Online Resource 1

The Proximate Determinants of Educational Homogamy: The Effects of First Marriage, Marital Dissolution, Remarriage, and Educational Upgrading

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In the main text of our paper, we decompose the extent to which first marriages, marital dissolutions, remarriages, and educational upgrades affect the odds of homogamy in the stock of marriages. In these supplementary analyses, we conduct sensitivity tests of our results using alternative specifications of educational resemblance. In brief, these analyses show (1) the impact of the flows on the odds of resemblance in the stock of marriages are consistent across measures (that is, the decomposition results are robust to alternative specifications); (2) differences in the resemblance of newlyweds and prevailing marriages are larger for homogamy than for alternate measures of resemblance; and (3) age patterns of resemblance vary somewhat depending on the measure of resemblance used. Overall, these supplementary results support our main conclusions—that first marriages are overwhelmingly responsible for the odds of homogamy in prevailing marriages, and other factors have small and offsetting effects. In addition, the point estimates from our supplementary models indicate that the direction of these effects is the same using alternative measures of resemblance across virtually all of the flows. Despite the similarity of the results to those presented in the main text, they may be of particular interest to scholars who wish to measure spousal resemblance using measures other than homogamy.

Model Fit

Homogamy models are one of many potential representations of the educational resemblance of spouses. In addition to homogamy models, we tested the goodness-of-fit of two other single-parameter models (uniform association and fixed distance models) as well as models that vary across the education distribution (crossings models).[1] Here, we discuss the model specifications and results for these additional models.

A linear by linear association model may be represented as

$$\log(\mu_{ijk}) = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^A + \lambda_{ik}^{HA} + \lambda_{jk}^{WA} + \beta_k^A u_i v_j \,, \qquad \text{(S1)}$$

where u_i are years of schooling corresponding to husbands' education category (u = 9, 12, 14, 17), v_j are years of schooling corresponding to the wives' education category (v = 9, 12, 14, 17),[2] β_k^A is the linear by linear association parameter for wives in age category k (k = 18-21,…, 38-41), and all else is as defined in Eq. (2) in the main text. The β_k^A terms give the predicted increase in husbands' (wives') years of schooling for a one-unit increase in wives' (husbands') years of schooling.

A fixed distance model may be represented as

$$\log(\mu_{ijk}) = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^A + \lambda_{ik}^{HA} + \lambda_{jk}^{WA} + \gamma_k^A \,|i - j|, \qquad \text{(S2)}$$

where $|i - j|$ is the number of educational categories that separate spouses and γ_k^A is the fixed distance parameter for wives in age category k.

A crossings model may be represented as

$$\log(\mu_{ijk}) = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^A + \lambda_{ik}^{HA} + \lambda_{jk}^{WA} + \delta_{kij}^{AHW} \,, \qquad \text{(S3)}$$

where

[1] We also tested education-specific homogamy models, but they fit the data substantially worse than the crossings models shown here.
[2] The *u* and *v* scale scores correspond to the approximate mean years of schooling completed by husbands and wives in each education category.

$$\delta_{kij}^{AHW} = \begin{cases} \sum_{q=j}^{i-1} \gamma_{kq} & \text{for } i > j, \\ \sum_{q=i}^{j-1} \gamma_{kq} & \text{for } i < j, \\ 0 & \text{otherwise.} \end{cases}$$

Here, γ_{kq} represents the change in the difficulty of crossing education barrier q for wives in age category k. Specifically, it is the log odds that a couple is married across adjacent education categories relative to being in the same category at age k. There are three education barriers corresponding to the four education categories.

Table S1 provides the fit statistics for the log-linear models defined above and the homogamy models defined in the main text for prevailing marriages and new first marriages. These models are estimated using the raw NLSY79 data rather than the multistate life table data. Because the multistate life table data are not sample data, traditional hypothesis tests and goodness-of-fit statistics are invalid. We compare patterns of educational resemblance using the raw and multistate life table data below.

To compare model fit, we present the Bayesian information criterion (BIC) (Raftery 1995), Akaike's (1973) information criterion (AIC), and likelihood ratio χ^2 statistics. For the BIC and AIC, smaller statistics indicate better-fitting models.[3] For each association measure, we present four models that make different assumptions about age pattern of educational resemblance. These assumptions are that (1) the age pattern of association is constant; (2) the association varies freely by wife's age; (3) the association varies linearly by wife's age; and (4) the association by wife's age can be described with a quadratic function. The likelihood ratio χ^2

[3] The BIC is defined as $G^2 - df \times \ln n$, where G^2 is the model deviance. AIC is defined as $(-2 \times \ln L + 2P) / n$, where L is the likelihood of the model, and P is the number of parameters.

statistics within each set of models test the fit of Models 2 through 4 against Model 1; in other words, they test whether there is evidence of an age pattern of educational resemblance.

