A New Methodological Framework for Studying Status Exchange in Marriage*

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Abstract

We propose a new methodological framework for studying status exchange in marriage. Highlighted by recent debates on race- and beauty-status exchange among American couples, the conventional contingency table approach is prone to controversial model specifications and interpretations. The ambiguity and disagreement mainly concern two methodological issues: balancing the differential distribution of characteristics and identifying the exchange. Log-linear models rely on complicated multi-way interaction terms for balancing and identification simultaneously, which easily conflates the two and produces results too sophisticated to interpret. Instead, we employ gender-cohort-specific relative ranking to balance the status distribution, and nonparametric matching to identify homogenous and heterogamous couples for pair-wise comparisons holding one spouse's characteristics equal. Our straightforward Exchange Index measures the average within-couple status difference between the matched couples. We study the race- and age-education exchange based on the 2000 US Census 5% microdata sample to communicate our improved methodological parsimony and flexibility with existing studies.

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1. Introduction

In this study, we propose a new methodological framework for studying status exchange in marriage. Building on the long-established literature on status exchange in marriage, two recent debates in the American Journal of Sociology (Rosenfeld 2005; 2010, Gullickson and Fu 2010, Kalmijn 2010) and American Sociological Review (McClintock 2014; 2017, Gullickson 2017) exemplify the controversial of the conventional contingency table framework. Studies in the two debates all derive from a common set of theories and concepts of assortative mating and status exchange behavior in marriage. They all aim at understanding whether and to what extent one's advantage in socioeconomic status is associated with his or her partner's advantage in another characteristic, either race (the AJS debate on status-caste exchange) or physical attractiveness (the ASR debate on status-beauty exchange). In the United States, evidence of status-caste exchange is found among interracial marriages between the White and Black by some studies while rejected by some others. Similarly, evidence of status-beauty exchange is mixed.

Methodologically, all involved studies rely on the framework of contingency table analysis, which has long been conventional in the literature of assortative mating and status exchange. In addition to simple descriptive statistics by husband and wife's characteristics, they apply log-linear models to examine the prevalence of couples with certain combinations of characteristics. The identification of status exchange relies on whether the observed prevalence of couples with dissimilar characteristics is different from the 'expected.'

However, they disagree with each other based on different empirical strategies, findings, and interpretations on the common existence of status exchange in the contemporary United States. Both debates encounter similar methodological disputes on what should be the expected, and, consequently, how to specify log-linear models to test the deviance. Overall, two common issues are concerned: distribution of characteristics and identification of exchange.

1.1. The issue of differential distribution

At least three kinds of systematic differences in the marginal distribution of individual educational attainment – the common indicator for socioeconomic status in the existing literature – are critical to studying on status exchange in marriage: gender, race/caste, and age/cohort. The gender gap that males on average have higher educational attainment than females has been substantial for long. As salient is the racial difference that the non-Hispanic White have higher average educational attainment than the Black. Over time, the expansion of education creates differences in average attainment between birth cohorts. All these three systematic differences, as well as any others that may confound the specific study of interest, need to be taken into account. Otherwise, the patterns we identify as assortative mating and status exchange may be spurious, simply an artifact of these systematic differences on top of marriage behavior. In log-linear models, this means to specify separate parameters for not only the husband and wife's education attainment categories but also their races and /or birth cohorts.

Moreover, those systematic differences in the marginal distribution of educational attainment are not independent of each other. Their complex multiple-way interactions are also consequential to the observed patterns of marriage behavior. From the 1950s to date, the gender gap in educational attainment shrinks to virtually none, but the racial disparity remains almost constant. Given these

intertwined yet changing socioeconomic dynamics, understanding the educational attainment gap between the husband and wife is contingent jointly on their races and birth cohorts. Also, previous studies suggest that the black and white have different educational assortative mating patterns, which further differ between men and women. As a result, in log-linear models, other than parameters for the main effects, we also need to specify additional parameters for interaction effects between educational attainment categories, genders, races, and/or birth cohorts.

