(x, x')}{\sigma/2}dx' \tag{2.3}$$

hence $(\sigma/2)\ln\pi(x,x') = U(x,x') - a(x)$, and adding $\pi(x,x')$ with $\pi(x',x)$ (with same value) yields expression

$$\log\pi\left(x,x'\right) = \frac{\Phi(x,x') - a(x) - a(x')}{\sigma}, \tag{2.4}$$

where the value of $a(.)$ is uniquely determined by the fact that $\int_{\mathcal{X}}\pi(x,x')\,dx' = f(x)$, that is

$$\int_{\mathcal{X}}\exp\left(\frac{\Phi(x,x') - a(x) - a(x')}{\sigma}\right)dx' = f(x)$$

which is a *symmetric Schrödinger-Bernstein system.* Combining the expression of π as a function of U and a and Equation (2.4) yields

$$U(x,x') = \left(\Phi(x,x') + a(x) - a(x')\right)/2. \tag{2.5}$$

The quantity $U(x,x')$ is the systematic part of utility that an individual of type x obtains at equilibrium from a match with an individual of type x'. It is equal to the half of the joint affinity, plus an adjustment $(a(x) - a(x'))/2$ which reflects the relative bargaining powers of x and x'. These bargaining powers depend on the relative scarcity of their types; indeed, $a(x)$ is to be interpreted as the Lagrange multiplier of the scarcity constraint that $\pi(.,x)$ should sum to $f(x)$.

It follows from DG, Theorem 1, that the equilibrium matching as characterized maximizes

$$\iint_{\mathcal{X}\times\mathcal{X}}\Phi(x,x')\pi(x,x')dxdx' - \sigma\mathcal{E}(\pi)$$

over $\pi\in\mathcal{M}(f,f)$, where

$$\mathcal{E}(\pi) = \iint_{\mathcal{X}\times\mathcal{X}}\pi(x,x')\ln\pi(x,x')dxdx'. \tag{2.6}$$

We will use this characterization as an optimal solution in order to estimate the joint affinity Φ based on the observation of the matching density π.

We summarize the findings of this section in the following result, whose proof is now immediate given these preparations:

Theorem A. *In the same-sex marriage problem described above:*

(i) The equilibrium matching density $\pi(x, x')$ *is a solution to*

$$\max_{\pi \in \mathcal{M}(f,f)} \iint_{\mathcal{X} \times \mathcal{X}} \Phi(x, x')\pi(x, x')dxdx' - \sigma\mathcal{E}(\pi), \tag{2.7}$$

where π *is defined by (2.6).*

(ii) The expression of $\pi(x, x')$ *is given by*

$$\pi(x, x') = \exp\left(\frac{\Phi(x, x') - a(x) - a(x')}{\sigma}\right), \tag{2.8}$$

where $a(.)$ *is a fixed point of* F*, which is given by*

$$F[a](x) = \sigma \log \int_{\mathcal{X}} \exp\left(\frac{\Phi(x, x') - a(x')}{\sigma}\right) dx' - \sigma \log f(x). \tag{2.9}$$

(iii) The equilibrium transfer $\tau(x, x')$ *from* x *to* x' *is given by*

$$\tau(x, x') = \left(\alpha(x', x) - \alpha(x, x') + a(x) - a(x')\right)/2. \tag{2.10}$$

(iv) The systematic part $U(x, x')$ *of the equilibrium utility of* x *matched to* x' *is obtained by*

$$U(x, x') = \left(\Phi(x, x') + a(x) - a(x')\right)/2. \tag{2.11}$$

3. Estimation

Estimation of the affinity matrix. Following Dupuy and Galichon (2014), we assume a quadratic parametrization of the affinity function Φ to focus on a limited number of parameters which could characterize the matching pattern. We parametrize Φ by an affinity matrix A so that

$$\Phi_A(x, y) = x'Ay = \sum_{ij} A_{ij}x^i y^j$$

where A has to be symmetric ($A_{ij} = A_{ji}$) in order for Φ to satisfy the symmetry requirement. Then the coefficients of the affinity matrix are given by $A_{ij} = \partial^2\Phi(x, y)/\partial x^i \partial y^j$ at any value (x, y). Matrix A has a straightforward interpretation: A_{ij} is the marginal increase (or decrease, according to the sign) in the joint affinity resulting from a one-unit increase in the attribute i for the first partner, in conjunction with a one-unit increase in the attribute j for the second.

Recall equation (2.7), the optimal matching π maximizes the social gain

$$\mathcal{W}(A) = \max_{\pi \in \mathcal{M}(f,f)} \mathbb{E}_\pi \left[x' A y\right] - \sigma \mathbb{E}_\pi \left[\ln \pi(x,y)\right] \tag{3.1}$$

and thus, by the Envelope theorem, $\partial \mathcal{W}(A)/\partial A_{ij} = \mathbb{E}_{\pi^A}\left[x^i y^j\right]$, where π^A is optimal in (3.1). Hence, our empirical strategy, following DG, is to look for $\hat{A}$ satisfying

$$\partial \mathcal{W}(A)/\partial A_{ij} = \mathbb{E}_{\hat{\pi}}\left[x^i y^j\right], \tag{3.2}$$

where $\hat{\pi}$ is empirical distribution associated with the observed matching. If a sample of size n $\{(x_1, y_1), ..., (x_n, y_n)\}$ is observed, then $\hat{\pi}(x,y) = n^{-1} \sum_{t=1}^n \delta(x - x_t) \delta(y - y_t)$. Our estimator $\hat{A}$ of A is obtained by solving the following concave optimization problem

$$\min_A \mathcal{W}(A) - \mathbb{E}_{\hat{\pi}}[\sum_{ij} A_{ij} x^i y^j]. \tag{3.3}$$

Indeed, the first order conditions associated to (3.3) is exactly given by (3.2).

Symmetry requirement. Symmetry of A is a requirement of the model. The population cross-covariance matrix $\mathbb{E}_\pi[x^i y^j]$ is symmetric, as π satisfies the symmetry restriction $\pi(x,x') = \pi(x',x)$ in the population. However, in sample, $\hat{\pi}$ does not need to verify the symmetry restriction, as the first variable typically designates the surveyed individual, while the second variable designates the partner of the surveyed individual. Hence, the empirical matrix of co-moments $\mathbb{E}_{\hat{\pi}}[x^i y^j]$ will only be approximately symmetric.

There are three strategies for overcoming this problem.

