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## Like Brother, Like Sister? The Importance of Family Background for Cognitive and Non-Cognitive Skills

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# Like Brother, Like Sister? – The Importance of Family Background for Cognitive and Non-Cognitive Skills

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Preliminary version – comments highly welcome!

## *Abstract*

This paper estimates sibling correlations in cognitive skills and non-cognitive skills to evaluate the importance of family background for skill formation. The study is based on a large representative German dataset, which includes IQ test scores and measures of personality (locus of control, reciprocity, Big Five) for brothers and sisters. Using a Restricted Maximum Likelihood (REML) model we find substantial influences of family background on the skills of both brothers and sisters. Sibling correlations of personality traits range from 0.24 to 0.59, indicating that even for the lowest estimate, one fourth of the variance can be attributed to factors shared by siblings. With one exception, all calculated sibling correlations in cognitive skills are higher than 0.50, indicating that more than half of the inequality can be explained by family characteristics. Comparing these findings to the results in the intergenerational skill transmission literature suggests that intergenerational correlations are only able to capture parts of the influence of the family on children's cognitive and non-cognitive skills. This result is in line with findings in the literature on educational and income mobility.

*JEL codes:* J24, J62

*Keywords:* Sibling correlations, intergenerational mobility, cognitive skills, personality

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# 1 Introduction

The last decades witnessed an increasing number of studies that stressed the importance of cognitive and non-cognitive skills for both individual labor market outcomes and social outcomes.<sup>1</sup> Motivated by these results, a growing body of literature developed analyzing the intergenerational transmission of cognitive and non-cognitive skills from parents to children. If there is a substantial intergenerational association of these skills, this could help to further understand the mechanisms behind the well-documented intergenerational transmission of economic outcomes, such as earnings or education.<sup>2</sup>

However, a number of authors have recently stressed that estimating intergenerational correlations only reveals part of the impact of family background (e.g. Björklund and Jäntti 2012).<sup>3</sup> Especially for the interpretation as an indicator of equality of opportunity, they suggest instead estimating sibling correlations. Sibling correlations are, compared to intergenerational correlations, a much broader measure of the influence of the family. While an intergenerational correlation only covers a one dimensional intergenerational association, a sibling correlation takes into account all factors that are shared by siblings of one family.<sup>4</sup> In this study, we follow this literature and investigate the importance of family background for cognitive and non-cognitive skills based on sibling correlations.

To the best of our knowledge, existing studies on cognitive and non-cognitive skill correlations within families – until now cover only the U.S. (Mazumder 2008) and Sweden (Björklund and Jäntti 2012, Björklund et al. 2010a) – which both are based on few skill measures and only on a single skill measurement at one point in time. Moreover, the Scandinavian study uses Swedish register data to obtain summary measures of non-cognitive

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<sup>1</sup> See for example Heckman et al. (2006) and Heineck and Anger (2010). An extensive overview can be found in Almlund et al. (2011).

<sup>2</sup> For an excellent overview, see Black and Devereux (2011).

<sup>3</sup> Björklund and Jäntti (2012) call this the „tip of the iceberg“.

<sup>4</sup> The notion of „family background“ in the literature is not restricted to parental background but includes the broader childhood environment, such as the school, neighborhood, or community.

skills (with a focus on leadership skills) and cognitive test scores from military enlistment tests, and is therefore restricted to males (Björklund and Jäntti 2012). In contrast, our estimates are based on data from the German Socio-Economic Panel Study (SOEP), which is a large representative household survey with information on both men and women. The SOEP contains test scores from two ultra-short IQ-tests, which we use as our measure of cognitive skills. Furthermore, the SOEP provides data on locus of control, reciprocity, and the Big Five personality traits (openness, conscientiousness, extraversion, agreeableness and neuroticism), which act as our measures of non-cognitive skills.

The contributions of our paper are threefold. First, we present findings from data that provide broader measures and repeated measurements of personality and cognitive skills for both men and women. Second, we provide the first estimates on the influence of family background on skill formation for Germany. Third, by comparing our sibling correlations to previous findings for other countries, we investigate whether differences in the skill formation process can potentially explain cross-country differentials in sibling correlations of labor market outcomes (Björklund et al. 2002, Schnitzlein forthcoming).

We find substantial influences of the family background on the skills of both brothers and sisters. Sibling correlations of the personality traits range from 0.24 to 0.59, indicating that even for the lowest estimate, one fourth of the variance or inequality can be attributed to factors shared by siblings. With one exception, all calculated sibling correlations in cognitive skills are higher than 0.50, indicating that more than half of the inequality can be explained by family characteristics. Comparing these findings to the results in the intergenerational skill transmission literature suggests that intergenerational correlations are only able to capture parts of the influence of the family on children's cognitive and non-cognitive skills. This result is in line with findings in the literature on educational and income mobility.