Indeed, all involved studies in both debates well agree on the necessity to account for the differential distribution issue, but they disagree on how to do it. While most studies specify the main effect parameters similarly, the consensus of model specification gets lost in specifying and interpreting multiple-way interaction effects. In the debate on the status-caste exchange, for example, at least four variables are relevant: husband's education, husband's race, wife's education, and wife's race. Rosenfeld (2005, 2010) argues for including all two- and three-way interactions as control for differential marginal distribution, but Gullickson and Fu (2010) and Kalmijn (2010) argue some of the three-way interaction terms also capture the effects of status exchange so that they should be omitted or specified in a particular way in order to identify status exchange. However, Gullickson and Fu (2010) and Kalmijn (2010) disagree on their ways of specifying and conceiving such interaction effects. And, Rosenfeld (2010) charges both as violating the hierarchical rules of nested model selection because they fail to control all three-way interactions but base their conclusion on the four-way interaction, that is, the interracial couples of dissimilar educational attainment. In the debate on the status-beauty exchange, a very similar disagreement on how to specify and interpret multiple-way interactions is also central.

Another disagreement is over the parametric data distribution assumption of log-linear models. As both Rosenfeld (2005) and McClintock (2014) suggest, estimated results of status exchange from log-linear models are sensitive to the assumption of data distribution. Positive evidence of status exchange often becomes null when replacing the assumption from Poisson distribution to negative binomial distribution.

1.2. The issue of identification

Identification of status exchange using log-linear models also relies on multi-way interaction parameter(s) – usually the highest-order interaction term that combines most if not all variables of interest. Take the status-race exchange as an example again, after controlling for the main and other lower-order (two- and three-way) interaction effects of gender, race and educational attainment, if adding a certain four-way interaction parameter for interracial couples of dissimilar educational attainment substantially improves model fitting to observed data, the evidence of status exchange is believed to exist. In other words, the observed prevalence of interracial marriages with an educational gap is likely to differ from the expected as if only shaped by the joint marginal distribution by gender, race and educational attainment of the couple.

Although theoretically sound, the empirical operationalization of the contingency table approach to identify status exchange is very complicated, because log-linear models require many multiple-way interaction terms to control for the complex joint distribution of multiple variables and, simultaneously, to identify status exchange. Such complication creates room for confusion of the comparison group, misspecification of the model, and misinterpretation of the result, which is evident in both the AJS and ASR debates.

Moreover, log-linear models could become very complex when introducing additional confounders to control for. As well summarized by M, the matching between husband and wife is multi-dimensional. More importantly, many individual characteristics are positively correlated with socioeconomic status. As a result, when only studying the exchange between two dimensions, we may overlook the fact that the two seemingly dissimilar spouses are matching on other dimensions. It is therefore important to account for multi-dimensional matching before identifying status exchange. However, log-linear models of that kind are largely infeasible and by no means easy to interpret.

In addition to the empirical complication, the contingency table approach lacks straightforward model selection criteria. In theory, the goodness-of-fit indices, such as Bayesian Information Criterion (BIC) and likelihood ratio test (G^2), help researchers decide on rejecting one model in favor of another. In practice, each study often compares a set of complex log-linear models, which may not always follow a nested structure. It is difficult to identify one model better fits the observed data than others. The selection of the main model, not uncommonly, has to be subject to the researcher's judgment call. As shown in both debates, inconsistent findings occur from similar yet unidentical models within and between studies. Given such sensitivity of status exchange evidence to model specification, the preference (and ignorance) of certain models on which to base the conclusion becomes critical.

All the controversial of the contingency table approach summarized above, in fact, has long been recognized. What all parties in both debates share in common is their pursuit of robust empirical evidence, which is less model dependent and easier to interpret. It motivates the initial studies of both debates to consider and contrast simple tabulations and complex log-linear models, even though the two are treated as discrete ways of investigation, each with its advantages and limitations.