We present two sets of goodness-of-fit statistics for prevailing marriages based on two scenarios about our effective sample size. In the first scenario, we compute goodness-of-fit statistics assuming that the total sample size is the sum of the total number of couple-years in which female respondents are married and are between the ages of 18 and 41 (n = 35,086); in the second, we compute these statistics assuming that there are only as many observations as there are married female respondents between the ages of 18 and 41 (n = 3,841). Because the prevailing marriage data contain one observation per interview year that respondents are married and these data are likely to be highly correlated within individuals, assuming that we have n = 35,086 independent observations is likely to overstate the precision of our results. By contrast, assuming that our effective sample size is only as large as the number of married women in our data is likely to be overly conservative. Many statistical methods allow for the easy adjustment of hypothesis tests and fit statistics to account for the clustering of observations within groups. Correcting for individual-level clustering in methods that use tabular data, however, is not straightforward unless the models cannot be readily translated into individual-level logistic or multinomial regression models (see Schwartz 2010 for an application of this method). Although it would be possible to better correct for individual-level clustering here, we view this model-fitting exercise as heuristic. Moreover, our conclusions are very similar regardless of which of the extreme assumptions about sample sizes we choose to interpret. Unlike for prevailing marriages, individual-level clustering is not an issue in our models for new first marriages because, by definition, respondents have only one new first marriage.

Table S1 shows that for prevailing marriages (under both sample size assumptions) and new first marriages, homogamy models provide a worse fit to the data than other models. Linear by linear association models tend to fit best. Whether fixed distance or crossings models provide a better fit depends on our sample size assumptions and whether prevailing or new marriages are considered. Table S1 also shows relatively weak evidence for age variation in educational resemblance, with the possible exception of variation in the odds of homogamy. Age variation in educational homogamy is significant by all indicators for prevailing marriages assuming n = 35,086 couple-years, but allowing homogamy to vary by age assuming one observation per woman does not improve the fit of the model by the BIC and improves the fit only very marginally by the AIC and likelihood ratio χ^2 test. There is stronger evidence for nonlinear age variation in homogamy among new first marriages.

Although homogamy models provide a poorer fit to the data than other models, we focus on results from these models in the text for several reasons. First, homogamy is the dominant concept in research on assortative mating. Concepts of association as measured by the linear by linear association parameter (the extent to which a one-unit increase in one spouse's years of schooling is associated with a *y*-unit increase in the other's) and the fixed distance parameter (the association between the numbers of educational categories crossed and the likelihood of marriage) are less intuitive and less easily interpretable. The goal of this paper is not to identify a potentially highly complex best-fitting model of assortative mating. Indeed, because we examine resemblance across many different samples (e.g., prevailing marriages, new first marriages, new remarriages, couples whose marriages are about to dissolve) it is likely that no single model would best fit all of them. More complex models also have the drawback that they are highly affected by the age distribution of education. For example, among young wives (e.g., those aged

18 to 21), the odds of crossing the college/noncollege barrier are extremely low (not shown) because very few of women in this age range have completed college themselves and because of strong patterns of age homogamy. From a substantive perspective, we prefer models that are equally applicable across the age spectrum, such as homogamy or linear by linear association models. Finally, although there is some evidence that age patterns of assortative mating across the single-parameter measures vary, the way that the flows affect resemblance in the stock of marriages is similar across measures, and thus the presentation of results from other models is largely redundant, as discussed below.

Alternative Single-Parameter Measures

Multistate Life Table versus Raw Data

Age Patterns of Resemblance

Figure S1 shows age patterns of educational resemblance for the three single-parameter measures of the association displayed in Table S1. We show patterns calculated from the multistate life table data (as in the main text for homogamy) and from the raw data (from which the fit statistics in Table S1 were calculated). Each panel shows age patterns smoothed with a quadratic function and the unsmoothed (observed) patterns. Patterns using the multistate life table and the raw data may differ because of censoring and survey attrition in the raw data and because of stochastic fluctuations in estimating the transition rates.

A comparison of Panel A with Panel B reveals somewhat larger differences between the odds of homogamy in prevailing and new first marriages, more muted age patterns, and somewhat more age variability in the odds of homogamy for new first marriages in the multistate life table than the raw data. The greater age variability in resemblance for new first marriages in the multistate life table data is most likely the result of sampling variability in the calculation of the transition rates used to construct the multistate life table data. Because we examine transition rates specific to husbands' and wives' education by single years of female respondent's age, our denominators are often small. The typical solution to this problem is to use regression models to obtain smoothed transitions rates (e.g., Land et al. 1994; Yang 2008). Our analysis uses unsmoothed rates. We opted instead to smooth age patterns of homogamy in the log-linear modeling stage of our analysis. Figure S1 shows that age patterns of homogamy in the multistate life table and raw data are similar. The 95% confidence intervals constructed around our decomposition results (Tables 2 and 3) account for the variability of the rates in constructing the multistate life table data.