## 2 Previous studies

The last decades witnessed an increasing number of studies that stressed the importance of cognitive and non-cognitive skills for both individual labor market outcomes and social outcomes (Heckman et al. 2006, Heineck and Anger 2010, Almlund et al. 2011). This finding resulted in a growing interest in the development of cognitive and non-cognitive skills and in the role of family background in the skill formation process. A growing body of literature developed in the field of intergenerational mobility, which analyzed the transmission of skills from parents to children. Intergenerational transmission of cognitive skills has been analyzed for Scandinavia (Black et al. 2009; Björklund et al. 2010a; Grönqvist et al. 2010), for the US (Agee and Crocker 2002), for the UK (Brown et al. 2009), and for Germany (Anger and Heineck 2010, Anger 2012), showing intergenerational correlations of between 0.3 and 0.5 for adult children. In contrast, there is only scarce evidence on intergenerational transmission of personality traits in the economic literature. The transmission of non-cognitive skills from parents to children has been examined for the US (Mayer et al. 2004, Duncan et al. 2005), Sweden (Grönqvist et al. 2010) and Germany (Anger 2012).<sup>5</sup> However, intergenerational correlations cover only part of the influence of family background. For example, Mazumder (2008) and Björklund et al. (2010b) show in the context of income mobility that even “more than half of the family and community influences that siblings share are uncorrelated with parental income”. Therefore, in order to cover more than the one-dimensional relationship between parents and their children’s outcomes, sibling correlations should be estimated as a broader measure of the impact of family background on the formation of cognitive and non-cognitive skills. So far, there is only very scarce evidence on sibling correlations in skills. The correlation in brothers’ IQ test scores and non-cognitive skills has been analyzed by Björklund and Jäntti (2012) based on Swedish register data. Using IQ test scores from the

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<sup>5</sup> Although economic research on non-cognitive skill formation is rather scarce, intergenerational correlations have been analyzed by psychologists for decades (e.g. Loehlin 2005). However, the data sets used by most psychological studies are based on a small number of observations or lack representativeness.

military enlistment test, they find brother correlations of 0.47.<sup>6</sup> Psychological ratings of leadership skills showed a weaker family influence on non-cognitive skills, with a brother correlation coefficient of 0.32. Using data from the National Longitudinal Study of Youth (NLSY), Mazumder (2008) estimates sibling correlations based on test scores from the AFQT, which is an achievement rather than an intelligence test, and on self-ratings of locus of control. His findings reveal that the family background can explain 62 percent of the variation in cognitive test scores for both brothers and sisters, but only 9 percent of the inequality in personality.

At the same time, there is a well-established literature on the intergenerational transmission of income and education and on the importance of family background for economic outcomes (Black and Devereux 2011, Björklund and Jäntti 2009). As is evident from cross-national research, there are cross-country differences in the estimated explanatory power of family background (Björklund et al. 2002, Schnitzlein forthcoming). Hence, by estimating sibling correlations in cognitive and non-cognitive skills, we aim at answering the question whether cross-country differences in family influences on skill formation are potential determinants of these differentials.

### **3 Data and descriptives**

Our estimates are based on data from the German Socio-Economic Panel Study (SOEP), which is a representative household panel survey that started in 1984 (Wagner et al. 2007). The SOEP conducts annual personal interviews with all household members aged 18 and above, and provides rich information on socio-demographic characteristics, family background, and childhood environment on about 20,000 individuals in more than 11,000

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<sup>6</sup> Björklund et al. (2010a) find similar results.

families in the most recent wave. We use the years 2005, 2006, 2009, and 2010, as the key variables in our study, personality measures and cognitive ability test scores, are available in these years. However, the identification of adult siblings may be based on information from earlier years, at the time when they lived as children in their parents' household. The information on family relations between household members and the follow-up concept of the SOEP allows to observe these children over time and to identify them as siblings even when they are grown up and live in different households. This study considers two children to be siblings if they have the same social parents at age 17.<sup>7</sup> Our sample includes all individuals that are aged 18 and above and have successfully answered at least one of the personality items in one of the waves or participated in the cognitive ability test. Persons who were not of German nationality were excluded from the study, since individuals with a migration background may be disadvantaged as compared to native speakers due to inadequate language skills when taking the tests or when rating their personality. Overall, we could identify one sibling for about 1,500 individuals, whereas two or more siblings could be identified for over 600 individuals in our sample.

### **3.1 Cognitive skills**

Information on cognitive skills was collected from adult respondents (aged 18 and above) in 2006 and comprises test scores from a word fluency test and a symbol correspondence test. Both are ultra-short tests and were especially developed for the SOEP, as fully fledged IQ tests cannot be implemented in a large-scale panel survey (Lang et al. 2007). Since the symbol correspondence test is carried out using a computer, these tests were only conducted with respondents with a computer assisted personal interview (CAPI) – about one third of all respondents. Both tests correspond to different modules of the Wechsler Adult Intelligence

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<sup>7</sup> However, alternative definitions of siblings using information on common fathers will be used in the robustness section to show that the results do not hinge on this definition.

Scale (WAIS) and produce outcomes, which are relatively well correlated with test scores from more comprehensive and well-established intelligence tests.<sup>8</sup>

The symbol correspondence test is conceptually related to the mechanics of cognition or fluid intelligence and comprises general abilities. The test involved asking respondents to match as many numbers and symbols as possible within 90 seconds according to a given correspondence list which is permanently visible to the respondents on a screen. The word fluency test is conceptually related to the pragmatics of cognition or crystallized intelligence. It involves the fulfillment of specific tasks that improve with knowledge and skills acquired in the past. The word fluency test implemented in the SOEP was based on the animal-naming task (Lindenberger and Baltes 1995): respondents name as many different animals as possible within 90 seconds. While verbal fluency is based on learning, speed of cognition is related to an individual's innate abilities (Cattell 1987). In addition, a measure of general intelligence is generated by averaging the two types of ability test scores.<sup>9</sup> All test scores are standardized. The overall sample of individuals with IQ measures, for whom at least one parent with valid information on IQ test scores can be identified, consists of 842 adult sons and daughters from 663 families.<sup>10</sup>

### **3.2 Non-cognitive skills**

Measures of personality for adult respondents are available for 2005 (Dehne and Schupp 2007), and were repeated in 2009 and 2010. The personality measures in 2005 include self-rated measures that were related to the Five Factor Model (McCrae et al. 1999) and comprise

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<sup>8</sup> Lang et al. (2007) carry out reliability analyses and find test–retest coefficients of 0.7 for both the word fluency test and the symbol correspondence test.