2. New causal inference framework

In the same spirit for transparency and robustness, below we propose a new methodological framework for studying status exchange, which conceptually connects to causal inference and empirically handles the issues of distribution and identification. First, we firstly employ relative ranking of status within the same gender and birth cohort to make the meaning of status possibly comparable between gender and birth cohort. Then, we apply nonparametric matching (i.e., exact mating or coarsened exact matching) to pair homogeneous and heterogeneous couples with the same characteristics of one spouse (and the same confounding characteristics of the couple). Finally, we measure the within-couple status difference between heterogeneous couples and matched homogeneous couples. This simple Difference-in-Differences estimator, as we call it Exchange Index, quantifies the status exchange in question. Unlike modeling the prevalence of certain types of marriages with log-linear models, our Exchange Index directly speaks to the status exchange theory which essentially concerns the status difference between husband and wife. Our new framework not only consolidates the advantages of simple tabulations and complex models, but also reduces model dependence, increases model flexibility to account for multidimensional matching, and produces results straightforward to interpret.

In this extended abstract, we skip the theoretical discussion and demonstrate our approach with two analytical examples. The first examines the education-race exchange among Black and White marriages, which speaks to the AJS debate. The second examines the education-age exchange among all US marriages in 2000, which has its own merit but also echoes the ASR debate on the status-beauty exchange.

2.1. Data, relative ranking, and measures

For both examples, we make use of the IPUMS 5 percent microdata sample of the 2000 US census. We focus on prevailing marriages of which the wife ages 25-49 years old and both spouses can be identified in the household, with no missing information on their educational attainment, age, and race.

The outcome variable measures the difference between the couple in their percentile ranks of educational attainment. First, we rank individual educational attainment relative to others of the same gender and from the same 10-year birth cohort. Although educational attainment is by nature categorical, we make use of the detailed 16 attainment categories in the 2000 census to best approximate a continuous measure. Then, we calculate the couple's educational gap as husband minus wife rank difference. A positive difference means the husband attains higher percentile ranks than his wife.

The treatment variable is dichotomous, distinguishing between racial/age heterogamy and homogamy. For simplicity, our main analysis only focuses on status exchange in the majority type of heterogamy in each example. In the first example on education-race exchange among black and white marriages, the variable is 1 for Black husband White wife marriages and 0 for same-race marriages. In the second example on education-age exchange among all marriages, it is 1 for marriages of which the husband is 5 or more years older than his wife, and 0 for marriages of which the husband minus wife age difference is smaller than 5 years and equal to or larger than -3 years.

Our Exchange Index (EI) is a difference-in-differences estimator, which quantifies the difference in couple's educational gap between heterogamy and homogamy. The magnitude of the EI indicates the difference in educational percentiles due to status exchange. Given that we operationalize the couple's educational gap as husband minus wife difference, a positive and statistically significant EI suggests evidence of status exchange. That is, Black husband exchanges higher education with a white wife than a black wife, or old husband exchanges higher education with a young wife than a similar-age wife.

2.2. Nonparametric matching

Heterogamy is often selective in the sense that heterogamous marriages only share commonalities with part of but not all their homogenous counterparts in a population. In both examples, such incomparability is mainly a joint product of racial, gender, and racial differences in educational attainment distribution, marriage propensity, and assortative mating preference. Therefore, in addition to EI based on the naïve comparison group of all homogenous marriages, we attempt to identify a subgroup of homogenous marriages that share similar observed characteristics with heterogamous marriages.

We rely on the matching approach to achieve such a plausible counterfactual sample. We apply exact matching on categorical variables and coarsened exact matching for continuous variables of selected characteristics. As within each matching stratum, the heterogamous and homogenous marriages, or the treated and control observations, often differs in number. We follow Blackwell et al. (2010) and weight each observation. The unmatched have 0 weight, the matched treated are weighted 1, and the matched control are weighted proportionally in each matching stratum to make the treated and control equal in weighted total number.