Turning to the linear by linear association models, again we see that couples in prevailing marriages are slightly more likely to resemble each other than those in new first marriages (except at the oldest ages). In addition, there is somewhat more age variability in the estimates using the multistate life table data than the raw data (Panel C vs. D), but overall patterns between the two data sources are similar. Consistent with the results in Table S1, Panels C and D show less evidence of age variation in the linear by linear association terms compared with homogamy. Thus, while there is some evidence that the odds of sharing the same education level as one's spouse (homogamy) is lower at younger ages, particularly for newlyweds, the average association or "closeness" of spouses' attainments is similar across the age range. This suggests that, at younger ages, spouses may be less likely to share the same attainment, but there may be greater clustering of spouses' attainments close to each other; at older ages, spouses are more likely to share the same attainment, but there may be more couples with more dissimilar educational attainments, which would lead to a relatively flat age pattern of association. These patterns are consistent with the age-structured nature of schooling and assortative mating. At younger ages, couples may be more likely to match just outside their education level if one partner has completed school and the other has not, but because of strong patterns of age homogamy, they may be unlikely to match across large educational distances.

By contrast to the homogamy and linear by linear association results, age patterns in the fixed distance parameters vary somewhat more between the multistate life table and raw data (Panels E vs. F). Recall, however, that Table S1 showed little evidence of significant age variation in these patterns. As in the two other single-parameter models, both data sources show that new first marriages tend to be matched across larger educational divides (couples are less likely to resemble each other) than prevailing marriages.

Resemblance in the Stocks and Flows

Figure S2 shows measures of resemblance in the stocks and flows of marriages using the multistate life table and raw data. With few exceptions, the relative resemblance of the stocks and flows for each measure of resemblance are quite similar across data sources. Moreover, this is also generally true across measures of resemblance. For instance, each of the three measures of resemblance shows that couples in prevailing marriages resemble each other most (or, in the case of the fixed distance measure, are separated by the fewest educational categories), generally followed by new first marriages. Couples whose marriages are about to dissolve are less likely to resemble each other than those in prevailing marriages, and couples entering remarriages are substantially less likely to resemble each other than either couples entering or exiting their marriages. By contrast, more variability exists in resemblance among couples making educational changes across measures and data sources. Overall, the consistency of spousal resemblance in the stocks and flows across measures is reassuring.

Decomposition

Table S2 shows the decomposition of educational resemblance in prevailing marriages into its proximate determinants using linear by linear association and fixed distance models to measure the association. The results are very similar to those for homogamy (Table 2): first marriages make up the vast majority of the observed resemblance of spouses in the stock of marriages. If only first marriages had contributed to the stock of marriages, the linear by linear association parameter would have been 16% higher than observed and the fixed distance parameter would have been 12% higher than observed. The other marital transitions decrease the resemblance of the stock of marriages, on average. For both of these measures, remarriages in particular reduce the resemblance of couples in prevailing marriages.

How well would researchers do if they were to infer the resemblance of newlyweds from data on prevailing marriages using linear by linear association and fixed distance measures? Table S3 addresses this question, showing that educational resemblance among prevailing and new first marriages are quite similar for both measures. Specifically, for wives aged 18 to 41 in prevailing marriages, the exponentiated linear by linear association parameter is only 0.2% higher than for observed new first marriages, and the exponentiated fixed distance parameter is only 3.4% lower. (Recall that because the fixed distance parameter measures distance and the linear by linear association measures closeness both measures indicate that couples in prevailing marriages resemble one another more than do those in new first marriages.) For these two measures of resemblance, prevailing marriages somewhat more closely reflect resemblance among newlyweds than do homogamy measures, for which prevailing marriages were 15% more likely to be homogamous than new first marriages (Table 3). For the odds of homogamy, restricting the sample to young wives slightly ameliorates these differences, but for the linear by linear association and the fixed distance parameters, limiting the sample to young couples slightly increases differences between prevailing and new first marriages. Rows (2) and (3) of Table S3 show that, like for homogamy, the greater resemblance of couples in prevailing marriages compared with new first marriages is entirely due to age patterns of resemblance and first marriage.