- A first possibility is to directly run (3.3). One obtains a matrix A that is not symmetric but that can be symmetrized by replacing A by $(A + A^\top)/2$.
- A second option is to symmetrize the sample by replacing $\hat{\pi}(x,x')$ by its symmetrized version $\hat{\pi}(x,x') + \hat{\pi}(x',x)$ before running the program (3.3). This means accounting for every household (x,x') twice, once with x as householder, and once with x' as householder. As a result of the symmetry of $\mathbb{E}_{\hat{\pi}}[x^i y^j]$, the solution $\hat{A}$ will be symmetric. This is the method of choice if doubling the sample size does not result in computational difficulties.

- A third and last possibility is to run (3.3) subject to symmetry constraint $A_{ij} = A_{ji}$. This is the recommended method if doubling the sample size as per the second method above is computationally difficult.

Saliency analysis. The rank of the affinity matrix is informative about the dimensionality of the problem, that is, how many indices are needed to explain the sorting in this market. This led DG to introduce *saliency analysis*, which consists in looking for successive approximations of the K-dimensional matching market by p-dimensional matching markets ($p \leq K$). Assume (without loss of generality as one can always rescale) that $var\left(X_i\right) = var\left(Y_j\right) = 1$. Then saliency analysis consists of a singular value decomposition of the affinity matrix $A = U'\Lambda V$, where U and V are orthogonal loading matrices, and Λ is diagonal with positive and decreasing coefficients on the diagonal[3]. This allows to introduce new indices $\tilde{x} = Ux$ and $\tilde{y} = Vy$ which are orthogonal transforms of the former, and such that the joint affinity reflects diagonal interactions of the new indices, i.e. $\Phi\left(x, y\right) = x'U'\Lambda V y = \tilde{x}\Lambda\tilde{y}$.

Here, we need to slightly adapt this idea to take advantage of the symmetry of A and of the requirement that the matrix of loadings U and V should be identical. The natural solution is the eigenvalue decomposition of A, which leads to the existence of an orthogonal loading matrix U and a diagonal $\Lambda = diag\left(\lambda_i\right)$ with nonincreasing (but not necessarily positive) coefficients on the diagonal such that

$$A = U'\Lambda U.$$

This allows us to introduce a new vector of indices $\tilde{x} = Ux$, which is an orthogonal transform of the previous indices. That way, the joint affinity between individuals x and x' is given by

$$\Phi\left(x, x'\right) = x'U'\Lambda U x' = \tilde{x}\Lambda\tilde{x}' = \sum_{p=1}^{K} \lambda_p \tilde{x}^p \left(\tilde{x}'\right)^p$$

[3]A similar idea is found in Heckman (2007), who interprets the assignment matrix as a sum of Cobb-Douglas technologies using a singular value decomposition in order to refine bounds on wages.

hence this term only reflects pairwise interactions of dimension p of $\tilde{x}$ and $\tilde{x}'$, which are either complements (if $\lambda_p > 0$) or substitute (if $\lambda_p < 0$), and there are no complementarities across different dimensions.

The following result summarizes the findings of this section:

Theorem B. *(i) The estimator $\hat{A}$ of the affinity matrix is obtained by*

$$\hat{A} = \arg\min_{A \in S_K} \{\mathcal{W}(A) - \mathbb{E}_{\hat{\pi}}[\sum_{1 \le i,j \le K} A_{ij} x_n^i y_n^j]\},$$

where S_K is the set of symmetric $K \times K$ matrices.

(ii) Assume that $\mathbb{E}_{\hat{\pi}}[X] = 0$ and that $var_{\hat{\pi}}(X^i) = 1$ for all i. Then there exists an orthogonal loading matrix $\hat{U}$ and a diagonal $\hat{\Lambda} = diag(\lambda_i)$ with nonincreasing coefficients on the diagonal such that

$$\hat{A} = \hat{U}'\hat{\Lambda}\hat{U}$$

and, denoting $\tilde{x} = \hat{U}x$, the estimator of the affinity function is given by

$$\hat{\Phi}(x, x') = \tilde{x}'\hat{\Lambda}\tilde{x} = \sum_{p=1}^{K} \lambda_p \tilde{x}^p (\tilde{x}')^p .$$

4. Data

Data on same-sex couples. Empirical studies on homosexuality have traditionally needed to cope with poor data and misreporting issues, due to the resistance faced by homosexuals in being morally accepted and to the late legal recognition of their partnerships, still unachieved in several countries. Social scientists have largely relied on the data collected by the US Census Bureau for large-scale analysis of homosexuality issues (Jepsen and Jepsen, 2002; Black, Sanders, and Taylor, 2007; Schwartz and Graf, 2009). Starting from the 1990 decennial census, individuals could report themselves as "unmarried partner" within the household, regardless of their sex, so that homosexual couples could somehow be identified. In more recent databases from the US Census Bureau, homosexual couples are still identifiable as out-of-marriage cohabiting partners. Indeed, although same-sex marriage has been recognized by some American states since 2004, it has been acknowledged at Federal level only in 2013, and currently available surveys conducted by the Census Bureau do not allow reporting marriage bonds other than the traditional.

Several analysts soon realized the inaccuracy of the US Census Bureau data on homosexual couples. In particular, Black, Gates, Sanders, and Taylor (2007); DeMaio, Bates, and O'Connell (2013) and O'Connell and Gooding (2006) point out the unreliability of the 2000 decennial Census. Going back to 1990 Census, if respondents declared themselves of the same sex and a married couple at one time, the answer was recognized as illogical and the sex of the householder's partner was automatically *allocated* by the Bureau. However, it was argued that some homosexual couples voluntarily declared themselves as being married if their partnership concretely resembled a marriage bond. Therefore, the 1990 Census would underestimate the number of homosexual couple households.

In the 2000 decennial Census, the Bureau adopted a different *allocation* strategy in order to improve the accuracy in measuring of homosexual couple households. In case of a questionnaire reporting a same-sex married couple, while sex variables were not touched any more, the marital status variable was now switched to "unmarried couple"[4]. However, a relatively small measurement error in the whole population for one variable can significantly generate misclassification issues for small subgroups. In the 2000 Census case, a large share[5] of the same-sex married couples turned out to be different-sex ones that wrongly compiled the questionnaire. As a result, estimates on the number of homosexual couple households turned out to be inflated. Since in the database it is possible to identify through an allocation flag variable those individuals whose marital status has been reallocated by the Bureau, it has been advised to exclude such observations from samples for studies on homosexuality, sometimes significantly reducing the sample size (e.g. in Schwartz and Graf (2009)).