In the matched sample, heterogamous and homogenous marriages are balanced in those observed characteristics. Under the ignorance assumption that the couple's educational gap does not differ systematically in dimensions other than the ones matched, the matched homogenous marriages share common support with heterogamous marriages and become their counterfactual for causal inference on the status exchange. The weighted mean of the educational gap in matched homogenous marriages is equal to the potential mean for heterogamous marriages as if they marry within the same race or similar age groups. The EI, which is the difference in weighted means between the two mating types, indicates the average treatment effect on the treated (ATT) of intermarriage on the couple's educational gap. Even if the ignobility assumption does not hold, the matching identifies a more plausible comparison group than the naïve one of all observed marriages. Compared with conventional log-linear modeling approach, this approach is also more flexible when we have to account for differential marginal distributions of multiple dimensions. Overall, as heterogamy is often rare and selective, the matching approach is preferred over regression adjustment to avoid extrapolation of estimated effects to incomparable couples.

In the first example of education-race exchange, because we have both black and white same-race marriages as the comparison group, we produce two matched samples by matching characteristics of each spouse. When comparing on the husband side, we match black husband white wife marriages with black same-race marriages and identify those black husbands with the same relative rank of educational attainment. When comparing on the wife side, we match black husband white wife marriages with white same-race marriages of which the wife has the same relative rank of educational attainment. Moreover, in producing both matched samples, we conduct coarsened exact matching on both husband's and wife's ages to ensure different age assortative mating patterns do not confound the estimated EI.

In the second example of education-age exchange, as we only have one kind of age homogamy that is couples of similar ages (-3 to 5 years of difference subtracting husband's age by wife's), we produce just one matched sample by exactly matching educational rank and age of both the husband and wife between age heterogamous and homogenous marriages. To ensure systematic racial differences are not confounding the results, we also match couples by their races.

2.3. Empirical results: Race-education exchange

We categorize marriages into four racial mating types, two heterogamous and two homogenous: Black husband marrying White wife (HeteroR1), White husband marrying Black wife (HeteroR2), Black husband marrying Black wife (HomoR1) and White husband marrying White wife (HomoR2).

We identify 1293450 prevailing marriages of which the wife ages 25-49 years old among the Black and non-Hispanic White population in the 2000 US census. Representation of these types in

the Black and non-Hispanic married population differs substantially. As reported in Table 1, 0.6 percent of all marriages under study are HeterR1, 0.2 percent are HeterR2, 7.5 percent are HomoR1, and 91.6 percent are HomoR2.

Table 1 here

We do not find empirical evidence for education-race exchange based on descriptive statistics. As reported in Table 1, the educational gap between husband and wife in average percentile rank of educational attainment in HeteroR1 (Black husband and White wife) marriages is the smallest among four mating types. In HeteroR2, White husbands on average have higher educational attainment than their Black wives, which also do not support the expectation of status exchange. As for the two types of racial homogamy, Black husbands attain lower education than their Black wives, but White husbands attain higher education than their White wives. An observation consistent with previous studies, this contrast suggests that educational assortative mating patterns and probably the accompanied preference may overall differ between the Black and White.

If status exchange exists in the Black husband White wife marriages, others being equal, we expect the Black husband to marry a White wife with lower education than a Black wife, or the White wife marry a Black husband with higher education than a White husband. Both point to a larger educational gap in racial heterogamy than homogamy, which leads to a positive and statistically significant EI. The identification requires two separate comparisons on both the husband and wife sides. We first compare on the husband side by calculating the HeteroR1-HomoR1 EI, that is, the difference in the couple's educational gap between Black husband White wife marriages and Black husband Black wife marriages. Between HeteroR1 and all observed HomoR1 marriages, reported in Table 2, we find an EI of 2.47 percentiles, which is statistically significant (p-value < 0.005). It suggests that the husband minus wife educational rank difference in HeteroR1 marriages is on average larger than HomoR1 marriages. In other words, marrying to Black husbands of the same educational rank, those White wives tend to rank 2.47 percentiles lower in education attainment than Black wives. This appears to be in line with the expectation based on the status exchange theory.