That the resemblance of couples in prevailing marriages is closer to that of new first marriages when measured by linear by linear association and fixed distance models than by homogamy models does not mean that marital dissolutions, remarriages, and educational upgrades have smaller effects on the resemblance of spouses. In fact, as can be seen by comparing Table S2 with Table 2, the impacts of the flows are often larger for these alternative single-parameter measures than for homogamy. The reason for the similarity between the resemblance of prevailing marriages and new first marriages for the alternative measures is that the resemblance of prevailing marriages is kept nearly as low as that of new first marriages by the impacts of marital dissolutions, remarriages, and educational upgrades. If first marriages were the only marital events to contribute to the stock of marriages, the differences would be greater.

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Table S1 Estimates of model fit for selected log-linear models of educational resemblance among prevailing and new first marriages

	Prevailing Marriages										New First Marriages				
	n = Number of Couple-Years (35,086)					*n* = Number of Female Respondents (3,841)					*n* = Number of Couple-Years (2,964)				
Measure of Resemblance and Model	G^2	*df*	BIC	AIC	Contrast *p* Value[a]	G^2	*df*	BIC	AIC	Contrast *p* Value[a]	G^2	*df*	BIC	AIC	Contrast *p* Value[a]
Baseline Model: HA + WA	11,672.0	54	11,107	.3535	—	11,672.0	54	11,107	.3535	—	893.8	54	462	.4576	—
Homogamy (O)															
(A1) Baseline + O	4,671.9	53	4,117	.1540	—	511.5	53	74	.2716	—	431.3	53	8	.3023	—
(A2) Baseline + O × A	4,618.4	48	4,116	.1528	.0000	505.6	48	109	.2727	.3201	412.1	48	28	.2991	.0017
(A3) Baseline + O × A(l)	4,654.2	52	4,110	.1536	.0000	509.5	52	80	.2716	.1643	425.4	52	10	.3009	.0151
(A4) Baseline + O × A(l)²	4,628.9	51	4,095	.1529	.0000	506.7	51	86	.2714	.0948	414.9	51	7	.2981	.0003
Linear by Linear Association (LA)															
(B1) Baseline + LA	489.7	53	–65	.0348	—	53.6	53	–384	.1524	—	71.1	53	–353	.1807	—
(B2) Baseline + LA × A	485.5	48	–17	.0350	.5187	53.2	48	–343	.1549	.9935	68.9	48	–315	.1833	.8138
(B3) Baseline + LA × A(l)	487.7	52	–57	.0348	.1527	53.4	52	–376	.1529	.6361	71.1	52	–345	.1814	.9299
(B4) Baseline + LA × A(l)²	485.7	51	–48	.0348	.1362	53.2	51	–368	.1533	.8039	69.1	51	–339	.1814	.3540
Fixed Distance (FD)															
(C1) Baseline + FD	684.8	53	130	.0404	—	75.0	53	–362	.1580	—	107.2	53	–317	.1929	—
(C2) Baseline + FD × A	680.0	48	178	.0406	.4478	74.4	48	–322	.1604	.9914	105.0	48	–279	.1955	.8269
(C3) Baseline + FD × A(l)	684.6	52	140	.0405	.6762	74.9	52	–354	.1585	.8901	105.9	52	–310	.1931	.2657
(C4) Baseline + FD × A(l)²	683.5	51	150	.0405	.5215	74.8	51	–346	.1590	.9312	105.3	51	–302	.1936	.3960
Crossings (XS)															
(D1) Baseline + XS	542.6	51	9	.0365	—	59.4	51	–362	.1549	—	103.5	51	–304	.1930	—
(D2) Baseline + XS × A	520.3	36	144	.0367	.1021	57.0	36	–240	.1621	.9999	92.8	36	–195	.1995	.7704
(D3) Baseline + XS × A(l)	535.4	48	33	.0364	.0661	58.6	48	–338	.1563	.8525	102.4	48	–281	.1946	.7637
(D4) Baseline + XS × A(l)²	535.0	45	64	.0366	.2734	58.6	45	–313	.1579	.9914	101.9	45	–258	.1965	.9504

Notes: Dependent variables are weighted cell frequencies. Model terms are as follows (*df* are in parentheses): H = husbands' education category (3); W = wives' education category (3); A = wives' age category (5); A(l) = wives' age category (linear) (1); A(l)² = wives' age category (linear and quadratic) (2); O = homogamy (1); LA = linear by linear association (1); FD = fixed distance (1); XS = crossings (3). Wives are aged 18 to 41.

Source: National Longitudinal Survey of Youth (NLSY79), 1979–2002.

[a]Shows the *p* value for a likelihood ratio χ^2 test of the difference in model deviance (G^2) between a given model and a model assuming no age variation in the association parameter.

