What Mom and Dad's Match Means for Junior: Marital Sorting and Child Outcomes

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Abstract

This paper employs recently developed marital matching models to examine empirically the role played by marital sorting in observed measures of marital production. Using the US Collaborative Perinatal Project (CPP), a large-scale study from the 1960s, we find that marital surplus is strongly correlated with indexes of child quality, as measured by cognitive test scores, and with the durability of the marital union. At ages beyond infancy, correlations between neurocognitive outcomes and marital surplus are independent of the parental characteristics that generate the match, suggesting that they may represent effects of the match itself. They are also robust to controlling for household income and number of siblings. High marital surplus is associated with assortative mating on education and age, suggesting complementarity in parental inputs in child production and a joint effect of parental education and age on child outcomes that exceeds the linear sum of the parts. To the extent that marital surplus can be considered a proxy for the subjective well-being of the couple, our results suggest that parental happiness is an important input for child quality above and beyond its indirect effects on marital stability and earnings.

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1 Introduction

This paper examines the role that parental sorting in the marriage market may play in marital production, specifically child neurocognitive outcomes and the likelihood of divorce. While there have been large literatures on marriage markets and the intergenerational transmission of parental characteristics, no previous research of which we are aware has focused on how joint parental characteristics generated by the marriage market may affect child outcomes. Our investigation adds to knowledge along these and other dimensions. There is renewed interest in the conditions of early-life development in general (Almond and Currie, 2011), and production of child quality has potentially important implications for intergenerational income mobility.

Our contribution is primarily empirical, and it represents a first step toward merging disparate literatures using a feasible identification strategy. We examine data on parental characteristics and child neurocognitive outcomes in the US Collaborative Perinatal Project (CPP), a large-scale longitudinal survey that covers roughly 30,000 children with data on both parents around 1960 (Niswander, 1972; Edwards and Roff, 2010). We are interested in the effects of parental matching on child outcomes, which are measured at several ages in the CPP, and in this paper we draw identification from cross-sectional variation in the initial parental match, based solely on time-invariant characteristics.[1] We test whether marital surplus, a nonlinear function of parental

[1] Marital history is recorded in the CPP, and an alternative strategy could attempt to draw identification from changes in marital status and thus the delivery of joint parental inputs during the panel. But as we show, the longevity of the marital union itself appears to be a function of (initial) marital surplus, raising questions about how one should interpret the effects of dissolution on child outcomes. Parental death could be a source of exogenous variation, but it too might be related to match quality and parental characteristics, and it is difficult to measure in the CPP. Other possible identification strategies include looking for other

characteristics underpinned by matching theory, is independently correlated with child outcomes and marital dissolution in linear regression models with parental characteristics.

Recent literature has focused on marital sorting over multiple characteristics to examine how partners may effectively 'trade off' one characteristic for another. There is renewed interest in matching models, led first by Choo and Siow's (2006) estimation of a transferable utility model to rationalize marital decisions with a systematic and idiosyncratic component. Important theoretical contributions to this framework have further explored the identification of matching games and have estimated matching models on socioeconomic and demographic characteristics like education and race (Iyigun and Walsh, 2006; Fox, 2010; Chiappori et al. 2010; Galichon and Salanié, 2010). In addition, Chiappori et al (2009) estimate marginal rates of substitution on partner socioeconomic and physical characteristics, and find evidence that men may compensate for a higher own body mass index via providing a higher wage, and that these effects are much smaller for women.

While a variety of research has identified intergenerational effects of education and parental age on child outcomes (Behrman and Rosenzweig, 2002; Currie and Moretti, 2003; Plug, 2004; Antonovics and Goldberger, 2005; Black et al, 2005; Carneiro et al, 2007), there has been little work focusing on possible tradeoffs and interactions between parental characteristics, or on how these tradeoffs may affect marital public goods, such

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measurable changes in parental characteristics or for exogenous shocks to the supplies of males or females (Chang and Zhang, 2012). We do not believe either of these is feasible in our data.

as children (see Beck et al, 2009 for an exception). Neither has there been research using recent advances in marital matching models to investigate these issues empirically.

Our findings here indicate that marital surplus derived from matching models is strongly correlated with key measures of marital production, in particular child cognitive scores and the probability of divorce. Moreover these effects are robust to the use of multiple matching specifications using different characteristics to calculate marital surplus. Perhaps most interestingly, marital surplus continues to have a significant effect even after separately controlling for parental characteristics in our linear regression models. This suggests that the match per se is affecting measures of marital production, rather than only the parental characteristics in isolation. Given that one of the motivations to marry in the first place is to augment productivity of marital and other goods, this result is not altogether unexpected. But we also view it as a novel result worthy of further inquiry.

2 A brief overview of matching theory applied to marriage markets

Becker (1973) provides a seminal contribution upon which much subsequent research has built. One of his core insights is that patterns of assortative mating are likely to be driven by the degree of complementarity between parental characteristics in child production, a key goal of mating. Empirical patterns of similarity between spouses along dimensions like education, height, parental wealth and race suggest that many parental characteristics are more complements than substitutes (for example, Dalmia and Lawrence, 2001; Nakosteen et al, 2004; Siow, 2009; Charles et al, 2011). Although Becker foresaw that the degree of complementarity was theoretically ambiguous, not all

aspects of the data fit Becker's basic model cleanly, in particular the relationship between male and female potential earnings observed in a couple.[2]

Recently, Galichon and Salanié (2010) have developed a framework that uses covariation in the data from the observed match (π) to estimate preferences on partner characteristics as well as to estimate overall marital surplus. As the title of Galichon and Salanié's paper suggests, this approach is particularly useful for examining the tradeoffs among multi-dimensional characteristics that marriage market participants make when finding a mate. Following this model, we impose a separability assumption on partners' observable and unobservable characteristics as well as a multinomial logit error structure, and adopt a linear functional form of the surplus function (Φ) over parental characteristics as follows:

$$\Phi_{\Lambda}(X_f, X_m) = \Sigma_{k=1}^{K} \lambda_k \varphi_k (X_f, X_m) \quad (1)$$

where X_f and X_m are observable father's and mother's characteristics, respectively, φ_k (X_f, X_m) are discrete basis functions which describe the K possible joint characteristics, and λ_k are the marital surplus weights on each of the K combinations to be estimated. The surplus weights, λ_k, can be interpreted as the contribution to marital surplus of joint characteristics and are estimated by maximizing a linear combination of the surplus function and the mutual information $I(\pi)$ as follows:[3]

[2] Becker identified patterns in earnings as an element that did not fit his model of matching particularly well. While the theory suggests a negative correlation between partners' earnings or characteristics that are close substitutes in home production, this is often not the case in data. Selection may explain some of the inconsistency (Zhang and Liu, 2003).

[3] The mutual information of a joint distribution $\prod$ is defined as $\Sigma_{xf, xm} \pi(x_f, x_m) \log [\pi(x_f, x_m) / [p(x_f) q(x_m)]]$, where p and q are the mother and father's marginal distribution, respectively. In our estimates, σ is normalized to 1.

$$E_{\pi}\,\Phi(X_{\mathbf{f}}, X_{\mathbf{m}}) - \sigma\, I(\pi) \qquad (2)$$

The mutual information may be thought of as a measure of the covariance between fathers' and mothers' characteristics, where the mutual information is greater than or equal to zero, and $I(\pi) = 0$ if father's and mother's characteristics are independent. The above objective function is weighted by unobserved heterogeneity, σ, in the model. If no heterogeneity exists, then this function simply amounts to simply maximizing the marital surplus function. If, however, there is a great deal of heterogeneity, then the objective function is maximized by minimizing the mutual information, and therefore by random matching. In other words, if unobserved heterogeneity is quite high, then much of the apparent observed covariation is due to noise, and should be treated as such.[4] For a full discussion of the objective function and estimation method, see Galichon and Salanié (2010).

To gauge robustness in our regression results later, we estimate four different matching models in order to recover four different estimates of couple-specific marital surplus, which we define shortly. Couples in the marriage market match across a range of multi-dimensional characteristics, which may include age, education, religion, physical appearance, and other variables. We observe only a subset of the matching variables, although the method outlined by Galichon and Salanié is designed to account for unobserved heterogeneity. Functionally, we find that matching on different subsets of measurable characteristics produces somewhat different estimates of the values of characteristics and thus the marital surplus associated with a particular match. As a result,

[4] Lundberg and Pollak (2008) offer an alternative modeling approach in which partners cannot make binding agreements, and thus sorting in the marriage market and allocation after marriage is determined by a two-stage game.

we specify matching over two and three subsets of the four types of characteristics and a fourth over all four.