[4]In 2000, homosexual marriage had not been introduced in any state yet. Later on, the same strategy has been kept, since homosexual marriage was not recognized at Federal level. This provision has specifically been imposed since 1996 by the Federal Defense of Marriage Act (DOMA) (DeMaio, Bates, and O'Connell, 2013).

[5]About three quarters of the same-sex married couples were actually different-sex married couples (Black, Gates, Sanders, and Taylor, 2007; Gates and Steinberger, 2009).

Besides, some studies argue that similar flaws affect other US Census Bureau, remarkably the 2005-2007 American Community Survey (ACS) (Gates and Steinberger, 2009) and the 2010 decennial Census (DeMaio, Bates, and O'Connell, 2013).

To tackle this issue, the US Census Bureau took over some improvements in the questionnaire layout and in the data editing tools, in order to minimize measurement errors on the sex of heterosexual couple partners (see US Census Bureau (2013) for further explanations). Such changes resulted in a sharp decline in the estimates on homosexual couples between 2007 and 2008, consequence of an increase in accuracy (Gates, 2009; DeMaio, Bates, and O'Connell, 2013)[6]. Therefore, though not flawless, the ACS data gathered since 2008 represent the best available database among the one provided by the Census Bureau in order to study homosexuality issues.

Accordingly, this work relies on the five-year Public Use Microdata Sample (PUMS) for 2008-2012 coming from the ACS, conducted by the US Census Bureau. We restricted our sample to the state of California, which first legalized same-sex marriage on June 16, 2008 following a Supreme Court of California decision, and then - after some judicial and political controversies that impeded the officialization of same-sex weddings from November 5, 2008 to June 27, 2013[7]- another decision of the Supreme Court finally accomplished full legalization. Restricting the sample to one state allows focusing on a marriage market undergoing a uniform judicial framework. Moreover, in states where same-sex marriage is recognized, estimates on the number of married same-sex couple households are more reliable, i.e. the incidence of the measurement error is smaller (Gates, 2010; Virgile, 2011).

The sample is limited to those individuals involved in a cohabiting partnership, both married and unmarried, thus excluding singles. Each couple is identified as a householder with his/her partner, where both share the same ID household number. The number of

[6]DeMaio, Bates, and O'Connell (2013) use 2010 ACS data as a benchmark to show the inaccuracy of 2010 decennial Census data, which are gathered with the older methodology.

[7]In this period, marriage licenses issued to same-sex couples held their validity.

householders involved in a relationship is equal to the one of their partners, as one should expect.

Furthermore, we restrict the number of couples to those where both partners are aged between 20 and 45. The patterns of observed couple characteristics are subject to attribute changes over time and to a selection effect through partnership dissolution (Schwartz and Graf, 2009; Dupuy and Galichon, 2014). The PUMS cross-sectional data allows describing a static situation in a fixed point in time, without following couples over time. It is therefore appropriate to restrict the sample to those couples that formed recently to limit the effects of time variations. In addition, Alexander, Davern, and Stevenson (2010) call attention to the correctness of US Census Bureau gender data for individuals aged 65 or older: since the gender dummy is crucial in the construction of the sample, excluding the elderly should boost the reliability of the data.

Descriptive Statistics. The main database is composed of 731,412 individuals in couples. The restriction of the sample to couples where both individuals are aged between 20 and 45 year old reduces our sample to 260,898 individuals. The 1.26% of the sample lives in same-sex couples, of which 1,720 live in male couples (0.66 %) and 1,560 live in female couples (0.60 %). Among heterosexual couples, 83.8 % are married and 16.2 % are cohabiting. For estimation purposes, after randomly selecting a subsample of the different-sex couple set, a total of 5,985 couples are considered, of which 3,802 are married and 2,183 are not.

To compare different marriage markets, following Jepsen and Jepsen (2002), the main sample is divided into four subsamples: same-sex male couples, same-sex female couples, different-sex unmarried couples and different-sex married couples. This repartition is first of all meant to represent the fact that individuals enter into separate markets according to their sexuality. However, another criterion is used to differentiate two of the subgroups: married and unmarried heterosexual couples are treated as two separate subpopulations, since empirical evidence has reported significant differences in patterns between these two kinds of partnership. In particular, Schwartz and Graf (2009) argue that assortative mating for unmarried couples is weaker, most likely because the bond is less engaging than marriage. Although it is impossible to know *a priori* if a person is interested in a marital union rather than in a less binding relationship, we believe that this repartition can be of great interest and deepen the analysis. Nevertheless, even if California represents the larger state-level ACS sample in the US, further splitting the male and female homosexual groups into two parts unfortunately implies working with relatively small samples. Moreover, although same-sex marriage is permitted, it has been recognized only recently and at the end of many legal struggles, which may have prevented a part of those same-sex couples that wished to marry from doing so. Whenever the number of registered homosexual partnerships increased and the share of married couples were known with more certainty, then considering married and unmarried homosexual couples separately would be extremely interesting, as proved by recent research of Verbakel and Kalmijn (2014).

This study takes into consideration several variables, some related to the labor market and some others to the general background. Non-labor market traits include age, education and race. Age and education are treated as continuous variables, with the latter defined as the highest schooling level attained by the individual. Thanks to the detailed data of the ACS, the variable has been built in order to reflect as many distinguished educational stages as possible.

The set of variables also contains three dummies for the three largest racial/ethnic minorities: Non-Hispanic Black, Non-Hispanic Asian and Hispanic[8]. This implies that the reference group is mainly constituted by Non-Hispanic White and the residual category "Others," which contains all those individuals who did not recognize themselves in any of the main groups. It is important to interpret these considerations by keeping in mind that race and ethnicity are self-reported, and thus say something about how the respondent

[8]American demographic institutions do not include a Hispanic category in variables on race, furnishing a separate variable for Hispanic origins, which is why there is some overlapping and the other categories bear the specification "Non-Hispanic". The issue concerns the conceptual differences of "race" and "ethnicity". See for instance Rodriguez (2000) for clarifications.

perceives himself. In addition, note that the number and the type of dummies that are included can alter the interpretation of the estimates, as it will be made clear later.

Finally, among labor market variables, we have hourly wage, which is computed from the yearly wage and the number of usual hours worked per week. Note that yearly wage is top-coded for very high values (over $999,999). Moreover, the amount of hours worked per week is included.