Table S2 Decomposition of the log odds of educational resemblance in prevailing marriages

Measure of Educational Resemblance and Sample or Simulation	Odds	Log Odds	Contribution to Log Odds	Percentage Contribution (%)	95% CI for Percentage Contribution (%)[a]
Linear by Linear Association					
Observed Prevailing Marriages	1.133	0.125	—	—	—
First Marriages (S1)	1.156	0.145	0.145	116.28	[106.2, 126.4]
+ First Dissolutions (S2)	1.158	0.147	0.002	1.57	[–4.45, 7.59]
+ Remarriages (S3)	1.142	0.133	–0.014	–11.27	[–16.3, –6.25]
+ Later Dissolutions (S4)	1.143	0.134	0.001	0.76	[–2.46, 3.98]
+ Educational Upgrades (S5)	1.133	0.125	–0.009	–7.34	[–14.2, –0.46]
Total			0.125	100.00	
Fixed Distance					
Observed Prevailing Marriages	0.458	–0.782	—	—	—
First Marriages (S1)	0.418	–0.872	–0.872	111.58	[103.7, 119.5]
+ First Dissolutions (S2)	0.415	–0.880	–0.008	1.00	[–3.83, 5.83]
+ Remarriages (S3)	0.438	–0.825	0.055	–7.02	[–11.5, –2.56]
+ Later Dissolutions (S4)	0.439	–0.823	0.002	–0.30	[–2.83, 2.22]
+ Educational Upgrades (S5)	0.458	–0.782	0.041	–5.26	[–10.2, –0.34]
Total			–0.782	100.00	

Notes: Data are weighted using 1979 sampling weights. Estimates are from log-linear models using data from multistate life tables. Wives are aged 18 to 41.
Source: National Longitudinal Survey of Youth (NLSY79), 1979–2002.
[a]95% confidence intervals (CIs) are estimated using 1,000 bootstrapped samples.

Table S3 Decomposition of the difference in the log odds of educational resemblance in prevailing and new first marriages

Measure of Educational Resemblance					Difference in Log Odds	Odds Ratio	95% CI for Odds Ratio (%)[a]
Linear by Linear Association							
Panel A. Wives Aged 18 to 41							
(1) Total Difference in Log Odds							
Observed Prevailing Marriages – Observed New First Marriages	0.125	–	0.122	=	0.002	1.002	[0.991, 1.014]
(2) Portion Due to Age Patterns of Homogamy and First Marriage							
First Marriages (S1) – Observed New First Marriages	0.145	–	0.122	=	0.023	1.023	[1.011, 1.035]
(3) Portion Due to Marital Dissolutions, Remarriages, Educational Upgrades							
Observed Prevailing Marriages – First Marriages (S1)	0.125	–	0.145	=	–0.020	0.980	[0.968, 0.992]
Panel B. Wives Aged 18 to 29							
(1) Total Difference in Log Odds							
Observed Prevailing Marriages – Observed New First Marriages	0.130	–	0.123	=	0.007	1.007	[0.993, 1.021]
(2) Portion Due to Age Patterns of Homogamy and First Marriage							
First Marriages (S1) – Observed New First Marriages	0.149	–	0.123	=	0.026	1.026	[1.009, 1.043]
(3) Portion Due to Marital Dissolutions, Remarriages, Educational Upgrades							
Observed Prevailing Marriages – First Marriages (S1)	0.130	–	0.149	=	–0.019	0.981	[0.969, 0.994]
Fixed Distance							
Panel A. Wives Aged 18 to 41							
(1) Total Difference in Log Odds							
Observed Prevailing Marriages – Observed New First Marriages	–0.782	–	–0.747	=	–0.034	0.966	[0.907, 1.026]
(2) Portion Due to Age Patterns of Homogamy and First Marriage							
First Marriages (S1) – Observed New First Marriages	–0.872	–	–0.747	=	–0.125	0.883	[0.825, 0.940]
(3) Portion Due to Marital Dissolutions, Remarriages, Educational Upgrades							
Observed Prevailing Marriages – First Marriages (S1)	–0.782	–	–0.872	=	0.091	1.095	[1.028, 1.162]
Panel B. Wives Aged 18 to 29							
(1) Total Difference in Log Odds							
Observed Prevailing Marriages – Observed New First Marriages	–0.810	–	–0.755	=	–0.055	0.946	[0.877, 1.016]
(2) Portion Due to Age Patterns of Homogamy and First Marriage							
First Marriages (S1) – Observed New First Marriages	–0.873	–	–0.755	=	–0.117	0.889	[0.813, 0.966]
(3) Portion Due to Marital Dissolutions, Remarriages, Educational Upgrades							
Observed Prevailing Marriages – First Marriages (S1)	–0.810	–	–0.873	=	0.062	1.064	[1.001, 1.128]

Note: Data are weighted using 1979 sampling weights.
Source: National Longitudinal Survey of Youth (NLSY79), 1979–2002.
[a]95% confidence intervals (CIs) are estimated using 1,000 bootstrapped samples.