<sup>9</sup> This approach has also been used in the intergenerational mobility literature to account for measurement error (for example, Zimmerman 1992). Using average test scores is expected to reduce the error-in-variable bias by diminishing the random component of measured test scores. Furthermore, average test scores could be interpreted as an extract of a general ability type, which captures both coding speed and verbal fluency.

<sup>10</sup> The severe reduction in sample size raises the issue of the representativeness of the data, as there might be selection problems with respect to intergenerational associations of interest. However, despite the restrictions on the sample, selection does not seem to be a major problem for the interpretation of the results (see Anger and Heineck 2010).



the five basic psychological dimensions – openness to experience, conscientiousness, extraversion, agreeableness, neuroticism (Big Five) – which are each measured with 3 items. In addition, self-rated measures of locus of control (10 items) and reciprocity (6 items) are included in 2005. Locus of control is the extent to which an individual believes that she controls the event that affects her. Psychologists differentiate between external locus of control, i.e. individuals believe that events are mainly the result of external effects, and internal locus of control, i.e. individuals believe that events are the results of their own action. Reciprocity measures the extent to which an individual is willing to respond to positive or negative behavior. One can distinguish positive reciprocity, i.e. the extent to which individuals respond positively to positive actions and negative reciprocity, i.e. the extent to which individuals respond negatively to negative behavior. All items related to the personality traits are answered on 7-point Likert-type scales (1 – “disagree completely” to 7 – “agree completely”). The scores are summed up among each dimension to create an index ranging from 1 to 7, and standardized. In 2009, respondents were repeatedly asked to rate their personality according to the dimensions of the Five Factor Model. Self-ratings of locus of control and of reciprocity were repeated in 2010.<sup>11</sup> The sample consists of 5,998 adult children with non-cognitive skill measures from 4,111 families who can be linked to their parents with valid information on personality traits.

### **3.3 Descriptive statistics**

Figure 1 to Figure 3 show the distribution of non-cognitive skills separately for men and women. Women have slightly higher standardized values for all of the Big Five personality traits: they score higher on openness, conscientiousness, extraversion, and agreeableness, but are also more neurotic than men. Furthermore, women show a slightly higher external locus of control, and the distribution of both their external and internal locus of control is more

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<sup>11</sup> Personal traits have been shown to be relatively stable over the adult lifespan (Cobb-Clark and Schurer 2012).

compressed than the distribution of men. A striking gender difference is shown for negative reciprocity, which is much more pronounced for males than for females, while positive reciprocity seems to be very similar for men and women. Graph 4 presents the distribution of cognitive skills, which is again slightly more compressed for women than for men.

Table 1 shows the mean values and the number of observations for measures on personality traits (locus of control, reciprocity, Big Five). Although all self-rated measures are answered on identical 7-point Likert-type scales, the average scores differ very much, ranging from 2.54 for internal locus of control to 5.78 for positive reciprocity. Hence, standardized values should be used in the analysis to have comparable measures. Moreover, Table 1 provides evidence that the personality measures do not change in the overall population over time, as the average values in 2005 and 2009 (2010) are virtually identical. Table 2 provides descriptive information on the measures on cognitive skills (crystallized, fluid, and general intelligence). Whereas respondents named on average 25 animals in the word fluency test (maximum: 99), they typed in on average 30 correct signs (maximum: 60). As mentioned above, the sample size is considerably smaller than for non-cognitive skills because only respondents with a CAPI interview participate in the intelligence tests.

#### **4. A simple statistical model and estimation strategy**

To provide an illustration of sibling correlations, we start with a simple statistical model as introduced by Solon et al. (1991) and Solon (1999). Let  $y_{ij}$  be a measure of cognitive or non-cognitive skills for child  $j$  of family  $i$ . This measure can be decomposed into two orthogonal<sup>12</sup> components  $\alpha_i$ , and an individual component  $\mu_{ij}$ .

$$y_{ij} = \alpha_i + \mu_{ij} \tag{1}$$

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<sup>12</sup> As we observe one child only in one family, these two components are orthogonal by construction.

where  $\alpha_i$  covers the combined effect of all factors that are shared by siblings from family  $i$ .  $\mu_{ij}$  covers all factors that are purely idiosyncratic to sibling  $j$ . The variance of the observed measure  $\sigma_y^2$  can be expressed as the sum of the two components:

$$\sigma_y^2 = \sigma_\alpha^2 + \sigma_\mu^2 . \quad (2)$$

The correlation coefficient  $\rho$  of the cognitive or non-cognitive skill measure of two siblings  $j$  and  $j'$  then equals the ratio of the variance of the family component  $\sigma_\alpha^2$  and the variance of the measure  $\sigma_\alpha^2 + \sigma_\mu^2$ :

$$\rho = \text{corr}(y_{ij}, y'_{ij}) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_\mu^2} \text{ with } j \neq j'. \quad (3)$$

The interpretation of  $\rho$  is that the correlation in cognitive and non-cognitive skills between two siblings (therefore sibling correlation) equals the proportion of the variance that can be attributed to factors shared by siblings, e.g. family factors or neighborhood factors.

$\sigma_\alpha^2$  and  $\sigma_\mu^2$  cannot be negative, so  $\rho$  can take on values between 0 and 1. A correlation of 0 indicates that there is no influence from family and community factors and 1 indicates that there is no influence from the individual. The first case would describe a fully mobile society and the latter a fully deterministic one.