Table 1 presents some descriptive statistics of our sample. Individuals in same-sex couples are on average more educated than individuals in opposite-sex couples. As predicted by Black, Sanders, and Taylor (2007), young homosexual women are much more likely to be part of the labor force than heterosexual ones and also have higher wages. We observe that unmarried heterosexual couples are much younger than married couples and same-sex couples. Unmarried heterosexual men and women are on average 4.5 year younger than others. Cohabitation is often (but not always) a "trial" period before marriage, which explains the age difference. Table 2 presents the distribution of ethnics among couples: same-sex couples are much more present among White people, whereas there is a remarkably high share of Black individuals among lesbian couples. On the contrary, Asians and Hispanics are under-represented in the homosexual population.

Table 3 presents the correlation rates among traits. It shows that age and education attainment are much more correlated among heterosexual couples than among homosexual ones. Moreover, the correlation is stronger for lesbian couples than for gay ones. Education is also more correlated among young same-sex couples than among older ones. This pattern is not observed for heterosexuals. Correlations or labor market outcomes are particularly interesting: there is a negative correlation only for different-sex couples, a possible clue of stronger household specialization, whereas it is low and positive for same-sex couples.

Table 4, 5 and 6 present the homogamy rates of couples with respect to race for different types of couples. The homogamy rate is the ratio between the observed number of couples of a certain type and the counterfactual number which should be observed if individuals formed couples randomly[9]. For instance, table 4 shows that lesbian couples among black women form 10 times much more than if they were formed randomly among the lesbian population.

Homogamy rates and correlations are interesting measures of assortative mating and provide a good starting point for our analysis. However, they do not control for simultaneous effects of the multiple variables we consider. Therefore, no conclusion on preferences can be drawn from their observation.

5. Results

We report in appendix the estimates of the affinity matrix for gays in table 7, for lesbians in table 10, for cohabiting individuals in table 13 and for married individuals in table 16.

Age, education and race/ethnicity. In the first place, our estimates of the diagonal elements of the affinity matrices are highly positive and significant for age, education and ethnicity, which strongly confirms the positive assortative mating observed in the literature. The complementarity in these non-labor market traits is once again empirically assessed. We find that the intensity of affinity by age and education is the lowest for male same-sex couples (respectively, 0.93 and 0.41) and increases in intensity on the other markets in the following order: female same-sex (1.24, 0.62), unmarried different-sex (1.35, 0.69) and married different-sex couples (2.06, 0.81).

As regards race/ethnicity dummies, members of the three minorities taken into account seem to enjoy some additional affinity which exhibits homogamous patterns. Differently than in the previous literature, we can separately measure the relevance of such bonus for each ethnic group. However, note that the estimates must be interpreted while keeping in mind that the group of reference is formed by the categories "Non-Hispanic White" (42% of the observations) and "Others" (0.7%). In fact, the parameters concerning race do not say anything about the absolute attractiveness of a group, but are simple relative

[9]If couples formed randomly across the population, the number of couples between a man of type i and a woman of type j would be equal to $n_{i.}n_{.j}/N$. The homogamy rate is then the ratio of the observed number of couples on this theoretical number of couples. See Vanderschelden (2006).

measures. Going back to the estimate tables, the intensity of the homogamous affinity for Hispanic follows the same ascending order of age and education. For Non-Hispanic Black, we observe a slight difference: homogamy is weakest for male same-sex couples, increases for married different-sex and unmarried different-sex couples, and is strongest for female same-sex couples. For Non-Hispanic Asian, the order is instead the following: female same-sex, male same-sex, unmarried different-sex and married different-sex couples. Interestingly, in most of cases, representatives of minorities do not seem to enjoy any particular utility boost from a union with a member of a different minority. In the lower-right corner of the affinity matrix, off-diagonal estimates for race dummies are often not significant, and, when they are, we usually observe lower positive values, with the exception of a strong relative distaste between married Asian men and Black women (-0.46). However, it is hard to see a common pattern across different markets.

The findings on positive assortative mating are in line with the ones presented in the cross-market analysis by Jepsen and Jepsen (2002) and Schwartz and Graf (2009) on the United States. Also the estimates on race/ethnicity homogamy, here computed separately for each minority, seem to follow very similar patterns. However, since the model relies on behavioral assumptions and the parameters of the matrix A are explicitly contained in the systematic marital affinity function, it is implied that differences in assortative mating reveal a different structure of preferences. It would be therefore more natural to interpret these results purely from a household production function point of view - as meant by Becker (1973) - than from a demographic point of view, concluding that the degree of complementarity between non-labor market inputs varies across markets.

Labor market traits. To describe labor market traits, we must be very cautious as these outcomes are potentially endogenous. As we do not observe these traits at the moment of the match formation but possibly a long time after, the specialization process at work in couples may have already begun. In particular, we expect that this specialization effect is strong in heterosexual couples, who are more likely to have children. Raising children takes time and a large part of mothers leave the labor force or reduce their working hours. Consequently, because of interrupted careers and less paid part-time jobs, their hourly wage does not rise as much as the one of their male counterparts and we observe many associations between low-wage women and high-wage men. This phenomenon could bias our estimates and we cannot interpret them directly as preference estimates, although we limited the sample to relatively young couples. However, the differences we observe between the estimates for our four types of couples help us to shed light on the specialization effect.

First, we do not observe a positive assortative mating on hourly wages nor on working hours for married couples, although, as we just explained, we cannot distinguish the real preferences from the specialization effect, which pushes in the opposite direction. However, we observe much higher and significant positive estimates for same-sex couples and for unmarried couples with respect to wages and working hours. As unmarried couples are more often young couples, these estimates must be much closer to the true preference estimates as the specialization process has not had time to happen yet[10]. Estimates must also identify preferences patterns for same-sex couples as homosexuals are less likely to have children and consequently have fewer reasons to specialize[11]. Consequently, it is very likely that there is a positive assortative mating on wages and working hours, and we could infer that this must also be the case for married couples even if we cannot estimate it directly. It is worth noting that the wage estimate is twice as large for gays than for lesbians. Wages may be more important for gays in match formation than for lesbians. However, the estimate for working hours is much higher for lesbians than for gays. Homosexual women may prefer a partner with similar time schedule than themselves. In general, the estimates for working hours are stronger for same-sex couples than for unmarried couples.

The cross-estimate between the wage of one partner and working hours of the other partner is also very interesting to analyze, although we may not be able to interpret it

[10]Unmarried couples can also be long dating couples who do not want to marry ever. Still, in that case, the specialization is not as strong as in married couples as they might not commit to the community as strongly as married individuals.