In order to test the ability of marital surplus to explain child outcomes and divorce independently of parental characteristics, we construct indicators of joint characteristics of the mother and separately of the father to populate X_m and X_f. As a result, the multinomial logit estimator generates estimates of marital surplus that are nonlinear functions of the underlying parental characteristics, so our regression models of child outcomes and divorce as functions of marital surplus and parental characteristics will be identified. While in some sense a statistical trick, this method remains fully consistent with matching theory; we have simply redefined the fundamental characteristics over which preferences are relevant as combinations or vectors of measures rather than scalars. Indeed, this may inject more realism into the matching model, but ultimately we believe it is a harmless translation of the problem that conveys a functional benefit.

We specify X_m and X_f using up to four types of characteristics: the age difference, education levels, and religious affiliation of both parents, and the pre-pregnancy BMI of the mother, a loose proxy for physical appearance.[5] We define categorical variables for the age difference using a threshold set to a five-year gap between mother's and father's ages,[6] for high education with a high school degree (12 years) as the cutoff, and for BMI

[5] Our only measure of physical appearance in the data (besides measures of physical defects which are extremely rare), is maternal height and weight. We use this data to compute a pre-pregnancy BMI. Unfortunately, this data is not available for males.

[6] We use a measure of endogamy in age, as opposed to discrete age categories for both males and females in order to limit the number of basis functions and since most have couples partner with someone close to their own age, which would leave off-diagonal cells sparse. While we assign this data to males since we do not have data on paternal BMI, we could have assigned it to females as well, without a material change in results.

using the sample median, which is slightly below the mean. We also define indicators for religious endogamy, measured as similarity across self-identifying as either Catholic, Protestant, or "Other."[7] The four matching models that we estimate are defined as follows and are shown along the columns in Table 3, which we describe in greater detail below.

1) Parents match on the age difference, the mother's physical appearance, and high education across 4 categories

2) Parents match on the age difference, the mother's physical appearance, and religious endogamy across 7 categories

3) Parents match on high education and religious endogamy across 7 categories

4) Parents match on the age difference, the mother's physical appearance, high education, and religious endogamy across 16 categories

2.1 Implications for Child Outcomes

The surplus function in equation (1) and observed matching patterns have obvious implications for marital production. Theory suggests that marital surplus should augment marital production, including child quality and the durability of the union, by improving the efficiency or quality of parental inputs supplied. But there has been no prior research to our knowledge that has examined the impact of matching on child outcomes empirically. Moreover, while associations between complementarities in parental characteristics and marital surplus and intergenerational investment in children have been

[7] Unfortunately, the data does not allow us to identify the religion of those who self-report as 'other', however, given patterns of religious belief in the U.S., it is likely that many of these respondents are Jewish. (U.S. Census Bureau, 1958))

well-documented (Becker and Tomes, 1979), there has been little empirical research on the explicit effect of matching across partner characteristics on child outcomes. Clearly, there may be complementarities or substitution effects between X_m and X_f that affect marital productivity and child outcomes, and about which only the data can inform us.

After recovering the surplus weights assigned by the data to the observed (X_m, X_f) combinations by maximizing equation (2), we can compute marital surplus to examine how marital surplus, computed before the birth of the child, may affect marital production, including child outcomes and the probability of divorce. If partners match on 'good' characteristics, such as education, which may be intergenerationally transmitted in part, then one might expect positive effects of marital surplus on child cognitive outcomes. However, the joint effect of these characteristics is less clear; maternal and paternal characteristics may be either substitutes or complements in household production. Moreover, if partners substitute among potential mates' different characteristics, the effects of particular characteristics on marital production may be more complicated.

As others have noted, many of the observed characteristics included in X_m and X_f may be acting in part as proxies for unobserved characteristics (particularly education as proxy for parental cognitive endowments). Furthermore, given partner choice, these results clearly cannot be interpreted as a causal effect of two randomly matched partner characteristics. As such, these results should be interpreted as the intergenerational effects of sorting on parental characteristics, which may be acting as proxies for underlying quality.

3 Empirical Evidence and Data

We use data drawn from three cross sections of the Collaborative Perinatal Project (CPP), based originally on pregnant women recruited from university hospitals between 1959 and 1965. These data provide an unusually rich set of developmental measures from three large cross sections over seven years. As shown in Table 1, which presents sample averages, standard deviations, and sample sizes, we have over 30,000 observations in many cases, although not on all of the father's characteristics. We focus on six CPP measures of children's neurocognitive development, two each at age 8 months, 4 years, and 7 years. In order, these include the Bayley Mental and Motor Scales for Infant Development (administered at 8 months); the Stanford Binet Intelligence Scale Form L-M, and the Graham-Ernhart Block Sort Test (administered at 4 yrs); and the Wechsler Intelligence Scale for Children (WISC) Full Scale IQ, and the Wide Range Achievement Test (WRAT) of Reading (administered at 7 years).

In addition to the cognitive measures, our data include the age, race/ethnicity,[11] maternal BMI prior to pregnancy, maternal religion and years of education of the mother at the time of birth, as well as the age, religion and years of education and of the father at the time of birth. Unfortunately, data on paternal height and weight are not provided. Our data also include household income at the time of birth and the seven year follow-up survey and the child's total number of siblings ever born. While the wealth of cognitive measures makes this dataset attractive, there are several drawbacks, including the age of the data and that it includes only matched couples who have had children. Since fertility

[11] Unfortunately, the data on paternal race is very limited; for this reason, we exclude race from our matching models.

is presumably a choice, the sample's surplus estimates may be biased upward, if those with more marital surplus are more likely to have children.

Before estimating marital surplus, we use a simple reduced form approach to illustrate basic sorting patterns in our data. This parallels Chiappori et al (2012), who show that the ratio of coefficients on characteristics in a simple linear regression setting can be interpreted as a marginal rate of substitution between characteristics under certain circumstances. Similarly, we simply model one characteristic as a function of the others and examine coefficients. The top panel of Table 2 presents regression results based on models of parental age differences, mother's BMI, and parental education, while the bottom panel adds in logged household income at the time of registration as a regressor. We estimate both types of regressions because income is highly correlated with partners' education and is only observed in our dataset for the household after the match has been completed, making it problematic as a match variable.[12]

The first column in Table 2 presents marginal effects from a probit regression of an age difference of 5 years or more favoring the husband on covariates. It reveals that the education level of either parent is predictive of an age gap less than 5 years, while the mother's pre-pregnancy BMI predicts an age gap of 5 or more years. In the lower panel, we see that household income also predicts a wider age gap, but this may simply reflect a mechanical association of husband's age with earnings. While the effect of partner age on utility may be non-monotonic, we posit that potential mates value homogamy in age as

[12] If one assumes that participants in the marriage market have some knowledge of their partner's future earnings, then participants may match on future earnings. While our estimates may be consistent with matching based on knowledge of future earnings, they also are of course consistent with a lower direct effect of BMI and education on income.

well as youth, and that the relative utility weight between these possibly contradictory preferences may vary with gender. In this case, a large age gap favoring the male may have a negative impact on female utility, all else equal, with an unknown effect on male utility. If so, then mothers with a large age difference may be compensated for the age difference by a higher household income, while males who marry younger women may trade off her youth for a higher body mass index, all else equal.

Column 2 illustrates the relationship between maternal BMI and parental characteristics. As one might expect, younger mothers have lower body mass indices. But women with lower BMIs also tend to marry men that are more educated, and are less likely to marry much older men, consistent with our theory. Moreover, women with lower pre-pregnancy BMIs are more likely to marry into higher income households.

Columns 3 and 4 of Table 2 show the OLS results for parental education regressed on paternal and maternal characteristics. Maternal education is positively associated with higher maternal age and partners show a high level of assortative mating related to education. Moreover, more educated mothers are less likely to have a 5-year age gap with their partners and to have higher household incomes, ceteris paribus. More educated fathers are also more likely to marry women with a lower BMI, consistent with the theory. As expected, paternal education is positively associated with household income and negatively associated with a large age gap, since younger fathers in our sample tend to be more highly educated.[13]

[13] If paternal age is included in the education and BMI regressions, the qualitative results remain the same. As might be expected, the primary difference is a loss of significance for the age gap variable in the height weight and paternal education regressions.