Solon (1999) shows that the relationship of the sibling correlation defined above and the often estimated intergenerational correlation is:

$$\rho = IGC^2 + \text{other shared factors uncorrelated with cor. parental measure} \quad (4)$$

The sibling correlation in cognitive and non-cognitive skills equals the square of the intergenerational correlation in skills plus the influence of all shared factors that are uncorrelated with the corresponding parental measure. As there are factors related to the

family that are not shared by siblings, the sibling correlation is a lower bound of the true influence of family background (see discussion in Björklund and Jäntti 2012).

The sibling correlations are estimated as the within-cluster correlation in the following linear multilevel model,

$$y_{ijt} = X_{ijt}\beta + \alpha_i + \mu_{ij} + v_{ijt} \quad (5)$$

with  $y_{ijt}$  being an annual observation of a specific outcome,  $X_{ijt}$  being a matrix of fixed year and age effects (including year dummies and polynomials of age)<sup>13</sup> and the remaining three parts being the family ( $\alpha_i$ ), individual ( $\mu_{ij}$ ) and transitory components ( $v_{ijt}$ ).<sup>14</sup> The sum of the family and individual component represents the permanent part of the observed outcome. Following Mazumder (2008), we apply Restricted Maximum Likelihood (REML) to estimate this model and to calculate the variances of  $\alpha_i$  and  $\mu_{ij}$ . In the results section, we will report the variance components along with the sibling correlation. The standard error for the sibling correlation is calculated using the delta method. For outcomes with only one observation in time, i.e. for cognitive skills, the model is estimated with only two levels.

## 5 Results

Tables 3-6 present our results. We provide results for brother and sister correlations, as well as sibling correlations including both, brothers and sisters. The first column in each of the tables contains the estimated brother correlation, the second column contains the sister correlation and the third column contains the sibling correlation.

### 5.1 Sibling correlations in cognitive and non-cognitive skills

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<sup>13</sup> In addition, the models in which men and women are jointly estimated, include a gender dummy and interactions of the gender dummy and the age and year variables.

<sup>14</sup> Solon et al. (1991) showed that not controlling for transitory fluctuations leads to serious underestimation of sibling correlations.

We begin the discussion of our results with the two dimensions of locus of control. Table 3 shows the estimated sibling correlations for the external and internal dimension. The estimates range from 0.5 (internal locus of control, sisters) to 0.66 (internal locus of control, brothers). This indicates a strong effect of family background on both dimensions of locus of control. For example, 66 percent of the variation in internal locus of control can be attributed to factors shared by brothers. The estimates are very similar between brothers and sisters and all siblings. Therefore the strong influence of family background on locus of control is true for brothers and sisters.

Table 4 contains the results for reciprocity, again measured in two dimensions. Positive reciprocity measures the extent to which individuals are willing to respond positively to positive actions of other individuals. In contrast, negative reciprocity describes the extent of negative responses to negative actions. We find very high sibling correlations for both dimensions, ranging from 0.43 (positive reciprocity, sisters) to 0.68 (negative reciprocity, sisters). Again, this indicates a strong effect of family background on both dimensions.

The results for the Big Five personality traits are presented in Table 5. The pattern here is not as clear as in Tables 3 and 4, as the estimates differ among the different traits. For openness, we estimated correlations ranging from 0.35-0.37, meaning that about one third of the variance in this trait can be attributed to factors shared by siblings. Again we find no differences between brothers and sisters. For conscientiousness we estimate a brother correlation of 0.59 and a sister correlation of 0.31. These two estimates are statistically different from each other, indicating that family background has a clearly stronger impact on the conscientiousness of brothers than that of sisters. Among the Big Five traits, we find the lowest estimates for sibling correlations in extraversion. Here the estimates range from 0.24-0.26 and are very similar between brothers and sisters. For agreeableness, we find again a higher point estimate for brothers (0.51) than for sisters (0.33), but the difference is not

statistically significant. The last dimension is neuroticism. This is the only dimension where the estimated sister correlation (0.48) is higher than the estimated brother correlation (0.34), but again the difference is not statistically significant.

Table 6 presents the estimates for the cognitive skill measures.<sup>15</sup> Again, we find a strong influence of family background on all dimensions of cognitive abilities. With one exception, all calculated sibling correlations are higher than 0.50, indicating that more than half of the inequality can be attributed to factors shared by siblings. Hence, family and community background explains at least 50 percent of the variation in IQ-test scores for both brothers and sisters.

## **5.2 Cross-country comparisons**

Björklund et al. (2002) and Schnitzlein (forthcoming) report significant cross-country differences in sibling correlations in earnings. In particular they find that in the United States and Germany, family background is more important than in the Scandinavian countries. In the next step, we compare our results to sibling correlations for the US and Sweden to explore whether these cross-country differentials in sibling correlations of labor market outcomes can potentially be explained by differences in the skill formation process. The sibling correlations in cognitive skills for the US reported by Mazumder (2008) are 0.6, and identical for brothers and sisters. Hence, compared to the estimates presented in Table 6 the influence of family background on the formation of cognitive skills is only slightly different in the US than in Germany.<sup>16</sup> Björklund and Jäntti (2012) find brother correlations of about 0.5 for cognitive skills in Swedish data. Again these estimates differ only slightly from the ones presented in Table 6. Therefore, we find no evidence that differences in the influence of family

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<sup>15</sup> These results are very preliminary due to the low number of observations. At the moment, there is only data available from two ultra-short IQ-tests carried out in the wave 2006. A replication of these tests is currently in the field as part of the 2012 wave. First results will be available in February. This will clearly increase our number of observations for this measure and will be included as soon as the data is available.

<sup>16</sup> However, it may be problematic to directly compare these results to Mazumder (2008), since he uses a different measure of cognitive skills (AFQT test scores).

background on the formation of cognitive skills can explain the cross-country differentials in sibling correlations in earnings.