[11]In our sample, among the 20-45 years-old, 14.7% of gays have children, 32% of lesbians, 51.8% of cohabiting different-sex couples and 80.5% of married different sex couples.

as a preference parameter. Instead, it must represent the well-known income effect at work in couples: when your partner's wage rises, your household income rises and you are free to work less. The estimate is surprisingly the same for both same-sex couples and married heterosexual couples and is around -0.13, whereas it is non-significant for unmarried couples. It seems that same-sex couples and married couples coordinate they labor supply: they pool a part of their income and adjust their work in reaction to variations of the labor market traits of their partner[12]. However, unmarried couples seem not to coordinate. As these couples are in average younger, the income effect is weaker since they do not pool their income yet and stay financially independent. Finally, we note a little asymmetry for married heterosexuals. The estimate between the working hours of the man and the wage of the woman is -0.08, whereas it is -0.13 between the man's wage and his wife working hours. This is not surprising, as we know that married men's working hours are less elastic with respect to income than married women's working hours.

Complementarity between wage and education. Significant positive cross-effects have been found also for wage and education. It is well-known that educational level of an individual is highly correlated with his salary: however, their simultaneous presence in the model should allow to distinguish a particular mixed effect, for which higher wage individuals have a preference for more educated partners, keeping constant their wage and all other characteristics. Once again, same-sex couples exhibit the weakest affinity between these two variables, regardless of their sex (0.12 for men, 0.13 for women). The intensity of the effect progressively increases for unmarried and married different-sex couples, although for the latter the effect is asymmetric, as a match between a high wage husband and a highly educated woman generates a stronger marginal utility increase (0.28) than the other way around (0.23).

This effect can be interpreted in different, not mutually exhaustive ways. First of all, as a matter of preferences, in that high-income individuals - independently of their educational level - may enjoy the company of cultured partners. This could clearly leave some space

[12]Other similarity between same-sex couples and heterosexual couples household dynamic has also been found in Oreffice (2011), in which she shows that individuals in same-sex couples bargain over the income as heterosexuals and respond to bargaining power shifts.

for explanations linked with the worth of economic and cultural capital[13] in the marriage market and with the possible rise in social status ensured by a highly educated partner, who in turn seeks someone wealthy to pair with. The simple complementarity of schooling levels (already captured by the diagonal element for education in the affinity matrix) can already indicate that the partners' educational profile is relevant on two dimensions: internally, the household may benefit from shared social norms (Kerckhoff and Davis, 1962; DiMaggio and Mohr, 1985; Kalmijn, 1994), whereas, on larger scale, the partners seek to increase the household stock of cultural capital to achieve a better social positioning (Bourdieu, 1979). However, the positive estimate for the mixed effect between wage and schooling might also suggest that the economic and the cultural capital are complementary inputs in matching. In addition, following this interpretation, the heterogeneity observed across markets may derive from the dissimilar social contexts that heterosexuals and homosexuals experience, as the weights assigned to different forms of capital vary from one subgroup of the society to the other. Finally, the highest and asymmetric affinity observed for married heterosexuals suggests that these dynamics are more relevant for more binding unions and that, for women (respectively, men), cultural (economic) capital plays a more important role in matching.

Nevertheless, we need to consider a second possible explanation related to the impact of labor market choices on these estimates. Since schooling level is a good proxy of future income, then a positive association of wage and education might simply resemble the complementarity between partners' wages, especially when one of them is younger and has just entered the job market. Conversely, since labor choices usually take place after the match as discussed earlier, we might have that one partner - typically the wife in married different-sex couples - quits labor market despite his/her earning potential ensured by a relatively high schooling level. Therefore, the mixed effect of wage and education could partially be explained by the complementarity on wages. The real preference for partners with higher labor income - already hard to detect from the interaction between wages - is thus partially captured by the complementarity between wage and education, since for one

[13]Note that the educational achievement can only be a raw measure of cultural capital. In sociological work, several alternative measures have been explored, as interests and hobbies (DiMaggio, 1982) or occupational schooling (Kalmijn, 1994).

partner we observe the actual salary, while for the other we can treat the educational level as an indicator of potential labor earnings. According to this interpretation, the positive association is due to endogenous labor choices: were these conjectures true, it would be hard to say to which extent the positive value of the estimate is purely due to preferences.

Considered the two possible explanations, two further arguments in favor of the first interpretation linked with real preferences can help to understand why we should expect complementarity between wage and education at the moment of the choice of the partner. First, recall that, for the same level of schooling, some fields of specialization ensure higher labor income than others. Moreover, there has been a widely-reported asymmetry in study choices with respect to gender, as some professions are typically considered "feminine" (e.g. nursing, teaching, arts and culture) although they are still selective and require a high level of schooling (Brown and Corcoran, 1997; Xie and Shauman, 2003). Hence, a couple could enjoy an improvement in terms of social status when one partner provides high labor earnings and the other has a high-skilled occupation that is not as well remunerated on the labor market but is intellectually influential and kept in high consideration because of its social function. Second, it is reasonable to think that education might well be a desirable attribute in household production - although far from being a comprehensive productivity rate for household activity - especially as concerns childrearing (DiMaggio, 1982; De Graaf, De Graaf, and Kraaykamp, 2000). It is thus a very valuable trait for those partners - typically women in different-sex couples - that are expected to dedicate more time to household activities and raising children (as also suggested by Bourdieu (1979)). Following this premise, the positive value of the estimate can partially capture the complementarity between labor and household productivity. In the end, all things considered, it seems appropriate to think that the positive interaction between wage and education is due to the real preferences of the partners at the very moment of the matching, although the estimate is likely to be upward-biased because of endogenous labor market choices.

Interaction between education and Hispanic origin. The affinity matrix also contains results on the interaction between racial identity and other traits, which can potentially reveal the presence of interesting social dynamics in couple formation. There are several estimates of off-diagonal parameters concerning ethnicity that are significant in at least one market, whereas only one estimate - cross-effect of schooling and being Hispanic - is significant on every market. We will therefore pick this parameter for an instance of cross-market analysis, in order to show how the affinity matrix can be helpful to describe some very subtle nuances of matching related to race/ethnicity. Looking at the estimate tables, we can observe that more educated individuals have a weaker affinity for Hispanic partners. The drop in affinity is lower for homosexuals (-0.11 for male and female) and higher and asymmetric for heterosexuals, with highly educated women and Hispanic men undergoing the highest marginal drop in affinity (-0.29, both in and out of marriage).