3.1 Marital Surplus Estimates

We estimate four marital surplus models using varying indicators of joint characteristics, and we report the results across the columns in Table 3. In the first model, parents match on mother's BMI, homogamy in age, and education; in the second, they match on religion, maternal BMI, and age; in the third, they match on religion and education; and in the last model, they match on all of the above characteristics. For each combination of mother's and father's characteristics that we consider, which are listed in the leftmost column, the relative size of that combination's estimated surplus weight (λ_k) indicates its importance in explaining observed matching patterns, as does the distance between the observed covariation of characteristics and the covariation that would be observed if couples were matched randomly.

In Model 1, the largest contributions to marital surplus derive from assortative mating on education and from positive matching between homogamy in age and highly educated mothers, with surplus weights of roughly 2.8 and 2.3, respectively. Given our normalization, these results indicate that the additional surplus from assortative mating among highly-educated partners is almost three standard deviations of the model's unobservable heterogeneity. The high observed covariation compared to random covariation of parents' education and of endogamy in age and maternal education confirm the importance of these dimensions of sorting. To a lesser extent, the results also indicate that highly educated fathers are more likely to match with women with a lower BMI, and that women with a low BMI are less likely to marry much older partners.

Turning next to Model 2, where we drop education and add parental religion, we see that couples generally have a preference for homogamy in religion combined with homogamy in age and low BMI ratios for women. This preference is particularly strong for those who identify themselves as Catholic or "Other," with a surplus weight on low maternal BMI and homogamy in religion among the Other group of over 15 standard deviations. As the random covariation in Table 3 suggests, and as shown in Table 1, the prevalence of mothers or fathers who report being neither Catholic nor Protestant is quite low, so the fairly modest observed covariation generates a high surplus weight for these characteristics. Still, we view these patterns as indicative of strong matching on religion in the early postwar period.

Looking next at matching on education and religious endogamy and dropping age and BMI in Model 3, we see that couples again show a strong preference for assortative mating among highly educated parents. Moreover, the joint contribution of parental education and religious endogamy to marital surplus varies by religious type, with a particularly strong contribution to marital surplus from highly educated Catholics and "Other" women who marry within their religion. As the bottom of the table indicates, this model has the strongest fit of the three, with a parametric mutual information of .419 and a non-parametric mutual information of .434.

Finally, the surplus weights for the full model, with age, mother's BMI, education, and religion, are shown at far right in Table 3. As in previous models, assortative mating among partners who are highly educated leads to strong contributions to marital surplus, as does matching between highly educated women with partners of similar age. Similarly, when combined with a range of characteristics, including low

BMI, homogamy in age, and in education, religious endogamy is generally associated with strong contributions to marital surplus, particularly among Catholics and those in the "Other" religious category. The fit for this model is not as strong as that of model three, with a parametric mutual information of .878 and a non-parametric mutual information of .524. But overall, these results are broadly consistent with evidence from the other specifications. Patterns in these data from the early 1960s suggest that marital surplus responds strongly to homogamy along several dimensions, most consistently education and religion.

Using the estimated surplus weights from any of these models, we can estimate each couple's marital surplus as a function of their characteristics and examine how marital surplus independently affects child outcomes. Since the couples in our dataset have already matched, we estimate expected surplus conditional on the match: $\Phi = \Phi + \chi + \xi$, where χ and ξ are father and mother's respective heterogeneous utility from the match. To do so, we simulate error terms consistent with the observed match by drawing 100 replications of type I extreme value errors for each observation, keeping only those that generate our observed match outcome. For each observation, we add the average of the remaining error terms to generate a conditional surplus estimate.

3.2 Sorting, Marital Surplus, Child Outcomes, and Divorce

Tables 4A through 4F examine the relationship between marital surplus as measured in our four models and our 6 child neurocognitive outcomes measured at ages 8 months, and four and seven years. In Table 5 we model the probability of divorce by the time the child is seven. In each table, we use our four different measures of marital

surplus separately and report results along the columns. We also begin each table with a bivariate regression specification of the outcome on marital surplus and a constant in the top row, followed by two additional specifications with expanded covariate sets in the subsequent rows. We restrict covariate sets in Specification 2 to include only those also included in the corresponding model of marital surplus. In Specification 3 we add household income and number of siblings to the covariate lists. As in Table 2, income and siblings should be affected by the match and marital surplus itself, and one could argue that their inclusion as controls may be problematic, but we include them because income and siblings obviously affect child quality. To the extent that we find reduced-form effects of marital surplus on child outcomes that appear in turn to be driven by household income or the number of siblings, we would be unable to say much definitively about the effects of marital surplus on child quality given the constraints of our econometric specifications and the data.

We begin by looking first at the effects of marital surplus on infant's scores on the Bayley Mental and Motor scores when the child is 8 months old. Tables 4A and 4B show scant evidence of any effects of marital surplus on test scores at this age. Without any covariates, marital surplus has some significance in some of the models, but adding parental and family characteristics washes it away. It is worth noting that these regressions have very little explanatory power presumably due to massive random variation in child cognition at early ages. None of the models shown can explain even 1 percent of the variation in these test scores. But other covariates such as parental education or household income are highly statistically significant, suggesting that marital surplus simply does not have an effect on very early childhood outcomes.

By age four, marital surplus has significant positive effects on children's cognitive outcomes across most of the models in Tables 4C and 4D, with the strongest effects among models that account for parental matching on education. In the bivariate regressions at the top of Table 4C, marital surplus alone explains over 10% of the variation at age 4 in Stanford Binet scores in models 1, 3 and 4, with smaller but still significant effects on the Graham Ernhart block test in Table 4D. Given that partners match on education in these models, it is perhaps not surprising that marital surplus has a significant effect on test scores. However, marital surplus continues to show strong effects on test scores in Specification 2, which controls for parental characteristics. The significant effect of marital surplus on children's cognition is not a simple linear combination of parental characteristics and may be attributable at least in part to matching patterns. Moreover, these effects are robust to the inclusion of household income and siblings in Specification 3, indicating that income effects, although themselves highly significant, play a limited role in explaining the strong correlation between marital surplus and child cognition. Marital surplus can be a significant determinant of test scores at age 4 even when we exclude education from the matching characteristics and the outcomes regression. Marital surplus in Model 2 is significant across specifications in the Stanford-Binet regressions in Table 4C, but not in the Graham-Ernhart results in Table 4D.

Turning next to children's test scores at age seven in Tables 4E and 4F, we see patterns that are similar to those we found at age four, with strong effects of marital surplus across all measures on both the WISC IQ scores in Table 4E and on the WRAT reading achievement test in Table 4F. Consonant with the results at age four, marital

surplus has particularly strong effects on test scores in the matching models which include education, even after controlling for parental characteristics, household income, and siblings, with significant but smaller effects for Model 2 which excludes parental education from consideration. As before, parents' joint characteristics, as measured by the matching algorithm's marital surplus variable, continue to be strongly correlated with children's test scores.

We next examine the effect of marital surplus on the durability of the union. Table 5 presents probit results for the probability of divorce by the time the child is 7 years old. We find that marital surplus is a statistically significant predictor of divorce in most of our regressions. Depending on the matching model and the covariate set, a unit of marital surplus is associated with a reduction in the probability of divorce at the seven-year follow-up survey of between 0 and 10 percentage points. As shown in Table YYY, one standard deviation in marital surplus in our models is roughly XXX.

3.3 Peering under the Hood

Tables 4A through 4F and 5 suggest that marital surplus is independently important for the production of child quality measured at ages 4 and 7, and for the longevity of the marital union. Our analysis raises several questions, chief among them being what our measures of marital surplus are really capturing, and whether the associations we see are likely to be causal. It is natural to ask which parental characteristics may be driving our results, so we regress child outcomes on the parental characteristics used to generate the basis functions, omitting marital surplus itself.