Turning to non-cognitive skills, Mazumder (2008) uses the Rotter scale for Locus of control and finds correlations of 0.11 for brothers, 0.07 for sisters, and 0.09 for all. These estimates are much lower than the ones presented in Table 3 for Germany. However, the Rotter questionnaire in the NLSY used by Mazumder (2008) is only a four-item version of the original 60-item scale (instead of 10 items in the SOEP) and each item is only scored on a scale of 1 to 4 (instead of 1 to 7 in the SOEP). In addition, Mazumder (2008) had only one observation available in the data and therefore could not control for transitory fluctuations. This might lead to a downward biased estimate (Solon et al. 1991). So the results might not be directly comparable to our estimates for Germany. Björklund and Jäntti (2012) present the second available estimate in the literature for non-cognitive skills. They used an aggregate measure of leadership skills, derived from interviews during the military enlistment test. They report a brother correlation of 0.32, which is in the range of brother correlations in personality traits revealed by our estimates for Germany. Again, however, it is not clear if this measure is comparable to one of our measures.

### **5.3 Comparison to intergenerational correlations in skills**

Finally, we compare the sibling correlations in cognitive and non-cognitive skills to intergenerational correlations reported in the literature to find out whether previous models of intergenerational skill transmission indeed underestimate the influence of family background on skill formation. Therefore, we draw on the intergenerational correlations reported in Anger (2012) who uses the same dataset and outcomes as we do. The coefficients are displayed in Table 7 for non-cognitive skills and in Table 8 for cognitive skills respectively. If we compare our results with the results from Anger (2012) it is apparent that, for all analyzed outcomes, the estimated sibling correlations are considerably higher than the corresponding adjusted R-

squared measures in the intergenerational transmission regressions. This finding suggests that intergenerational correlations are in fact only able to capture parts of the influence of the family on children's cognitive and non-cognitive skills. This result is in line with findings in the literature on educational and income mobility.

## **6 Conclusion**

In this study, we investigate the importance of family background for cognitive and non-cognitive skills based on sibling correlations in order to provide a broader measure of the role of family background in the process of skill formation than the previously used intergenerational transmission estimates. Our estimates are based on data from the German Socio-Economic Panel Study (SOEP), which is a large representative household survey and provides measures of cognitive skills from two ultra-short IQ-tests, and self-rated measures of locus of control, reciprocity, and the Big Five personality traits (openness, conscientiousness, extraversion, agreeableness and neuroticism).

Previous analyses on Sweden and the US are restricted in as much as they are based only on males (Björklund and Jäntti 2012, Björklund et al. 2010a), use only locus of control out of many personality traits (Mazumder 2008), and use only a single measurement at one point in time. Hence, this study contributes to the literature by providing evidence on sibling correlations in broader measures of personality for both men and women.

We show that family background is important for cognitive and non-cognitive skills for both men and women. Sibling correlations of the personality traits range from 0.24 to 0.59, indicating that even for the lowest estimate, one fourth of the variance or inequality can be attributed to factors shared by siblings. With one exception, all calculated sibling correlations in cognitive skills are higher than 0.50, indicating that more than half of the inequality can be



explained by family characteristics. Comparing these findings to the results in the intergenerational skill transmission literature suggests that sibling correlations are indeed able to provide a more complete picture of the family influence on children's cognitive and non-cognitive skills. This result is in line with findings in the literature on educational and income mobility.

Comparing our results to previous findings for the US and Sweden provides no evidence that the differential in sibling correlations in economic outcomes can be explained by differences in the formation of cognitive skills. The evidence from cross-country comparisons with respect to sibling correlations in non-cognitive skills is less clear.