As we did for wage and education, we shall try to give an explanation based on preferences. The lack of affinity between highly educated individuals and Hispanics may suggest that the two subsets of the population do not share similar values and social norms, making matches between them not desirable. The size of the loss increases with schooling level *ceteris paribus*, meaning that a higher education widens the social distance independently from the educated individual's other characteristics. The importance of social categories in education has been stressed by the work of Akerlof and Kranton (2002), which creates a bridge between and economics of education and sociological and ethnographic studies[14]. In their paper, educational choices are described as heavily influenced by the prescriptions of an individual's social category. At the same time, racial and ethnic identities are important predictors of cultural attitudes[15] and social group identification (Delpit, 1995; Akerlof and Kranton, 2000, 2002), alongside gender and other socioeconomic variables. Social theorists agree that educational institutions play a key role in reinforcing or reshaping both social categories and prescriptions during school and college years[16]. Accordingly, it is possible

[14]Akerlof and Kranton (2002) provide an exhaustive literature review of sociological work on social categories, behavior and achievement in schools, starting from Coleman (1961).

[15]In the economic literature, ethnic diversity has often been regarded as a possible source of heterogeneity of preferences, especially in the political economy literature. In recent research, Desmet and Wacziarg (2014) explicitly discuss the relationship between ethnicity and culture, conducting an empirical study on the World Values Survey data. According to their findings, ethnicity is a good predictor of cultural traits (although a large share of a country's cultural heterogeneity is within-group).

[16]The influence of educational institutions on individuals - especially on political participation and orientation - has long been discussed. A common denominator is the idea that educational institutions have a

that highly-achieving students are formed in schools where the prevailing social norms clash with those of Hispanic communities. Given the importance of values and social norms absorbed in school, the negative association between education and Hispanic origins is likely to persist on the marriage market. Here, heterogeneity across markets possibly indicates that the distance between the highly educated and Hispanics is greater among heterosexuals than homosexuals, i.e. the cultural attitudes developed both in educational institutions and because of strong ethnic identity are more persistent for heterosexuals.

While proposing this interpretation, we must also caution the reader that the choice of including Non-Hispanic White in the reference group does matter, as anticipated at the beginning of this section. In fact, the distribution of schooling attainment for White is completely different than the one for Hispanics: 49.08% of the White in the sample has at least a Bachelor's degree, while only 12.88% of the Hispanics have one. As a consequence, individuals with higher education are also more likely to be White. Since the latter are in the reference group, it is impossible to separately identify the affinity/repulsion between the two racial groups and the interaction between education and being Hispanic. However, the cross-effects between racial identities and other labor or non-labor market traits are mostly weak and not systematic, as well as cross-racial interactions among minorities. Hence, the strongly negative values taken regularly by the education-Hispanic parameters stand out and deserve to be thoroughly analyzed. That is why we propose an additional explanation based on social norms and categories, whose strong bond with education and racial/ethnic identity is well-known in the economic and sociological literature.

Saliency analysis. The decomposition of the affinity matrices in orthogonal dimensions is presented in appendix from table 8 to table 18. In the four markets, we show that more of 85% of the joint affinity could be explain in three orthogonal dimensions that we could name "indices of attractiveness" as in DG. These indices load on different characteristics of individuals. In the four market, the first index is almost only composed of the age and explains by itself more than 40% of the affinity: age is then the first dimension of sorting.

deep impact on students' values and ideas. See Friedman, Kremer, Miguel, and Thornton (2011) for a clear summary of the main opposing views in economics and social sciences in general.

The second dimension of sorting is composed of education and wage and explains around 20% of the sorting, whereas the third dimension relies more on race/ethnicity and explains around 14% of the sorting.

When we consider heterosexual couples, the indices of mutual attractiveness could differ between genders. However, we only find relevant differences for married couples. For unmarried couples, our results show that the three main dimensions are very similar between men and women, meaning that attractiveness is not gender-dependent for this market. In the concluding part, we will discuss the fact that changes in social norms and in the concept of marriage gain may lead toward more homogamy and complementarity of traits between partners. Instead, we observe that more important differences between genders exist for married couples. The second dimension for instance, which explains 22% of the utility, loads more on education for women than for men, and more on wage for men than for women.

The impact of race/ethnicity on indices of attractiveness is ambiguous, as the second and the third dimension load on the origins of the participants in opposite directions. We will decompose their impact on the last two different dimensions of attractiveness: education and race. Again, we find that a Non-White ethnicity penalizes the attractiveness related to education and labor outcomes. The Hispanic ethnicity is particularly penalizing: the penalty is high on the four markets and is even higher for heterosexuals than for homosexuals. Asian origins are penalizing on the education index only on the heterosexual marriage market. There is, however, a low penalty for Black racial identity. With respect to the third dimension, mainly composed of ethnicity, we observe that Hispanic ethnicity adds a strong boost to attractiveness on the male same-sex market, the unmarried market and an even higher boost on the female same-sex market. However, we do not find any boost of Hispanic ethnicity on the heterosexual marriage market. Black origins represent a strong advantage on the female same-sex market. To a lesser extent, it is also an advantage on the different-sex cohabitation market and on the male same-sex one, but it is a strong penalty on the different-sex marriage market. Asian origins have no effect on the attractiveness on the female same-sex market, but consist in a strong boost on the different-sex marriage market and in an intermediate boost on the cohabitation market. However, being Asian represents a strong penalty on the male same-sex market.

6. Discussion and perspectives

We believe that the contributions of our paper are twofold. From a methodological point of view, this paper is the first to propose a structural estimator of the matching affinity which applies to the unipartite matching problem. Our methodology could be applied to many other markets (e.g. roommates, co-workers). In addition, we apply the model in order to provide an empirical analysis of mating preferences in the same-sex marriage market in California. We conduct a cross-market comparison: we analyze the heterogeneity in preferences between homosexual and heterosexual couples. First, we find that, as concerns non-labor market traits, the heterosexual population has a stronger "preference for homogamy" than the homosexual one. Second, we discuss the differences in complementarity and substitutability of inputs in the household production function as defined in the family theories of Gary Becker. Our findings seem to suggest that labor market traits are substitutes for married heterosexual couples but complementary for other types of couples. This result challenges the traditional concept of the marriage gain based on specialization within the couple. Finally, we provide some possible interpretations that could explain the estimates suggesting complementarity between wage and education, and substitutability between Hispanic origins and education. This exercise shows how the model can be used to study subtle interactions among inputs in matching markets.