The seven columns in Table 6 present simple linear regressions of the six child neurocognitive outcomes and a probit model of divorce on parental characteristics and the homogamy indicators we have previously used in our matching models. Here, as before, childhood outcomes at age 8 months are not well modeled by our covariates, nor are many parental characteristics strongly correlated with them. While parental education levels show the expected effects and there is some evidence of a negative effect of the age gap on motor skills, the explanatory value of parental characteristics overall on child developmental scores at eight months is weak. Model fit as measured by the R-squared statistics are again around 1 percent. But by age four and thereafter, many of the sorting variables are strongly and consistently correlated with child outcomes. Across all four of the 4-year and 7-year assessments, there is a strong interaction between mother's and father's education that suggests that children of parents who are both highly educated have an additional advantage over children of parents with low education, beyond that associated with individual parental education levels alone. Joint high parental education is associated with around an additional five points on the Stanford Binet test and one on the Graham-Ernhart, and around three points on the WRAT reading achievement and WISC general intelligence test.

To illustrate the potential impacts of parental matching on children's cognitive outcomes according to these estimates, consider a child whose parents are both high-school graduates compared to one whose mother completed 10 years of education and whose husband completed 14. These roughly coincide with sample averages and standard deviations shown in Table 1, and they are consistent with the male rather than female advantage in education we more often see in the data. According to Table 6, the child of

the high-school graduates would score up to one third of a standard deviation higher than the other child primarily because of the estimated benefit of jointly high parental education. In all our models, a year of mother's education is more valuable than one of father's, implying that the male advantage in education is already bad for child outcomes. One might infer from this alone that the ideal match for child outcomes would consist of a highly educated mother and a father with low education. But as evidenced by the relatively similar coefficients on mother's and father's education, this impact is relatively circumscribed and tends to be outweighed by the bonus associated with educational homogamy. In this context, homogamy in parental education appears to demonstrate a kind of increasing returns in child quality production.

Table 6 also indicates a significantly reduced probability of divorce for those couples with jointly higher education. An interesting result is that father's education is independently predictive of divorce, while mother's education and homogamy are both protective against it. Here the benefits of homogamy are even more starkly apparent.

There are other notable patterns we see in Table 6; we also find that a parental age difference of greater than five years is associated with a significantly lower test score at age 4, while this is less true for the scores at age 7. A lower maternal pre-pregnancy BMI is associated with higher scores but is insignificant in the divorce regression. Since parents with a bigger age difference and mothers who have higher BMIs tend to be those (and to partner with those) with less education, these sorting patterns appear to compound the negative effects on test scores among the less educated.

Marital sorting on partner characteristics surely involves multiple layers of choice, including individual-level choices on education and other personal characteristics, as well as partner choice. Personal characteristics such as education may be a proxy for other traits, while joint characteristics may act as proxies for other underlying joint characteristics of the couple. This paper does not attempt to specify the mechanism through which these characteristics affect marital surplus or the quality of the union; instead, we are interested in how marital sorting patterns and surplus may affect marital production as measured by union durability and children's cognitive results.

4 Conclusion

While it is widely known that parents' education levels and other characteristics affect child outcomes, little research has examined the role that parents' interacting characteristics may play in child outcomes. Our research indicates that marital surplus, here a nonlinear function of parental characteristics derived from matching theory, has strong cross-sectional associations with children's test scores and with marital union duration, and that these effects are robust to inclusion of individual parental traits. Our results suggest that parental trait complementarity, particularly in education but also in religion and age, appears to have important implications for child outcomes. Homogamy in parental characteristics appears to be a significant predictor of a good match, of improved child neurocognitive outcomes, and of union durability, and these associations remain independently significant after controlling for household income and number of siblings. Given the association between test scores and future earnings, the correlation

between joint parental education and child cognitive scores may be important for understanding intergenerational socioeconomic mobility.[18]

To be sure, parental education, the age gap, and religion are effectively proxies for unobserved treatment variables. A key shortcoming of the our dataset, the Collaborative Perinatal Project (CPP), is that it does not directly measure many of these treatments, like time spent on children. This paper does not identify the extent to which marital surplus affects child outcomes through either selection, marital "happiness" or other treatment channels. Future research could attempt to examine mechanisms through which the age gap, parental education, and match characteristics may affect child outcomes.

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Table 1: Characteristics of parents and children in the CPP

Characteristic	Sample Mean	Standard Deviation	N
Mother's current age (Age_m)	24.3	6.0	46,080
Father's current age (Age_f)	28.4	7.0	34,914
Percent of couples where father's age ≥ mother's age + 5	31.0	46.3	34,914
Mother's current body mass index (BMI)	22.8	4.3	42,099
Mother's education at baseline ($Educ_m$)	10.7	2.6	45,007
Father's education at baseline ($Educ_f$)	11.1	3.1	36,741
Percent of mothers Protestant	58.7	49.2	45,003
Percent of mothers Catholic	37.2	48.3	45,003
Percent of mothers Other religion	4.1	19.9	45,003
Percent of fathers Protestant	56.3	49.6	18,838
Percent of fathers Catholic	37.4	48.4	18,838
Percent of mothers Other religion	6.3	24.3	18,838
Percent of parents divorced at registration	7.8	26.9	46,079
Percent of parents divorced by age 7	22.3	41.6	38,471
Total siblings at registration	1.9	2.1	44,559
Total siblings by age 7	2.7	2.2	44,559
Household income at registration (current $)	4,093	2,216	42,628
Child's Bayley Mental score at age 8 months	79.9	5.5	37,607
Child's Bayley Motor score at age 8 months	33.7	4.5	37,610
Child's Stanford-Binet score at age 4 years	97.9	16.6	32,883
Child's Graham-Ernhart Block score at age 4 years	33.9	8.5	32,376
Child's Weschler Intelligence score at age 7 years	96.4	14.9	34,305
Child's WRAT score at age 7 years	36.1	12.4	34,114

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics are known. The unit of observation is the child; the parents of siblings who are present in the CPP appear multiple times in the parental characteristics.

Table 2: Marital sorting patterns as revealed by simple regression models of characteristics

	Endogenous variable			
Covariate	Father's age ≥ mother's age + 5	Mother's pre-pregnancy body mass index	Mother's education	Father's education
Excluding log household income:				
Father's age ≥ mother's age + 5	-	0.6151 ***	-0.3531 ***	-0.2695 ***
		(0.0548)	(0.0268)	(0.0331)
Mother's pre-pregnancy body mass index (BMI)	0.0217 ***	-	-0.0166 ***	-0.0676 ***
	(0.0019)		(0.0030)	(0.0036)
Mother's education	-0.0527 ***	-0.0667 ***	-	0.7233 ***
	(0.0038)	(0.0123)		(0.0064)
Father's education	-0.0280 ***	-0.1889 ***	0.5032 ***	-
	(0.0033)	(0.0102)	(0.0045)	
Sample size	30,140	30,140	30,140	30,140
R-squared				
Including log household income:				
Father's age ≥ mother's age + 5	-	0.6149 ***	-0.3582 ***	-0.2842 ***
		(0.0562)	(0.0271)	(0.0333)
Mother's pre-pregnancy body mass index	0.0216 ***	-	-0.0145 ***	-0.0641 ***
	(0.0019)		(0.0031)	(0.0036)
Mother's education	-0.0543 ***	-0.0594 ***	-	0.6794 ***
	(0.0040)	(0.0127)		(0.0067)
Father's education	-0.0302 ***	-0.1847 ***	0.4762 ***	-
	(0.0034)	(0.0106)	(0.0048)	
Log household income at baseline	0.0674 ***	-0.1726 ***	0.5307 ***	0.7784 ***
	(0.0164)	(0.0549)	(0.0246)	0.0295
Sample size	28,951	28,951	28,951	28,951
R-squared				

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all parents with children measured at least once in the panel whose parental characteristics are known. The unit of observation is the parental couple. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 3: Surplus weights and goodness-of-fit generated by matching models across several choices of covariate set