Table 2 here

However, when the comparison is refined to the matched sample, in line with Rosenfeld's conclusion (2005, 2010), we find no evidence of status exchange from comparison either on the husband or wife side. In the comparison between matched HeteroR1 and HomoR1 on the husband side, the EI is negative. Similarly, in the comparison between matched HeteroR1 and HomoR2 on the wife side, the EI is also negative. Namely, the couple's gap in educational attainment of Black husband and White wife marriages is smaller than same-race marriages that have a comparable Black husband or a White wife.

In addition to the overall patterns examined above, our approach allows for examining the heterogeneity in status exchange patterns. For example, Figure 1 presents the EI across educational attainment of matched Black husbands (on the left) and matched White wives (on the right), separately by quintile rank groups. When comparing between matched HeteroR1 and HomoR1 marriages, no matter the Black husbands attain high or low education, we find no evidence of status exchange in any attainment groups. However, when comparing between matched HeteroR1 and

HomoR2 marriages, we find evidence of status exchange in interracial marriages of white wives who rank the bottom 40 percent in educational attainment among all her female peers.

Figure 1 here

To reconcile with the AJS debate on status exchange in interracial marriages, our findings based on the new methodological framework suggest status exchange is not representative in the population. However, it exists in interracial marriages where the white wife has relatively low educational attainment and when compared with white same-race marriages. Unlike our ranking-matching approach, the conventional log-linear model approach has to rely on interaction terms to simultaneously adjust for complex joint distributions along multiple social dimensions and identify the status exchange between them. As our findings suggest, the heterogeneity of status exchange is subject to specific gender, educational attainment, and comparison group. This may have led to the inconsistent findings between previous studies that specify high-order interaction terms between gender, race and educational attainment differently. It is not surprising if some model specification strategies happen to capture the status exchange patterns of specific intermarriage groups while others do not but look at the big picture. This innate difficulty of log-linear models to handle complex interaction terms creates temptation of misspecification and overgeneralization, especially in the absence of precise model selection criteria.

2.4. Empirical results: Age-education exchange

We categorize marriages into three age mating types: Old husband young wife marriages (HeteroA1), young husband old wife marriages (HeteroA2), and similar-age marriages (HomoA1). We define HeteroA1 as marriages of a husband at least 5 years older than his wife, HeteroA2 as marriages of a wife at least 4 years older than his husband, and HomoA1 as marriages of a husband minus wife age difference between 5 and -3 years.

In the IPUMS 5 percent sample of the US 2000 Census, we identify 1609309 marriages of which the wife ages 25-49. As reported in Table 3, 20.2 percent of are HeteroA1, 6 percent are HeteroA2, and 73.8 percent are HomoA1. Our main analysis focuses on status in HeteroA1 since old husband young wife marriages are the majority of age heterogamy. We report parallel results on status exchange in young husband old wife marriages (HeteroA2) in the appendix. Couples of similar-age marriages are likely to attain higher education on average than their counterparts in old husband young wife marriages. HomoA1 husbands and wives rank on average the 53.09 and 52.10 percentile among their same-gender peers, while HeteroA1 husbands and wives rank 49.44 and 47.47.

Table 3 here

If status exchange exists in old husband young wife marriages, others being equal, we expect the husband to marry a young wife with lower education than a similar-age wife, or wife to marry an old husband with higher educational attainment than a similar-age husband. Both again point to a larger educational gap in age heterogamy than homogamy, which results in a positive and statistically significant EI. Comparing HeteroA1 and HomoA1 marriages on the husband side, we find strong evidence for status exchange. Simply based on all HeteroA1 and HomoA1 marriages, reported in Table 4, we find a positive and statistically significant EI of 0.98. After matching HeteroA1 with HomoA1 marriages of the same educational attainment and age of the husband as well as the race of both spouses, the EI becomes 1.65 and remains statistically significant. It suggests that the couple's

gap when a husband marries a young wife is 1.65 percentiles wider than when a husband of all matched conditions marries a similar-age wife.