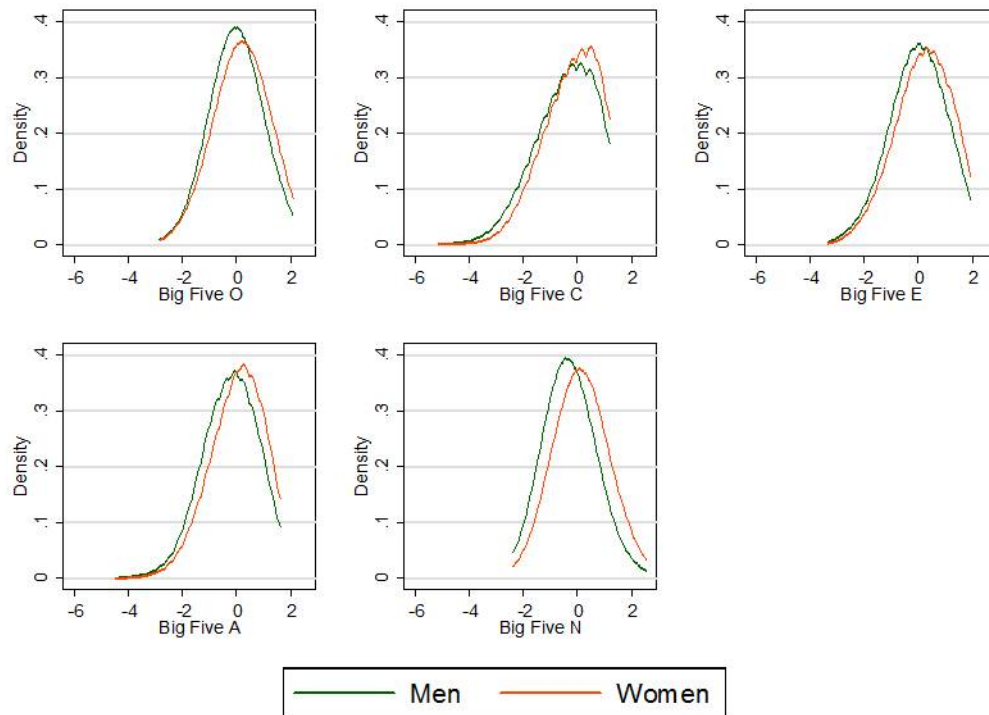
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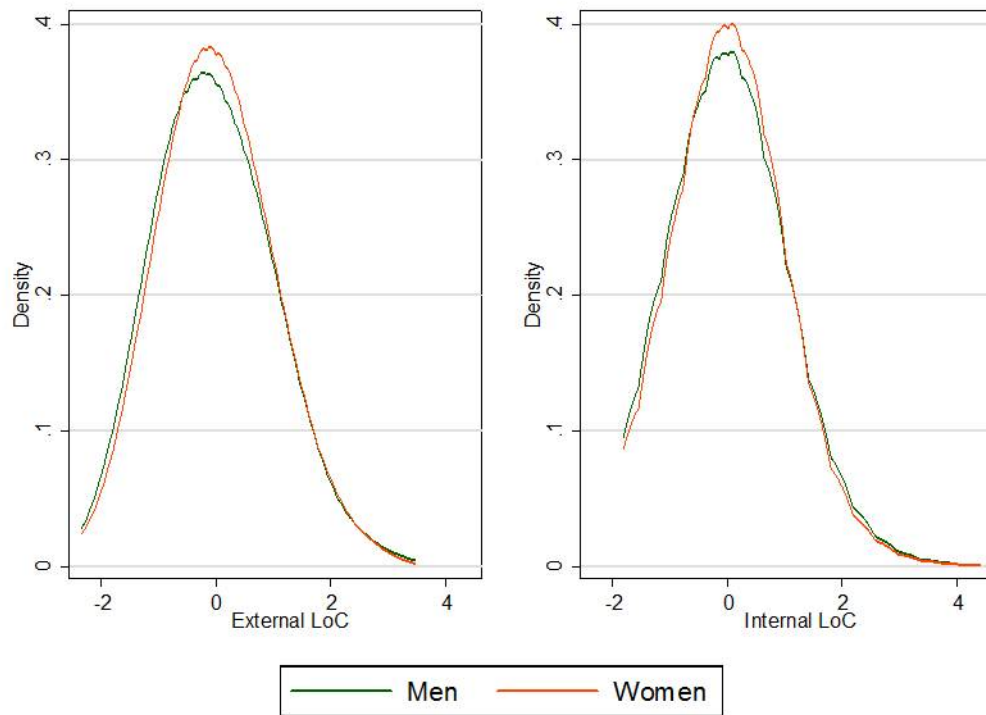
## Figures and tables

**Figure 1: Distribution of Big Five personality traits**



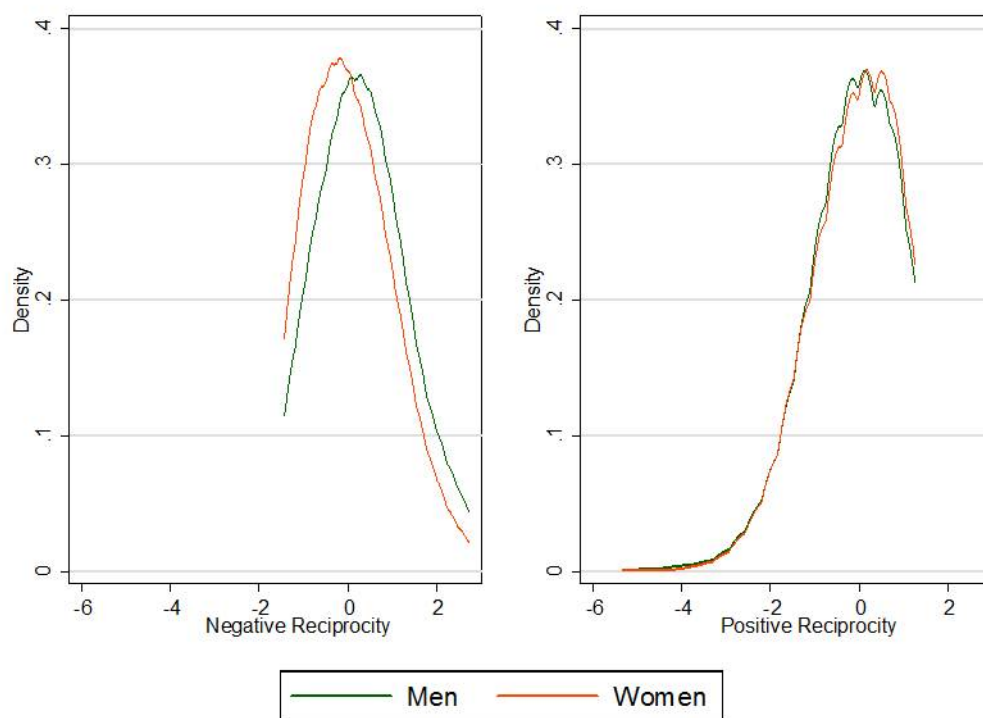
Source: SOEPv28 (2005-2010).