Combination of parental characteristics	Surplus weight (λ_k)		Covariation: Observed	Random	Surplus weight (λ_k)		Covariation: Observed	Random	Surplus weight (λ_k)		Covariation: Observed	Random	Surplus weight (λ_k)		Covariation: Observed	Random
Model 1: Matching on age, BMI, and education					*Model 2: Age, BMI, and religion*				*Model 3: Education and religion*				*Model 4: Age, BMI, education, religion*			
Father's age < mother's age + 5	0.281	***	0.366	0.35	0.107	***	0.375	0.359					0.430	***	0.384	0.363
and mother's BMI is below median	(0.010)				(0.013)								(0.018)			
Father's age < mother's age + 5	2.263	***	0.383	0.303									4.845	***	0.410	0.315
and mother has 12+ years education	(0.011)												(0.029)			
Father has 12+ years education	0.334	***	0.273	0.251									0.689	***	0.288	0.261
and mother's BMI is below median	(0.014)												(0.016)			
Father has 12+ years education	2.816	***	0.353	0.217					2.305	***	0.355	0.224	4.966	***	0.383	0.226
and mother has 12+ years education	(0.012)								(0.017)				(0.028)			
Mother's BMI is below median					1.594	***	0.166	0.074					2.262	***	0.169	0.075
and both parents are Catholic					(0.018)								(0.022)			
Mother's BMI is below median					-0.020		0.219	0.155					0.301	***	0.220	0.153
and both parents are Protestant					(0.014)								(0.019)			
Mother's BMI is below median					15.384	***	0.024	0.001					2.116	***	0.025	0.002
and both parents are Other religion					(0.023)								(0.051)			
Father's age ≤ mother's age + 5					2.090	***	0.24	0.106					2.401	***	0.246	0.108
and both parents are Catholic					(0.013)								(0.018)			
Father's age ≤ mother's age + 5					0.878	***	0.333	0.226					0.014		0.335	0.228
and both parents are Protestant					(0.009)								(0.014)			
Father's age ≤ mother's age + 5					3.823	***	0.031	0.002					1.903	***	0.035	0.002
and both parents are Other religion					(0.038)								(0.092)			
Mother has 12+ years of education									2.404	***	0.149	0.063	3.909	***	0.168	0.065
and both parents are Catholic									(0.020)				(0.035)			
Mother has 12+ years of education									1.717	***	0.22	0.135	3.101	***	0.233	0.128
and both parents are Protestant									(0.016)				(0.033)			
Mother has 12+ years of education									9.572	***	0.031	0.002	2.842	***	0.036	0.002
and both parents are Other religion									(0.053)				(0.060)			
Father has 12+ years of education									0.672	***	0.154	0.072	0.129	***	0.168	0.076
and both parents are Catholic									(0.021)				(0.028)			
Father has 12+ years of education									0.181	***	0.231	0.158	1.683	***	0.224	0.156
and both parents are Protestant									(0.016)				(0.025)			
Father has 12+ years of education									3.516	***	0.032	0.002	2.330	***	0.035	0.002
and both parents are Other religion									(0.034)				(0.070)			
Parametric mutual information	0.236				0.312				0.419				0.878			
Non-parametric mutual information	0.113				0.380				0.434				0.524			

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all parents with children measured at least once in the panel whose parental characteristics and initial household income at baseline are known. The unit of observation is the parental couple. Each model shown estimates marital surplus as described in the text by constructing indicator variables for the joint characteristics listed in the first column. The larger the estimated surplus weight is, the more important matching on that joint characteristic is in the data, and typically the greater the difference between the observed covariation between those characteristics and the random variation one would observe if there were no matching. Parameteric and non-parametric mutual information indexes the fit of the matching model using the indicator variables as defined in the model. A smaller information score indicates a better fit balanced against model parsimony, like a standard information criterion score. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 4A: Linear models of child's Bayley Mental scores at age 8 months using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	0.0093	0.0072	0.0395 ***	0.033 ***
	(0.0204)	(0.0195)	(0.0144)	(0.0088)
R-squared	0.0000	0.0000	0.0004	0.0013
N	24,215	11,441	14,893	10,944
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	0.0354	0.0014	0.003	0.0057
	(0.0247)	(0.0228)	(0.0251)	(0.0133)
Mother's education in years	0.0434 **	-	0.0424 *	0.0547 **
	(0.0190)		(0.0224)	(0.0273)
Father's education in years	0.0155	-	0.0422 **	0.0282
	(0.0148)		(0.0181)	(0.0207)
Mother's pre-pregnancy BMI	0.016 *	0.011	-	0.0269
	(0.0092)	(0.0135)		(0.0126)
Mother's age	0.0163	0.026 *	-	0.0183
	(0.0103)	(0.0143)		(0.0158)
Father's age	-0.0213 **	-0.0334 ***	-	-0.0276
	(0.0085)	(0.0124)		(0.0137)
Mother is Catholic	-	-0.1333	-0.0691	-0.1606
		(0.1433)	(0.1122)	(0.1383)
Mother is Other religion	-	-0.0942	-0.2491	-0.2951
		(0.2499)	(0.2683)	(0.2554)
Father is Catholic	-	0.2416	0.2407 **	0.2768 *
		(0.1473)	(0.1133)	(0.1436)
Father is Other religion	-	0.1316	0.0903	0.0415
		(0.2056)	(0.1902)	(0.2137)
R-squared	0.0017	0.0011	0.0021	0.0033
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	0.0098	0.0129	-0.0136	-0.0039
	(0.0236)	(0.0201)	(0.0224)	(0.0133)
Mother's education in years	0.0006	-	0.0078	0.0185
	(0.0192)		(0.0220)	(0.0281)
Father's education in years	-0.0212	-	0.0212	-0.0061
	(0.0152)		(0.0184)	(0.0211)
Mother's pre-pregnancy BMI	0.0217 **	0.0232 *	-	0.0283 **
	(0.0093)	(0.0139)		(0.0127)
Mother's age	0.0433 ***	0.0359 **	-	0.042 **
	(0.0111)	(0.0159)		(0.0178)
Father's age	-0.0198 **	-0.0241 *	-	-0.0305 **
	(0.0087)	(0.0125)		(0.0137)
Mother is Catholic	-	-0.2136	-0.1374	-0.2281
		(0.1460)	(0.1155)	(0.1414)
Mother is Other religion	-	-0.2633	-0.1029	-0.1047
		(0.2558)	(0.2265)	(0.2326)
Father is Catholic	-	0.1411	0.1791	0.1988
		(0.1471)	(0.1141)	(0.1440)
Father is Other religion	-	0.0716	0.1426	0.0992
		(0.2077)	(0.1869)	(0.2109)
Log household income	0.64 ***	0.4983 ***	0.3306 ***	0.4478 ***
	(0.0674)	(0.0939)	(0.0700)	(0.0886)
Number of siblings	-0.2172 ***	-0.1482 ***	-0.1146 ***	-0.1534 ***
	(0.0238)	(0.0344)	(0.0230)	(0.0385)
R-squared	0.0099	0.0073	0.005	0.0074
N	24,212	11,230	14,545	10,757

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is the Bayley Mental score assessed at age 8 months, and the regression models are ordinary least squares. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 4B: Linear models of child's Bayley Motor scores at age 8 months using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	0.0902 ***	0.0075	0.0487 ***	0.048 ***
	(0.0151)	(0.0155)	(0.0136)	(0.0075)
R-squared	0.0014	0.0000	0.0008	0.0036
N	25,348	11,442	14,894	10,945
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	0.0246	-0.0189	-0.0377 *	0.0151
	(0.0202)	(0.0201)	(0.0212)	(0.0115)
Mother's education in years	0.0319 **	-	0.0665 ***	0.0613 **
	(0.0160)		(0.0197)	(0.0249)
Father's education in years	0.045 ***	-	0.079 ***	0.0485 ***
	(0.0126)		(0.0156)	(0.0182)
Mother's pre-pregnancy BMI	0.0281 ***	0.0059	-	0.0296
	(0.0074)	(0.0111)		(0.0112)
Mother's age	-0.0404 ***	-0.0005	-	-0.0222
	(0.0086)	(0.0120)		(0.0130)
Father's age	-0.0197 ***	-0.0516 ***	-	-0.033
	(0.0072)	(0.0101)		(0.0111)
Mother is Catholic	-	-0.1293	-0.0951	-0.1169
		(0.1247)	(0.1009)	(0.1249)
Mother is Other religion	-	0.1666	0.0617	-0.2616
		(0.2804)	(0.2518)	(0.2594)
Father is Catholic	-	0.1149	0.1236	0.0808
		(0.1262)	(0.1016)	(0.1271)
Father is Other religion	-	0.2387	0.089	0.1125
		(0.2151)	(0.1832)	(0.2155)
R-squared	0.0084	0.0069	0.0063	0.0122
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	0.0093	-0.0199	-0.0456 **	0.0074
	(0.0204)	(0.0196)	(0.0209)	(0.0116)
Mother's education in years	0.0093	-	0.037 *	0.0394
	(0.0164)		(0.0200)	(0.0255)
Father's education in years	0.0222 *	-	0.0561 ***	0.0266
	(0.0129)		(0.0160)	(0.0185)
Mother's pre-pregnancy BMI	0.0333 ***	0.0181	-	0.0326 ***
	(0.0076)	(0.0113)		(0.0113)
Mother's age	-0.0207 **	0.0103	-	-0.0043
	(0.0095)	(0.0132)		(0.0144)
Father's age	-0.0169 **	-0.0431 ***	-	-0.0341 ***
	(0.0074)	(0.0102)		(0.0112)
Mother is Catholic	-	-0.1924	-0.1305	-0.1517
		(0.1267)	(0.1028)	(0.1270)
Mother is Other religion	-	0.1213	0.196	-0.1506
		(0.2854)	(0.2483)	(0.2590)
Father is Catholic	-	0.0219	0.0598	0.0186
		(0.1268)	(0.1027)	(0.1281)
Father is Other religion	-	0.1024	0.0526	0.0558
		(0.2164)	(0.1852)	(0.2173)
Log household income	0.2909 ***	0.4033 ***	0.1278 **	0.2653 ***
	(0.0196)	(0.0796)	(0.0610)	(0.0811)
Number of siblings	-0.1504 ***	-0.1401 ***	-0.16 ***	-0.1151 ***
	(0.0196)	(0.0266)	(0.0189)	(0.0292)
R-squared	0.0126	0.0134	0.0115	0.0148
N	24,215	11,231	14,546	10,758