The need for effective analytical frameworks to study and describe relatively modern forms of families has recently emerged in the economic literature, both as concerns same-sex couples (Black, Sanders, and Taylor, 2007; Oreffice, 2011) and cohabiting partners (Stevenson and Wolfers, 2007; Gemici and Laufer, 2011). In this paper, we first identified three separate subpopulations according to sexual preferences, and then we separately analyzed the matching of married couples and of unmarried ones. We found preferences disparities between the four markets. However, can we state with certainty that these markets are mutually exclusive? In fact, at least for what concerns cohabiting couples, individuals may first endogenously choose into which market they are willing to match. Moreover, there could be spillovers between markets.

In this paper, we show that the cohabitation and the marriage market correspond to different preferences for mating and household organization, which is what has also been observed in the literature (Schwartz and Graf, 2009; Gemici and Laufer, 2011; Verbakel and Kalmijn, 2014). Cohabitation is a developing phenomenon and is associated with a lower degree of specialization and a higher degree of positive assortative mating. A promising area of research would be to understand the preferences for marriage or cohabitation jointly with sorting preferences. Mourifié and Siow (2014) set a first model in that direction for heterosexual couples. An empirical paper of Verbakel and Kalmijn (2014) separately analyzes the marriage and cohabitation markets in Netherlands also for homosexuals. With the consolidation of the same-sex marriage and the availability of more and more accurate data, it will soon be possible to expand our understanding of differences and similarities across markets. Families and household arrangements are evolving quickly and we need to understand the underlying forces of these changes.

One issue that needs to be investigated is the possible presence of spillovers between markets. Many opponents to the same-sex marriage fear that this would cause the marriage institution to lose its value and would instead promote alternative forms of families, typically more flexible/less stable, such as cohabitation. For now, researchers have found no effect of same-sex marriage on the number of different-sex marriages or on the number of divorces (Trandafir, 2014, 2015). However, we wonder whether the legal recognition of same-sex marriage could someway impact the preferences observed on the different markets. What changes should we expect in the behavior of heterosexuals? And could it be that same-sex couples become more homogamous as homosexual marriage is institutionalized?

Finally, in Becker's theory, a rationale for marriage is the home production complementarities between men and women skills. However, the traditional gains from marriage have diminished for two main reasons. First, the progress in home technology has decreased the value of domestic production; second, as women took control over their fertility and have been getting more and more educated, their opportunity cost to stay at home has increased (Stevenson and Wolfers, 2007; Greenwood, Guner, Kocharkov, and Santos, 2012). Despite the decrease in the traditional marriage gains, the institution of marriage has not disappeared. On the contrary, there has been a high demand for same-sex legal marriage in many developed countries. Stevenson and Wolfers (2007) argue that individuals now look for a mate with whom they "share passions" and the new rationale for marriage is now "consumption complementarities" instead of "production complementarities". It is also possible that the act of marriage itself is still considered as intrinsically valuable for cultural and social reasons. In any case, this evolution may lead to even higher correlation of traits. We wonder how these changes will impact macroeconomic outcomes, life quality and social distance among individuals.

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Table 1. Descriptive Statistics of couples (means)

Type of couples	**Age**	**Education**	**Wage***	**Hours**	**Sample size**	Share
			All			
Married Heterosexuals						
Men	52.48	12.50	31.01	42.25	327005	98.56 %
Women	49.82	12.38	22.36	36.70	327005	
Unmarried Heterosexuals						
Men	40.39	11.90	19.48	40.51	33441	
Women	38.38	12.33	17.68	37.00	33441	
Homosexuals						
Men	49.04	13.86	32.84	40.73	5744	0.79 %
Women	48.55	13.73	27.29	39.41	2388	0.65 %
			20-45 year old			
Married Heterosexuals						
Men	36.46	12.45	29.18	43.37	107872	98.74 %
Women	34.69	12.70	21.83	36.06	107872	
Unmarried Heterosexuals						
Men	32.00	11.57	18.26	40.74	20937	
Women	30.34	12.00	16.57	37.00	20937	
Homosexuals						
Men	35.36	13.84	30.75	41.91	1720	0.66 %
Women	34.36	13.75	23.45	39.78	1560	0.60 %

7. Tables

Table 2. Race (20-45 year old)

Ethnic	Heterosexual	Gay	Lesbian	All
White	41.7	61.9	60.3	42.0
Black	3.1	2.8	5.6	3.2
Others	0.7	0.9	1.3	0.7
Asian	15.7	10.5	6.0	15.6
Hispanic	38.7	24.0	26.7	38.6
Total	100.0	100.0	100.0	100.0

Table 3. Couple Correlations

Type of couples	**Age**	**Education**	**Wage**	**Hours**
All				
Heterosexual couples	0.92	0.68	0.12	-0.012
Gay couples	0.70	0.50	0.05	0.09
Lesbian couples	0.80	0.56	0.20	0.09
20-45 year old				
Heterosexual couples	0.76	0.69	0.23	-0.08
Gay couples	0.60	0.56	0.15	0.08
Lesbian couples	0.70	0.63	0.19	0.14

Table 4. Homogamy rates of Lesbians (20-45 year old)

	White	Black	Others	Asian	Hispanic
White	1.31	0.38	0.79	0.80	0.49
Black	0,38	10,00	1,67	0,75	0,51
Others	0,79	1,67	20,00	0,00	0,54
Asian	0,80	0,75	0,00	7,02	0,20
Hispanic	0,49	0,51	0,54	0,20	2,46

Table 5. Homogamy rates of Gays (20-45 year old)

	White	Black	Others	Asian	Hispanic
White	1.20	0.63	0.54	0.87	0.60
Black	0.63	12.86	0.00	0.59	0.77
Others	0.54	0.00	20.00	1.88	1.39
Asian	0.87	0.59	1.88	3.40	0.30
Hispanic	0.60	0.77	1.39	0.30	2.35

Table 6. Homogamy rates of Heterosexuals (20-45 year old)

	Women				
Men	White	Black	Others	Asian	Hispanic
White	1.97	0.34	0.86	0.38	0.30
Black	0.51	21.06	1.53	0.35	0.40
Others	0.87	0.51	56.67	0.46	0.45
Asian	0.17	0.12	0.33	5.32	0.08
Hispanic	0.28	0.20	0.47	0.11	2.20

Table 7. Estimation of A. Gays (20-45 year old)