Figure S1. Educational Resemblance Among Prevailing Marriages and New First Marriages Using Multistate Life Table and Raw Data

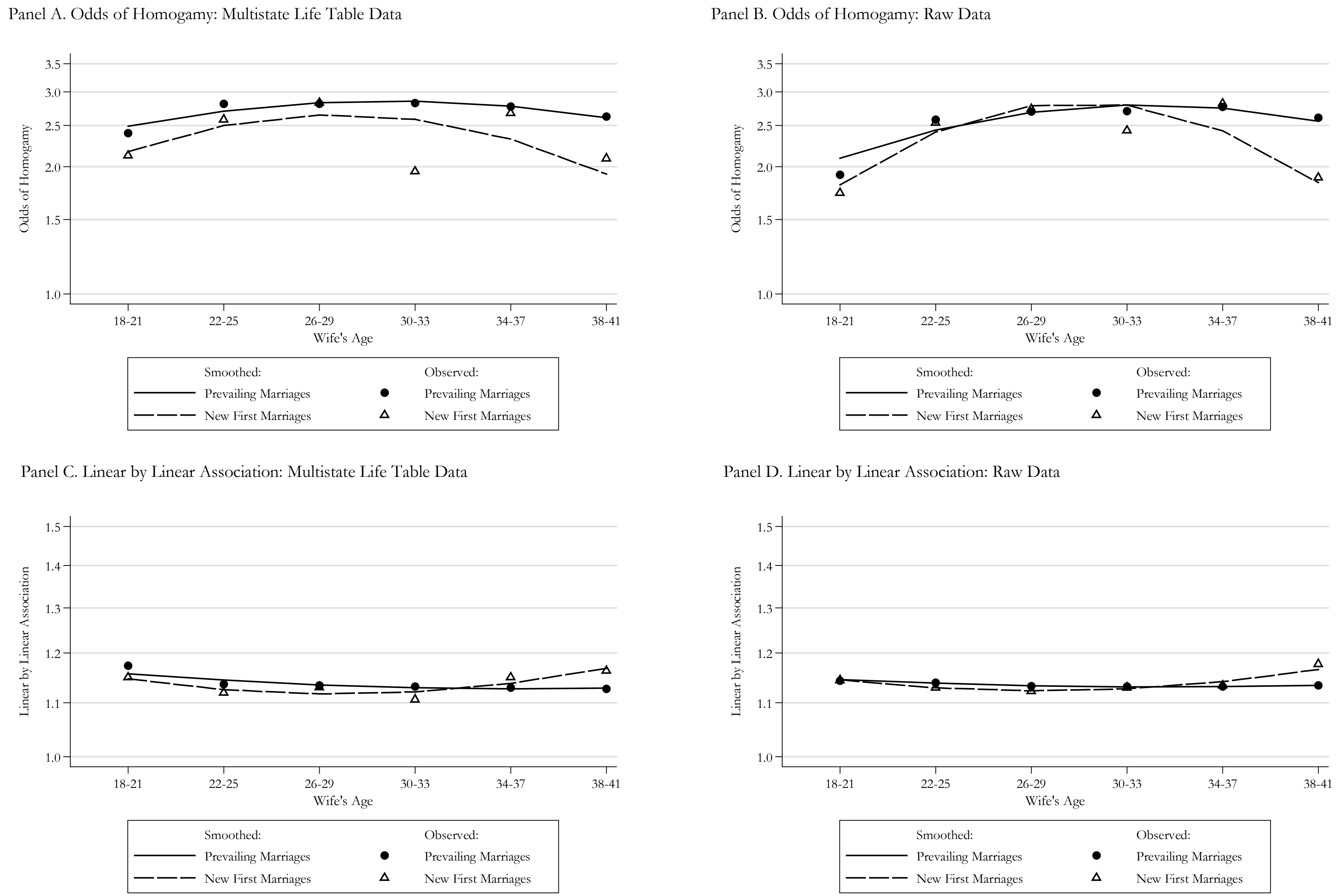

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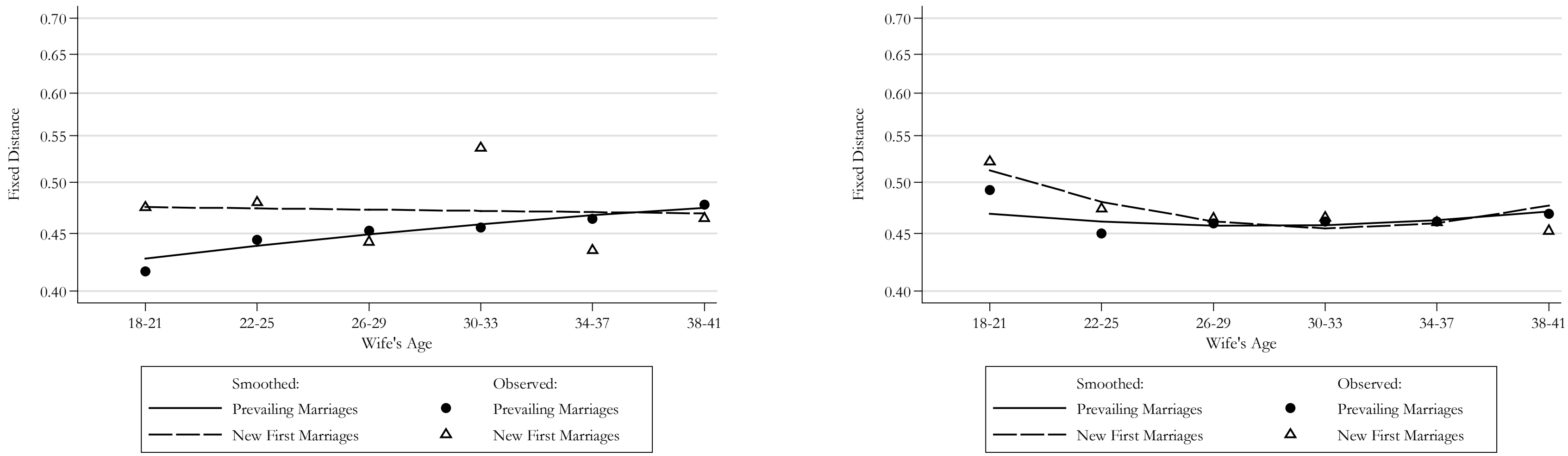
Figure S1. Continued

Panel E. Fixed Distance: Multistate Life Table Data

Panel F. Fixed Distance: Raw Data



Notes: Data are weighted using 1979 sampling weights. Estimates are from log-linear models.
Sources: National Longitudinal Survey of Youth (NLSY79), 1979-2002.

Figure S2. Educational Resemblance in the Stocks and Flows of Marriages Using Multistate Life Table and Raw Data