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is the Bayley Motor score assessed at age 8 months, and the regression models are ordinary least squares. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 4C: Linear models of child's Stanford-Binet scores at age 4 years using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	2.900 ***	1.149 ***	2.362 ***	1.282 ***
	(0.0591)	(0.0884)	(0.0692)	(0.0307)
R-squared	0.1017	0.0241	0.1003	0.1601
N	22,099	9,789	12,788	9,366
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	0.7513 ***	0.3124 ***	0.5525 ***	0.3301 ***
	(0.0719)	(0.1059)	(0.0850)	(0.0432)
Mother's education in years	1.304 ***	-	1.747 ***	1.449 ***
	(0.0566)		(0.0734)	(0.0936)
Father's education in years	1.314 ***	-	1.132 ***	1.266 ***
	(0.0448)		(0.0589)	(0.0676)
Mother's pre-pregnancy BMI	-0.0901 ***	-0.3998 ***	-	-0.0511
	(0.0247)	(0.0414)		(0.0380)
Mother's age	0.2938 ***	0.5011 ***	-	0.167
	(0.0304)	(0.0507)		(0.0486)
Father's age	0.0353	-0.2318 ***	-	0.1133
	(0.0250)	(0.0402)		(0.0391)
Mother is Catholic	-	1.958 ***	2.776 ***	1.504 ***
		(0.4964)	(0.3751)	(0.4553)
Mother is Other religion	-	8.593 ***	2.504 **	3.647 ***
		(1.4210)	(1.0730)	(1.1460)
Father is Catholic	-	2.738 ***	3.22 ***	2.583 ***
		(0.5006)	(0.3781)	(0.4633)
Father is Other religion	-	4.626 ***	2.835 ***	3.456 ***
		(1.1150)	(0.7855)	(0.9467)
R-squared	0.1958	0.0633	0.2332	0.2575
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	0.6117 ***	0.2569 **	0.4272 ***	0.2722 ***
	(0.0725)	(0.0998)	(0.0850)	(0.0431)
Mother's education in years	1.039 ***	-	1.568 ***	1.236 ***
	(0.0575)		(0.0751)	(0.0954)
Father's education in years	1.11 ***	-	1.035 ***	1.067 ***
	(0.0459)		(0.0600)	(0.0689)
Mother's pre-pregnancy BMI	-0.0553 **	-0.2232 ***	-	-0.0243
	(0.0247)	(0.0401)		(0.0379)
Mother's age	0.3506 ***	0.6163 ***	-	0.249 ***
	(0.0331)	(0.0540)		(0.0537)
Father's age	0.0278	-0.1177 ***	-	0.1016 ***
	(0.0251)	(0.0386)		(0.0387)
Mother is Catholic	-	0.5401	2.142 ***	0.9693 **
		(0.4753)	(0.3778)	(0.4554)
Mother is Other religion	-	5.361 ***	2.55 **	3.081 ***
		(1.3650)	(1.0680)	(1.1530)
Father is Catholic	-	1.605 ***	2.82 ***	2.128 ***
		(0.4787)	(0.3791)	(0.4608)
Father is Other religion	-	4.183 ***	3.068 ***	3.553 ***
		(1.0510)	(0.7893)	(0.3234)
Log household income	4.54 ***	7.357 ***	3.705 ***	3.544 ***
	(0.2176)	(0.3301)	(0.2410)	(0.3234)
Number of siblings	-0.77 ***	-1.934 ***	-0.0182	-0.7522 ***
	(0.0654)	(0.1011)	(0.0650)	(0.1005)
R-squared	0.2192	0.168	0.2481	0.2734
N	21,066	9,613	12,485	9,211

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is the Stanford Binet score assessed at age 4 years, and the regression models are ordinary least squares. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 4D: Linear models of child's Graham-Ernhart scores at age 4 years using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	0.6991 ***	0.2885 ***	0.5451 ***	0.3189 ***
	(0.0288)	(0.0253)	(0.0253)	(0.0138)
R-squared	0.0249	0.0072	0.0247	0.0485
N	21,800	9,650	12,591	9,236
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	0.1788 ***	0.0275	0.0674 *	0.0694 ***
	(0.0392)	(0.0361)	(0.0392)	(0.0214)
Mother's education in years	0.2794 ***	-	0.429 ***	0.3171 ***
	(0.0308)		(0.0382)	(0.0486)
Father's education in years	0.3442 ***	-	0.2695 ***	0.3115 ***
	(0.0243)		(0.0305)	(0.0348)
Mother's pre-pregnancy BMI	-0.0232	-0.1246 ***	-	-0.0455
	(0.0142)	(0.0212)		(0.0215)
Mother's age	0.0583 ***	0.0613 ***	-	-0.0146
	(0.0170)	(0.0237)		(0.0252)
Father's age	-0.0048	-0.0244	-	0.0534
	(0.0144)	(0.0192)		(0.0207)
Mother is Catholic	-	1.151 ***	1.095 ***	0.9923 ***
		(0.2362)	(0.1940)	(0.2344)
Mother is Other religion	-	2.958 ***	1.134 **	1.544 ***
		(0.5320)	(0.4639)	(0.4706)
Father is Catholic	-	1.12 ***	1.369 ***	1.1 ***
		(0.2388)	(0.1956)	(0.2380)
Father is Other religion	-	1.148 **	1.003 **	0.7621 *
		(0.4906)	(0.3989)	(0.4602)
R-squared	0.0471	0.0304	0.071	0.0806
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	0.1443 ***	0.0064	0.0496	0.0609 ***
	(0.0400)	(0.0364)	(0.0401)	(0.0216)
Mother's education in years	0.2189 ***	-	0.3969 ***	0.2907 ***
	(0.0318)		(0.0396)	(0.0502)
Father's education in years	0.2928 ***	-	0.2613 ***	0.2767 ***
	(0.0253)		(0.0313)	(0.0356)
Mother's pre-pregnancy BMI	-0.0158	-0.088 ***	-	-0.0399 *
	(0.0144)	(0.0213)		(0.0215)
Mother's age	0.0508 ***	0.0588 **	-	-0.0309
	(0.0185)	(0.0258)		(0.0278)
Father's age	-0.0138	-0.0068	-	0.0474 **
	(0.0147)	(0.0193)		(0.0208)
Mother is Catholic	-	0.819 ***	0.9796 ***	0.8522 ***
		(0.2342)	(0.1968)	(0.2364)
Mother is Other religion	-	2.142 ***	1.043 **	1.29 ***
		(0.5368)	(0.4769)	(0.4841)
Father is Catholic	-	0.9111 ***	1.295 ***	1.059 ***
		(0.2362)	(0.1976)	(0.2394)
Father is Other religion	-	1.186 **	1.033 **	0.8539 *
		(0.4873)	(0.4089)	(0.4696)
Log household income	1.432 ***	1.8 ***	0.7626 ***	0.8759 ***
	(0.1168)	(0.1513)	(0.1209)	(0.1599)
Number of siblings	-0.0727 **	-0.2807 ***	0.0666 *	0.0024
	(0.0363)	(0.0502)	(0.0378)	(0.0549)
R-squared	0.0543	0.0514	0.0746	0.0832
N	20,788	9,481	12,298	9,087