	Age	**Education**	**Wage**	**Hours**	**Black**	**Hispanic**	**Asian**
Age	**0.93**	0.03	-0.00	**-0.11**	0.03	**0.09**	**0.15**
Education	0.03	**0.41**	**0.12**	-0.05	0.02	**-0.11**	0.01
Wage	-0.00	**0.12**	**0.09**	**-0.13**	-0.01	**0.07**	**-0.06**
Hours	**-0.11**	-0.05	**-0.13**	**0.15**	-0.03	0.01	0.04
Black	0.03	0.02	-0.01	-0.03	**0.10**	0.05	0.02
Hispanic	**0.09**	**-0.11**	**0.07**	0.01	0.05	**0.30**	-0.04
Asian	**0.15**	0.01	**-0.06**	0.04	0.02	-0.04	**0.18**

f=14.42, FOC=0.00, N=1720

Table 8. Gays (20-45 year old)

	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**
Share of joint utility explained	43.12	22.29	15.74	8.02	4.98	3.18	2.66
Standard deviation of shares	2.43	2.14	1.08	1.31	0.79	1.33	1.00

Table 9. Gays (20-45 year old)

	I1	**I2**	**I3**
Age	0.97	-0.03	-0.07
Education	0.05	0.85	0.08
Wage	0.02	0.25	0.47
Hours	-0.13	-0.22	-0.35
Black	0.05	-0.01	0.12
Hispanic	0.12	-0.40	0.66
Asian	0.17	-0.01	-0.44

Table 10. Estimation of A. Lesbians (20-45 year old)

	Age	**Education**	**Wage**	**Hours**	**Black**	**Hispanic**	**Asian**
Age	**1.24**	0.02	**0.10**	**-0.07**	**-0.10**	**-0.07**	**-0.14**
Education	0.02	**0.62**	**0.13**	-0.04	0.02	**-0.11**	0.01
Wage	**0.10**	**0.13**	**0.04**	**-0.13**	**-0.17**	0.02	-0.01
Hours	**-0.07**	-0.04	**-0.13**	**0.23**	0.02	0.01	0.01
Black	**-0.10**	0.02	**-0.17**	0.02	**0.25**	**0.12**	**0.07**
Hispanic	**-0.07**	**-0.11**	0.02	0.01	**0.12**	**0.43**	-0.05
Asian	**-0.14**	0.01	-0.01	0.01	**0.07**	-0.05	**0.15**

f=13.97, FOC=0.00, N=1560

Table 11. Lesbians (20-45 year old)

	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**
Share of joint utility explained	40.48	21.58	13.68	10.57	6.65	3.78	3.26
Standard deviation of shares	2.31	2.15	0.61	0.99	0.99	1.06	0.68

Table 12. Lesbians (20-45 year old)

	I1	**I2**	**I3**
Age	0.97	-0.13	0.11
Education	0.06	0.89	0.39
Wage	0.11	0.19	0.02
Hours	-0.09	-0.12	-0.03
Black	-0.13	-0.09	0.44
Hispanic	-0.10	-0.36	0.80
Asian	-0.12	0.06	-0.06

Table 13. Estimation of A. Unmarried Heterosexuals (20-45 year old)

	Women						
Men	**Age**	**Education**	**Wage**	**Hours**	**Black**	**Hispanic**	**Asian**
Age	**1.35**	**-0.07**	-0.02	-0.04	-0.04	0.00	-0.02
Education	**-0.10**	**0.69**	**0.18**	0.06	-0.03	**-0.26**	0.03
Wage	0.04	**0.19**	**0.06**	-0.02	-0.00	-0.01	0.03
Hours	-0.04	-0.04	-0.03	**0.10**	-0.05	0.04	0.01
Black	-0.03	-0.03	0.02	0.00	**0.23**	**0.11**	**0.05**
Hispanic	0.06	**-0.29**	**0.06**	**-0.10**	**0.14**	**0.64**	**0.12**
Asian	0.01	-0.05	**0.06**	-0.02	**0.10**	**0.07**	**0.24**

f=15.19, FOC=0.00, N=3138

Table 14. Unmarried Heterosexuals (20-45 year old)

	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**
Share of joint utility explained	40.67	28.78	14.78	7.16	5.04	3.29	0.28
Standard deviation of shares	1.63	1.28	0.55	0.65	0.65	0.92	0.58

Table 15. Unmarried Heterosexuals (20-45 year old)

	I1 M	**I1 W**	**I2 M**	**I2 W**	**I3 M**	**I3 W**
Age	0.98	0.98	0.20	0.18	0.04	0.06
Education	-0.18	-0.16	0.68	0.70	0.62	0.57
Wage	0.01	-0.03	0.15	0.08	0.28	0.38
Hours	-0.02	-0.05	-0.04	0.09	-0.06	-0.09
Black	-0.02	-0.01	-0.14	-0.17	0.27	0.31
Hispanic	0.12	0.09	-0.67	-0.65	0.60	0.53
Asian	0.01	-0.01	-0.12	-0.10	0.31	0.37

Table 16. Estimation of A. Married Heterosexuals (20-45 year old)

	Women						
Men	**Age**	**Education**	**Wage**	**Hours**	**Black**	**Hispanic**	**Asian**
Age	**2.06**	**-0.11**	-0.03	**-0.08**	-0.01	-0.04	-0.02
Education	0.02	**0.81**	**0.23**	**-0.09**	**-0.08**	**-0.19**	**0.10**
Wage	0.04	**0.28**	**0.02**	**-0.13**	-0.02	-0.02	-0.00
Hours	0.05	**0.06**	**-0.08**	-0.01	-0.02	-0.01	**-0.10**
Black	0.00	**-0.08**	-0.06	**0.11**	**0.15**	**0.10**	0.04
Hispanic	-0.04	**-0.29**	0.02	0.01	0.02	**0.74**	**0.10**
Asian	**-0.10**	**-0.14**	0.00	**-0.05**	**-0.46**	**0.18**	**0.74**

f=15.21, FOC=0.00, N=3768

Table 17. Married Heterosexuals (20-45 year old)

	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**
Share of joint utility explained	41.42	22.32	17.74	11.03	3.74	2.33	1.41
Standard deviation of shares	1.49	0.93	0.12	0.38	0.32	0.63	0.73

Table 18. Married Heterosexuals (20-45 year old)

	I1 M	**I1 W**	**I2 M**	**I2 W**	**I3 M**	**I3 W**
Age	1.00	1.00	-0.04	0.00	0.06	0.05
Education	-0.01	-0.04	0.64	0.74	0.49	0.34
Wage	0.02	-0.02	0.21	0.13	0.14	0.14
Hours	0.03	-0.04	0.06	-0.07	-0.06	-0.13
Black	-0.00	0.01	-0.12	0.09	-0.10	-0.50
Hispanic	-0.03	-0.03	-0.60	-0.59	0.02	0.06
Asian	-0.07	-0.04	-0.39	-0.27	0.85	0.77