**Figure 2:      Distribution of locus of control**



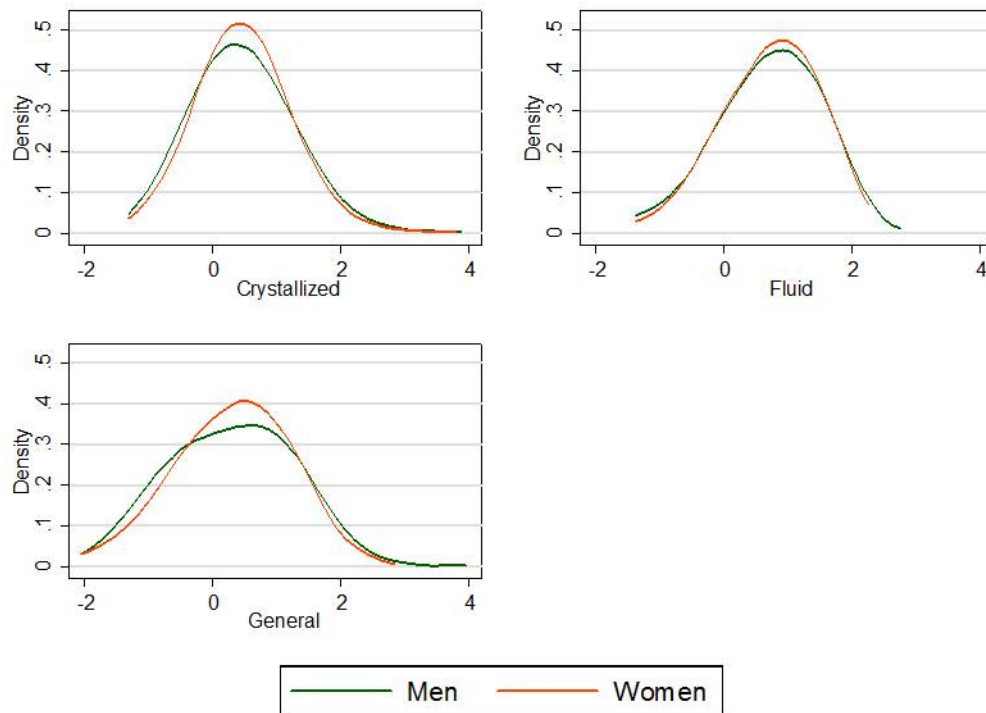
Source: SOEPv28 (2005-2010).

**Figure 3: Distribution of reciprocity**



Source: SOEPv28 (2005-2010).

**Figure 4: Distribution of cognitive skills**



Source: SOEPv28 (2005-2010).

**Table 1: Descriptive statistics – non-cognitive skills**

Year	Ext. LoC	Int. LoC	Recip (p)	Recip (n)	B5 O	B5 C	B5 E	B5 A	B5 N
<b>2005</b>	3.44	2.54	5.78	3.39	4.61	5.62	4.94	5.37	3.83
	4,791	4,847	4,868	4,858	4,860	4,856	4,867	4,866	4,864
<b>2009</b>					4.49	5.54	4.89	5.27	3.76
					4,272	4,278	4,275	4,283	4,293
<b>2010</b>	3.37	2.63	5.77	3.24					
	3,986	4,038	4,038	4,019					

Note: Given are mean test scores and number of observations for measures on external and internal locus of control, positive and negative reciprocity and Big Five personality traits measures. Only respondents with identified mothers are included in the sample.

Source: SOEPv28 (2005-2010).



**Table 2: Descriptive statistics – cognitive skills**

<b>Year</b>	<b>Crystallized</b>	<b>Fluid</b>	<b>General</b>
<b>2006</b>	25.34	30.28	27.81
	(99)	(60)	(65)
	842	842	842

Note: Given are mean test scores and number of observations for measures of crystallized and fluid intelligence. General intelligence is calculated as average of the two other dimensions. Maximum scores in parentheses. Only respondents with identified mothers are included in the sample.

Source: SOEPv28 (2005-2010).

**Table 3: Sibling correlations in non-cognitive skills (Locus of Control)**

Locus of control	Brothers	Sisters	All
<b>External</b>	<b>0.525</b> [ 0.405 ; 0.645 ] (0.061)	<b>0.527</b> [ 0.376 ; 0.679 ] (0.077)	<b>0.515</b> [ 0.441 ; 0.588 ] (0.038)
Observations	4,571	4,206	8,777
Individuals	3,143	2,855	5,998
Families	2,551	2,355	4,111
<b>Internal</b>	<b>0.663</b> [ 0.502 ; 0.825 ] (0.082)	<b>0.500</b> [ 0.287 ; 0.713 ] (0.109)	<b>0.536</b> [ 0.437 ; 0.634 ] (0.050)
Observations	4,633	4,252	8,885
Individuals	3,167	2,875	6,042
Families	2,571	2,371	4,135

Note: Presented are sibling correlations for external and internal locus of control. The mixed effects models are estimated via REML. Standard errors of the sibling correlations (presented in parentheses) are calculated via the delta method. 95 percent confidence interval is given in brackets. All estimations control for fixed aged profiles (age and age squared) as well as fixed year effects. The estimation model that includes all siblings additionally contains a gender dummy and interactions of the gender dummy and the polynomials of age.

Source: SOEPv28 (2005-2011).

**Table 4: Sibling correlations in non-cognitive skills (Reciprocity)**

Reciprocity	Brothers	Sisters	All
<b>Positive</b>	<b>0.647</b> [ 0.458 ; 0.835 ] (0.096)	<b>0.428</b> [ 0.241 ; 0.616 ] (0.096)	<b>0.500</b> [ 0.395 ; 0.605 ] (0.054)
Observations	4,642	4,264	8,906
Individuals	3,173	2,880	6,053
Families	2,576	2,373	4,144
<b>Negative</b>	<b>0.535</b> [ 0.414 ; 0.656 ] (0.062)	<b>0.681</b> [ 0.537 ; 0.825 ] (0.074)	<b>0.508</b> [ 0.434 ; 0.583 ] (0.038)
Observations	4,628	4,249	8,877
Individuals	3,170	2,879	6,049
Families	2,573	2,370	4,139

Note: Presented are sibling correlations for positive and negative reciprocity. The mixed effects models are estimated via REML. Standard errors of the sibling correlations (presented in parentheses) are calculated via the delta method. 95 percent confidence interval is given in brackets. All estimations control for fixed aged profiles (age and age squared) as well as fixed year effects. The estimation model that includes all siblings additionally contains a gender dummy and interactions of the gender dummy and the polynomials of age.