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is the Graham-Ernhart score assessed at age 4 years, and the regression models are ordinary least squares. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 4E: Linear models of child's WISC IQ scores at age 7 years using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	2.7340 ***	0.9285 ***	1.9340 ***	1.1230 ***
	(0.0498)	(0.0599)	(0.0540)	(0.0244)
R-squared	0.1168	0.0244	0.1008	0.1767
N	22,865	9,769	12,656	9,317
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	0.6329 ***	0.1107	0.2275 ***	0.2027 ***
	(0.0626)	(0.0773)	(0.0666)	(0.0356)
Mother's education in years	1.257 ***	-	1.606 ***	1.327 ***
	(0.0497)		(0.0615)	(0.0790)
Father's education in years	1.243 ***	-	1.13 ***	1.194 ***
	(0.0390)		(0.0496)	(0.0563)
Mother's pre-pregnancy BMI	-0.1141 ***	-0.467 ***	-	-0.1142
	(0.0219)	(0.0359)		(0.0332)
Mother's age	0.1923 ***	0.4302 ***	-	0.0951
	(0.0273)	(0.0431)		(0.0418)
Father's age	0.0277	-0.2585 ***	-	0.0691
	(0.0235)	(0.0350)		(0.0348)
Mother is Catholic	-	2.54 ***	2.923 ***	2.102 ***
		(0.4238)	(0.3193)	(0.3835)
Mother is Other religion	-	9.327 ***	3.019 ***	4.026 ***
		(1.0720)	(0.8006)	(0.8689)
Father is Catholic	-	2.807 ***	2.562 ***	2.218 ***
		(0.4248)	(0.3222)	(0.3871)
Father is Other religion	-	3.343 ***	2.418 ***	1.841 **
		(0.9228)	(0.6355)	(0.7558)
R-squared	0.2207	0.0848	0.267	0.2886
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	0.4275 ***	0.0334	0.1391 **	0.1203 ***
	(0.0624)	(0.0721)	(0.0671)	(0.0357)
Mother's education in years	0.9472 ***	-	1.273 ***	1.023 ***
	(0.0505)		(0.0642)	(0.0806)
Father's education in years	0.9749 ***	-	0.8617 ***	0.9251 ***
	(0.0404)		(0.0513)	(0.0579)
Mother's pre-pregnancy BMI	-0.0835 ***	-0.2921 ***	-	-0.1022 ***
	(0.0216)	(0.0341)		(0.0327)
Mother's age	0.2609 ***	0.4597 ***	-	0.2058 ***
	(0.0278)	(0.0437)		(0.0438)
Father's age	0.0464 **	-0.0961 ***	-	0.0692 **
	(0.0231)	(0.0339)		(0.0349)
Mother is Catholic	-	1.971 ***	2.493 ***	1.949 ***
		(0.3844)	(0.3150)	(0.3730)
Mother is Other religion	-	7.576 ***	3.69 ***	4.332 ***
		(1.0110)	(0.8114)	(0.8830)
Father is Catholic	-	1.999 **	2.184 ***	1.939 ***
		(0.8342)	(0.3179)	(0.3790)
Father is Other religion	-	7.228 ***	1.855 ***	1.492 **
		(0.2635)	(0.6337)	(0.7570)
Log household income	4.504 ***	7.228 ***	4.59 ***	4.029 ***
	(0.1786)	(0.2635)	(0.2152)	(0.2603)
Number of siblings	-0.9836 ***	-1.743 ***	-0.6043 ***	-0.9871 ***
	(0.0507)	(0.0784)	(0.0559)	(0.0763)
R-squared	0.2639	0.2422	0.3067	0.3278
N	21,483	9,223	11,874	8,800

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is the WISC IQ score assessed at age 7 years, and the regression models are ordinary least squares. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 4F: Linear models of child's WRAT reading scores at age 7 years using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	1.9850 ***	0.7696 ***	1.5010 ***	0.8342 ***
	(0.0430)	(0.0565)	(0.0464)	(0.0216)
R-squared	0.0882	0.0245	0.0901	0.1414
N	22,758	9,724	12,584	9,274
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	0.4978 ***	0.15 **	0.2755 ***	0.1811 ***
	(0.0427)	(0.0699)	(0.0610)	(0.0320)
Mother's education in years	0.9563 ***	-	1.163 ***	0.9884 ***
	(0.0497)		(0.0549)	(0.0699)
Father's education in years	0.8113 ***	-	0.794 ***	0.7824 ***
	(0.0335)		(0.0424)	(0.0496)
Mother's pre-pregnancy BMI	-0.1343 ***	-0.3334 ***	-	-0.1016
	(0.0180)	(0.0282)		(0.0271)
Mother's age	0.0645 ***	0.2819 ***	-	0.0206
	(0.0226)	(0.0354)		(0.0349)
Father's age	0.0446 **	-0.2057 ***	-	0.0472
	(0.0190)	(0.0290)		(0.0292)
Mother is Catholic	-	1.71 ***	2.224 ***	1.371 ***
		(0.3601)	(0.2773)	(0.3385)
Mother is Other religion	-	7.372 ***	2.676 ***	3.892 ***
		(0.9733)	(0.7371)	(0.7912)
Father is Catholic	-	2.002 ***	1.566 ***	1.516 ***
		(0.3633)	(0.2795)	(0.3449)
Father is Other religion	-	1.396 *	1.256 **	1.418 **
		(0.7563)	(0.5344)	(0.6565)
R-squared	0.1617	0.07	0.2148	0.2225
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	0.3939 ***	0.1105 *	0.2166 ***	0.1425 ***
	(0.0544)	(0.0668)	(0.0620)	(0.0324)
Mother's education in years	0.7615 ***	-	0.939 ***	0.7634 ***
	(0.0438)		(0.0569)	(0.0727)
Father's education in years	0.6305 ***	-	0.5869 ***	0.5866 ***
	(0.0347)		(0.0441)	(0.0515)
Mother's pre-pregnancy BMI	-0.099 ***	-0.1965 ***	-	-0.0806 ***
	(0.0180)	(0.0274)		(0.0273)
Mother's age	0.1139 ***	0.3134 ***	-	0.103 ***
	(0.0236)	(0.0366)		(0.0376)
Father's age	0.0558 ***	-0.0926 ***	-	0.0496
	(0.0191)	(0.0290)		(0.0302)
Mother is Catholic	-	1.284 ***	1.897 ***	1.218 ***
		(0.3439)	(0.2789)	(0.3400)
Mother is Other religion	-	5.96 ***	2.975 ***	4.069 ***
		(0.9330)	(0.7482)	(0.8060)
Father is Catholic	-	1.453 ***	1.331 ***	1.292 ***
		(0.3470)	(0.2804)	(0.3460)
Father is Other religion	-	1.37 *	0.8923	1.064
		(0.7102)	(0.5448)	(0.6701)
Log household income	2.544 ***	4.714 ***	2.794 ***	2.359 ***
	(0.1527)	(0.2175)	(0.1782)	(0.2220)
Number of siblings	-0.7408 ***	-1.351 ***	-0.616 ***	-0.8072 ***
	(0.0448)	(0.0645)	(0.0463)	(0.0649)
R-squared	0.1878	0.1815	0.2406	0.2454
N	21,423	9,205	11,842	8,784

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is the WRAT reading score assessed at age 7 years, and the regression models are ordinary least squares. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 5: Probit models of parental divorce by the child's 7th birthday using 4 different estimates of marital surplus