Table 4 here

However, comparing HeteroA1 and HomoA1 marriages on the wife side, we do not find evidence for status exchange. Although the naïve EI based on all HeterA1 and HomoA1 is 0.98 and statistically significant, after matching on wife's education, age, and the race of both spouses, the EI becomes negative. In other words, similar to the previous example of status exchange in interracial marriages, we again find gender asymmetry in identifying status exchange that depends on whom to compare.

Moreover, in examining the heterogeneity in education-age exchange patterns, we find strong linear dependence of the exchange pattern on husband and wife's educational attainment. Comparing the matched HeteroA1 and HomoA1 marriages on the husband side and separately by educational quintile ranks of the husband, education-age exchange happens to all but the poorly educated, that is, about the bottom 20 percent educated. Moreover, the exchange between husband's educational attainment and wife's youth increases when the husband attains higher education. By contrast, when a similar comparison is on the wife side, education-age exchange only happens to the relatively poorly educated, that is, about the bottom 40 percent educated. Although in the opposite direction compared to the trend of matched husbands, it also follows a linear relation with wife's educational attainment. The couple's educational gap becomes even smaller when a wife marries an old husband than a similar-age husband.

Figure 2 here

References available upon request

Table 1. Average education of couples among non-Hispanic White and Black US population, 2000 census IPUMS 5% sample

	Husband's education		Wife's education		
Racial mating type	Black	White	Black	White	Percentage
HeteroR1: Black husband & White wife	51.60			51.01	0.6%
HeteroR2: White husband & Black wife		57.01	55.25		0.2%
HomoR1: Black husband & Black wife	45.66		47.57		7.5%
HomoR2: White husband & White wife		54.59		53.70	91.6%
Total number of couples					1293450

Note: Education is measured by individual relative percentile ranks within the same-gender 10-year birth cohort.

Table 2. Education-race exchange in black husband white wife marriages

	Comparison (and matching) on the husnband side: Black husband & White wife couples (HeteroR1) vs. Black husband & Black wife couples (HomoR1)			*Comparison (and matching) on the wife side:* Black husband & White wife couples (HeteroR1) vs. Black husband & Black wife couples (HomoR2)		
	HeteroR 1	HomoR 1		HeteroR 1	HomoR 2	
	Observed	Observed	Counterfactual	Observed	Observed	Counterfactual
Husband's education	**51.62**	45.66	**51.62**	51.62	54.59	52.77
Wife's education	51.06	47.57	50.09	**51.03**	53.70	**51.03**
Exchange index		2.47***	-0.97***		-0.30	-1.15***
N	7502	97545	89819	7576	1185431	1130313

Notes: 1) Exchange Index = E(Husband_edu - Wife_edu | HeteroR1) - E(Husband_edu - Wife_edu | HomoR1 or HomoR2). A positive and statistically significant Exchange Index suggests evidence for race-education exchange between the couple (***: $p < 0.005$). 2) Matching includes exact matching on the education of husband or wife, plus coarsened exact matching on age of both spouses. Statistics of the treatment group vary slightly because unmatched marriages on the husband and wife sides differ. 3) Statistics of the counterfactual control group and t-tests of the treatment effect are both weighted inversely proportional to the number of matches to each HeteroA 1 case. T-tests are based on robust standard errors. 4) Parallel analysis on race-education exchange in white husband black wife couples (HeteroR 2) is available upon request.

Table 3. Average education of couples by age mating patters in the US population, 2000 census IPUMS 5% sample

	Husband			Wife			
Age mating type	Older	Younger	Similar age	Older	Younger	Similar age	Percentage
HeteroA1: Older husband (diff. > 5 yrs)	49.44				47.47		20.2%
HeteroA2: Older wife (diff. < -3 yrs)		47.09		47.33			6.0%
HomoA1: Similar age (-3 <= diff. <= 5 yrs)			53.09			52.10	73.8%
Total number of couples							1609309

Note: Education is measured by individual relative percentile ranks within the same-gender 10-year birth cohort.