Source: SOEPv28 (2005-2011).

**Table 5: Sibling correlations in non-cognitive skills (Big Five)**

Big Five	Brothers	Sisters	All
<b>Openness</b>	<b>0.359</b> [ 0.248 ; 0.470 ] (0.057)	<b>0.366</b> [ 0.245 ; 0.486 ] (0.062)	<b>0.353</b> [ 0.292 ; 0.415 ] (0.031)
Observations	4,754	4,378	9,132
Individuals	3,105	2,826	5,931
Families	2,519	2,329	4,057
<b>Conscientiousness</b>	<b>0.590</b> [ 0.473 ; 0.707 ] (0.060)	<b>0.307</b> [ 0.172 ; 0.442 ] (0.069)	<b>0.406</b> [ 0.338 ; 0.474 ] (0.035)
Observations	4,756	4,378	9,134
Individuals	3,109	2,822	5,931
Families	2,524	2,324	4,060
<b>Extraversion</b>	<b>0.263</b> [ 0.147 ; 0.379 ] (0.059)	<b>0.258</b> [ 0.142 ; 0.375 ] (0.060)	<b>0.242</b> [ 0.179 ; 0.304 ] (0.032)
Observations	4,765	4,377	9,142
Individuals	3,113	2,827	5,940
Families	2,527	2,330	4,063
<b>Agreeableness</b>	<b>0.511</b> [ 0.362 ; 0.659 ] (0.076)	<b>0.334</b> [ 0.189 ; 0.480 ] (0.074)	<b>0.375</b> [ 0.306 ; 0.444 ] (0.035)
Observations	4,767	4,382	9,149
Individuals	3,115	2,826	5,941
Families	2,529	2,331	4,069
<b>Neuroticism</b>	<b>0.337</b> [ 0.206 ; 0.469 ] (0.067)	<b>0.479</b> [ 0.349 ; 0.610 ] (0.067)	<b>0.348</b> [ 0.276 ; 0.420 ] (0.037)
Observations	4,768	4,389	9,157
Individuals	3,112	2,827	5,939
Families	2,525	2,331	4,063

Note: Presented are sibling correlations for Big Five personality traits. The mixed effects model is estimated via REML. Standard errors of the sibling correlations (presented in parentheses) are calculated via the delta method. 95 percent confidence interval is given in brackets. All estimations control for fixed aged profiles (age and age squared) as well as fixed year effects. The estimation model that includes all siblings additionally contains a gender dummy and interactions of the gender dummy and the polynomials of age.

Source: SOEPv28 (2005-2011).

**Table 6: Sibling correlations in cognitive skills (PRELIMINARY)**

Cognitive Skills	Brothers	Sisters	All
<b>Crystallized intelligence</b>	<b>0.551</b> [ 0.394 ; 0.707 ] (0.080)	<b>0.530</b> [ 0.299 ; 0.760 ] (0.118)	<b>0.516</b> [ 0.410 ; 0.622 ] (0.054)
Observations	446	396	842
Families	386	350	663
<b>Fluid intelligence</b>	<b>0.479</b> [ 0.308 ; 0.650 ] (0.087)	<b>0.619</b> [ 0.470 ; 0.768 ] (0.076)	<b>0.517</b> [ 0.420 ; 0.613 ] (0.049)
Observations	446	396	842
Families	386	350	663
<b>General intelligence</b>	<b>0.545</b> [ 0.387 ; 0.703 ] (0.081)	<b>0.691</b> [ 0.558 ; 0.824 ] (0.068)	<b>0.543</b> [ 0.446 ; 0.639 ] (0.049)
Observations	446	396	842
Families	386	350	663

Note: Presented are sibling correlations for cognitive skills. The mixed effects models are estimated via REML. Standard errors of the sibling correlations (presented in parentheses) are calculated via the delta method. 95 percent confidence interval is given in brackets. All estimations control for fixed aged profiles (age and age squared) as well as fixed year effects. The estimation model that includes all siblings additionally contains a gender dummy and interactions of the gender dummy and the polynomials of age.

These results are very preliminary due to the low number of observations. At the moment, there is only data available from two ultra-short IQ-tests carried out in the wave 2006. A replication of these tests is currently in the field as part of the 2012 wave. First results will be available in February. This will clearly increase our number of observations for this measure and will be included as soon as the data is available.

Source: SOEPv28 (2005-2011).

**Table 7: Intergenerational correlations in non-cognitive skills (Anger 2012)**

	Ext. LoC	Int. LoC	B5 O	B5 C	B5 E	B5 A	B5 N
<b>Sib. Cor.</b>	0,52	0,54	0,35	0,41	0,24	0,38	0,35
<b>Adj. R2</b>	0,07	0,11	0,08	0,07	0,04	0,07	0,02

Note: Adj. R2 are taken from Anger (2012). In all cases the numbers refer to IGC specifications including both sons and daughters.

**Table 8: Intergenerational correlations in cognitive skills (Anger 2012)**

	Crystallized	Fluid	General
<b>Sib. Cor.</b>	0,52	0,52	0,53
<b>Adj. R2</b>	0,25	0,24	0,28

Note: Adj. R2 are taken from Anger (2012). In all cases the numbers refer to IGC specifications including both sons and daughters.