	Marital surplus is estimated using:			
Covariate	Model 1	Model 2	Model 3	Model 4
Specification 1: no covariates other than marital surplus				
Marital Surplus	-0.1034 ***	-0.0307 ***	-0.1007 ***	-0.0551 ***
	(0.0053)	(0.0071)	(0.0085)	(0.0031)
R-squared	0.0175	0.0025	0.0218	0.0403
N	22,647	9,709	12,326	9,276
Specification 2: Marital surplus, education, BMI, age, religion				
Marital Surplus	-0.0559 ***	-0.0169 **	-0.0615 ***	-0.0337 ***
	(0.0072)	(0.0079)	(0.0081)	(0.0046)
Mother's education in years	-0.0278 ***	-	-0.0536 ***	-0.0282 ***
	(0.0056)		(0.0069)	(0.0093)
Father's education in years	-0.0376 ***	-	-0.0307 ***	-0.0412 ***
	(0.0044)		(0.0053)	(0.0065)
Mother's pre-pregnancy BMI	0.0041	0.0135 ***	-	0.001
	(0.0025)	(0.0036)		(0.0038)
Mother's age	-0.0318 ***	-0.0439 ***	-	-0.0275
	(0.0033)	(0.0048)		(0.0052)
Father's age	-0.0088 ***	0.0062	-	-0.0106
	(0.0027)	(0.0038)		(0.0043)
Mother is Catholic	-	-0.1222 ***	-0.1593 ***	-0.0939 **
		(0.0438)	(0.0364)	(0.0446)
Mother is Other religion	-	-0.0686	0.247 ***	0.1658 ***
		(0.1054)	(0.0867)	(0.0100)
Father is Catholic	-	-0.1359 ***	-0.1378 ***	-0.061
		(0.0443)	(0.0367)	(0.0452)
Father is Other religion	-	-0.0305	0.0502	0.0001
		(0.0847)	(0.6940)	(0.0864)
R-squared	0.0458	0.0292	0.0451	0.0681
N				
Specification 3: Marital surplus, education, BMI, age, religion, household income, siblings				
Marital Surplus	-0.0221 ***	-0.003	-0.0377 ***	-0.0233 ***
	(0.0082)	(0.0092)	(0.0089)	(0.0052)
Mother's education in years	0.0181 ***	-	0.0063	0.0207 *
	(0.0066)		(0.0081)	(0.0107)
Father's education in years	0.0097 *	-	0.0059	0.008
	(0.0052)		(0.0064)	(0.0079)
Mother's pre-pregnancy BMI	0.0035	0.0053	-	0.0035
	(0.0027)	(0.0039)		(0.0041)
Mother's age	-0.0232 ***	-0.0248 ***	-	-0.0206 ***
	(0.0036)	(0.0054)		(0.0057)
Father's age	-0.009 ***	-0.0062	-	-0.0084
	(0.0029)	(0.0042)		(0.0064)
Mother is Catholic	-	-0.0563	-0.0492	-0.0408
		(0.0492)	(0.0404)	(0.0499)
Mother is Other religion	-	0.1136	0.2031 **	0.1699
		(0.1192)	(0.0966)	(0.1106)
Father is Catholic	-	-0.0907 **	-0.1021 **	-0.0431
		(0.0400)	(0.0408)	(0.0509)
Father is Other religion	-	0.1088	0.1629 **	0.1027
		(0.0928)	(0.0753)	(0.0930)
Log household income	-1.301 ***	-1.248 ***	-1.152 ***	-1.237 ***
	(0.0317)	(0.0421)	(0.0352)	(0.0463)
Number of siblings	0.0069	0.0047	0.0044	0.0027
	(0.0064)	(0.0092)	(0.0070)	(0.0099)
R-squared	0.2417	0.2527	0.2225	0.2559
N	21,803	9,407	11,941	8,986

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. In each of the 4 columns shown, a different estimate of marital surplus is included as a covariate. These 4 models of marital surplus vary by the choice of joint parental characteristics and are shown in Table 3 and described in the text. Each specification in this table adds more covariates, but we omit those covariates that are also omitted from the marital surplus model as shown in Table 3. The endogenous variable in each specification and column is an indicator of the parents' having divorced by the time the child is aged 7 years, and the regression models are probits. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.

Table 6: Linear models of children's neurocognitive outcomes as function of parental characteristics only, omitting marital surplus

	Endogenous variable						
Covariate	Bayley Mental test score	Bayley Motor test score	Stanford Binet test score	Graham-Ernhart test score	WISC IQ test score	WRAT reading test score	Probability of parental divorce by age 7
Mother's education in years	0.0584 **	0.0630 ***	1.4600 ***	0.3186 ***	1.2700 ***	0.9914 ***	-0.0415 ***
	(0.0258)	(0.0233)	(0.0876)	(0.0457)	(0.0740)	(0.0650)	(0.0086)
Father's education in years	0.0283	0.0413 **	1.0250 ***	0.2611 ***	0.9953 ***	0.6526 ***	0.0286 ***
	(0.0227)	(0.0199)	(0.0739)	(0.0389)	(0.0619)	(0.0547)	(0.0072)
Mother and father have 12+ years education	0.0293	0.1840	4.8290 ***	1.0030 ***	3.7830 ***	2.6150 ***	-0.3269 ***
	(0.1439)	(0.1252)	(0.4755)	(0.2431)	(0.3974)	(0.3507)	(0.0495)
Mother's pre-pregnancy BMI	0.0264 **	0.0287 ***	-0.0594	-0.0469 **	-0.1183 ***	-0.1080 ***	0.0027
	(0.0126)	(0.0111)	(0.0377)	(0.0214)	(0.0331)	(0.0271)	(0.0038)
Mother's age	0.0214	0.0630 ***	0.1425 **	-0.0533 *	0.0816	0.0033	-0.0347 ***
	(0.0219)	(0.0233)	(0.0607)	(0.0313)	(0.0525)	(0.0440)	(0.0065)
Father's age	-0.0307	0.0413 **	0.1343 **	0.0968 ***	0.0797	0.0627	-0.0025
	(0.0210)	(0.0199)	(0.0557)	(0.0290)	(0.0494)	(0.0413)	(0.0060)
Father's age ≥ mother's age + 5	0.0223	-0.2367	-1.1960 ***	-0.7432 ***	-0.7344 *	-0.6958 *	-0.0176
	(0.1878)	(0.1504)	(0.0557)	(0.2681)	(0.4443)	(0.3792)	(0.0522)
Mother is Catholic	-0.1878	-0.1656	2.5480 ***	1.4560 ***	2.2270 ***	1.6350 ***	0.0274
	(0.1957)	(0.1796)	(0.6389)	(0.3293)	(0.5397)	(0.4728)	(0.0605)
Mother is Other religion	-0.4591	0.9160	3.1950	1.6440 **	7.1540 ***	3.4070 **	0.1548
	(0.4140)	(0.5601)	(2.2560)	(0.8105)	(1.6170)	(1.5920)	(0.1974)
Father is Catholic	0.2654	0.0972	3.7950 ***	1.6450 **	2.3860 ***	1.8100 ***	0.0460
	(0.2123)	(0.1800)	(0.6562)	(0.8106)	(0.5480)	(0.4875)	(0.0629)
Father is Other religion	0.2628	0.2885	2.5540 *	1.6250 ***	3.1510 ***	1.2180	0.0880
	(0.2747)	(0.3064)	(1.4130)	(0.3427)	(1.1670)	(0.9479)	(0.1256)
Mother and father are Catholic	0.0712	0.0798	-1.4070	-0.8285 *	0.2367	-0.0360	-0.3417 ***
	(0.2943)	(0.2585)	(0.9288)	(0.4772)	(0.7796)	(0.6925)	(0.0898)
Mother is Catholic, father is Other religion	-0.2526	0.3798	1.0620	0.2367	-0.0816	-0.3776	-0.2288
	(0.5504)	(0.4868)	(2.1160)	(1.0850)	(1.7300)	(1.5000)	(0.2099)
Mother is Other religion, father is Catholic	-1.1440 *	-0.9878	0.7843	0.3050	0.2400	-0.1925	-0.0400
	(0.6103)	(0.8055)	(3.6000)	(1.3070)	(2.4530)	(2.4960)	(0.2982)
Mother and father are Other religion	-1.0130 *	-1.4650 **	2.7040	0.2415	-4.5580 **	1.5820	-0.2020
	(0.5513)	(0.6668)	(2.8390)	(1.1770)	(2.1130)	(1.9670)	(0.2489)
(Pseudo) R-squared	0.0034	0.0130	0.2619	0.0825	0.2939	0.2250	0.0688
N	10,944	10,945	9,366	9,236	9,317	9,274	9,276

Notes: Data are from the Collaborative Perinatal Project (CPP), collected between 1959 and 1965. The universe is all children measured at least once in the panel whose parental characteristics (and initial household income at baseline) are known. The unit of observation is the child. Parents with multiple children in the CPP appear multiple times on the right-hand side. The regression models are ordinary least squares for the 6 children's neurocognitive outcomes and probit for divorce. Asterisks denote statistical significance at the 10% (*), 5% (**), and 1% (***) levels.