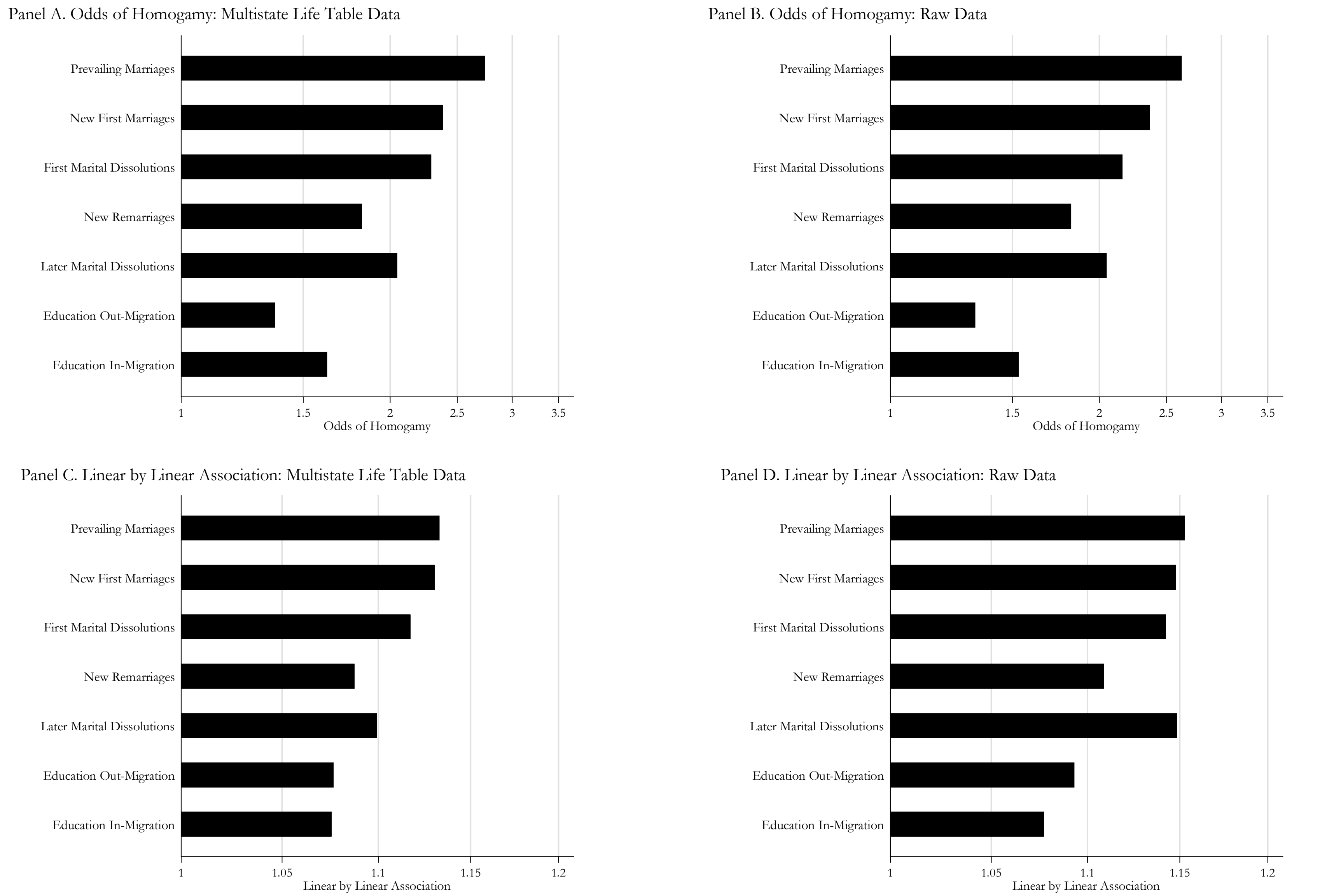


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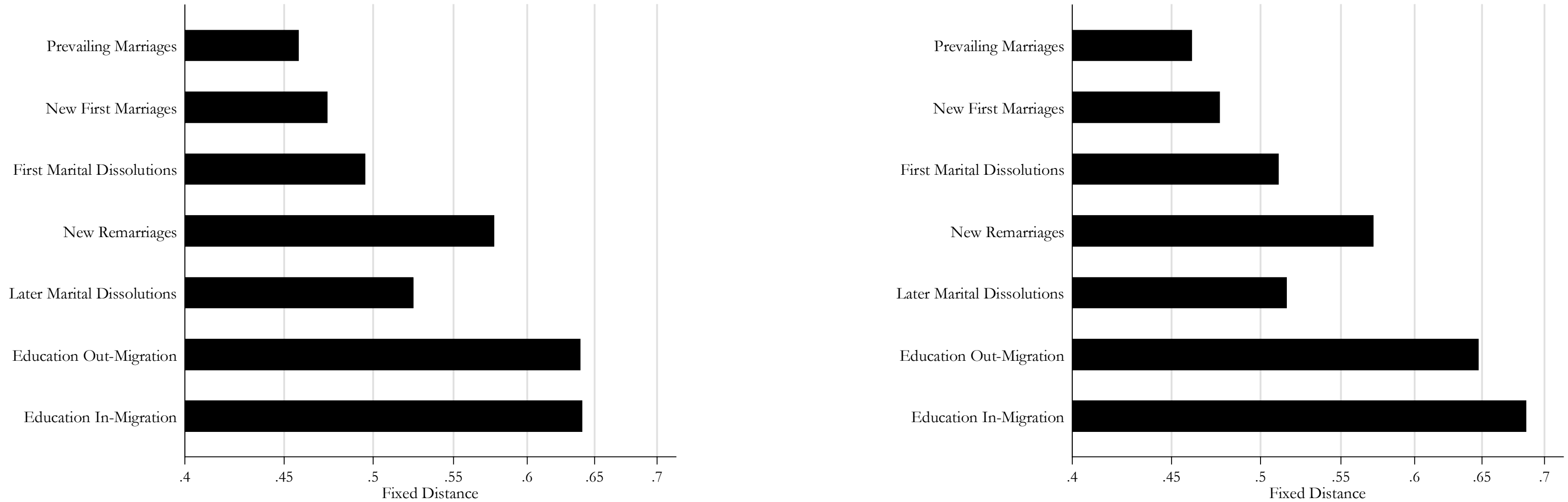
Figure S2. Continued

Panel E. Fixed Distance: Multistate Life Table Data

Panel F. Fixed Distance: Raw Data



Notes: Data are weighted using 1979 sampling weights. Estimates are from log-linear models. Wives aged 18 to 41.
Sources: National Longitudinal Survey of Youth (NLSY79), 1979-2002.