Table 4. Age-education exchange in old husband young wife marriages

	Comparison (and matching) on the husnband side: Older husband couples (HeteroA1) vs. Similar age couples (HomoA1)			*Comparison (and matching) on the wife side:* Older husband couples (HeteroA1) vs. Similar age couples (HomoA1)		
	HeteroA 1	HomoA 1		Hetero1	HomoA 1	
	Observed	Observed	Counterfactual	Observed	Observed	Counterfactual
Husband's education	**49.16**	53.09	**49.16**	49.45	53.09	50.26
Wife's education	47.51	52.10	49.16	**47.52**	52.10	**47.52**
Exchange index		0.98***	1.65***		0.98***	-0.81***
N	259840	1187981	1016769	323962	1187981	1130313

Notes: 1) Exchange Index = E(Husband_edu - Wife_edu | HeteroA 1) - E(Husband_edu - Wife_edu | HomoA 1). A positive and statistically significant Exchange Index suggests evidence for age-education exchange between the couple (***: $p < 0.005$). 2) Matching includes exact matching on the education of husband or wife, plus exact matching on race of both spouses and coarsened exact matching on age of both spouses. Statistics of the treatment group vary slightly because unmatched marriages on the husband and wife sides differ. 3) Statistics of the counterfactual control group and t-tests of the treatment effect are both weighted inversely proportional to the number of matches to each HeteroA 1 case. T-tests are based on robust standard errors. 4) Parallel analysis on age-education exchange in older wife couples (HeteroA 2) is available upon request.

Figure 1. Heterogeneity in the race-education exchange of black husband white wife marriages

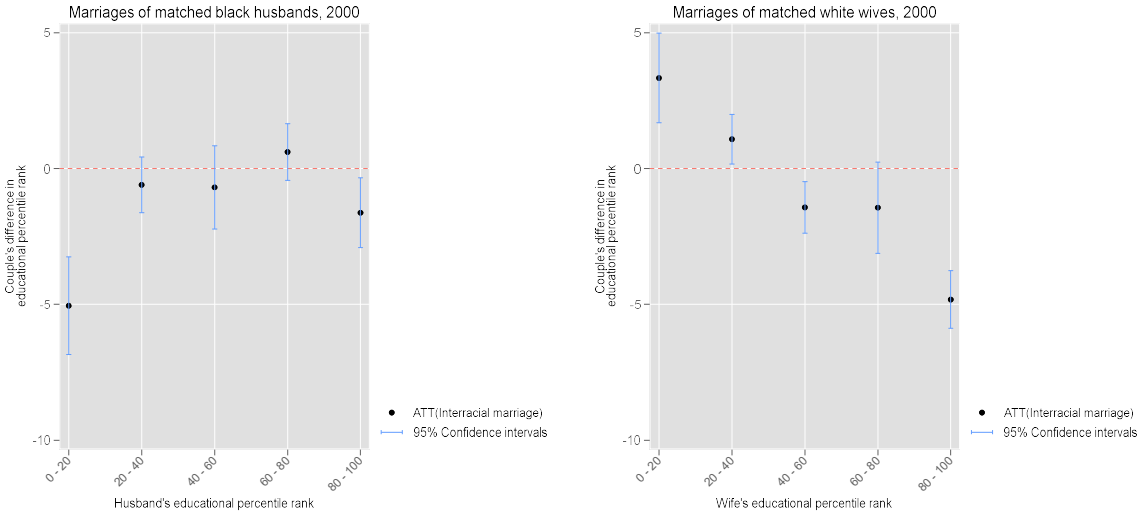

Figure 2. Heterogeneity in the age-education exchange of old husband young wife marriages