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Overview of intergenerational earnings mobility in Germany[1]

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Abstract

This paper analyses intergenerational earnings mobility in Germany, reviewing the recent literature, further investigating the impact of sampling and methodological strategies and presenting alternative results. Using data from the German SocioEconomic Panel (SOEP), the aim is to evaluate the role of father's earnings level on son's one, taking a close look at attenuation and life-cycle biases. We first estimate the association of current and lifetime earnings over the life-cycle. We then estimate the intergenerational elasticity at 0.3. We average fathers' earnings over different periods of time to evaluate and reduce attenuation bias, and we handle life-cycle bias by controlling son's age span or adding the interaction between son's age and father's earnings in the regression equation.

Keywords: intergenerational mobility, life-cycle bias, earnings, Germany, SOEP

JEL classification: D31, J62

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1 Introduction

The extent of intergenerational transmission of socioeconomic status has interested economists for decades, as it reflects the impact of family background on inequality and thus the level of equality of opportunities of a society. The degree to which socioeconomic status is transmitted from one generation to the next indeed captures the impact family background can have on children's success in later life: the effect of factors independent from children's choices, talents and efforts on their future socioeconomic status. In other words, it represents to what extent childhood circumstances are reflected in adult life, or how children's success is determined by socioeconomic background.

The major theoretical model of income distribution and transmission across generations has been developed by Becker and Tomes (1979, 1986). The model of Solon (2004) is based on this work and formalizes the role of different mechanisms in the transmission: genetic heritability of income-generating characteristics and abilities, as well as human capital investment (possibly limited by credit constraints) and public policy (public provision of health care or education for instance). Empirical investigation of intergenerational economic mobility is developed in this framework and surveyed in particular in Solon (1999, 2002), Black and Devereux (2011) and Blanden (2013). As a measure of the degree of transmission, empirical studies have mostly analyzed the intergenerational elasticity (IGE), the regression coefficient relating child's log earnings to father's ones. A high IGE indicates a relatively rigid society, in which parental position in the income distribution and thus inequality is largely transmitted to the next generation. On the contrary, a low IGE reflects a more mobile society, in which children's economic success is largely independent of parental socioeconomic status.

Considering the existing literature, uncertainty about the extent of intergenerational economic mobility in Germany remains. The studies discussed here have exclusively employed data from the German Socio-Economic Panel (SOEP) – also used in this paper – and estimates range from 0.16 to 0.30 and from 0.18 to 0.36 in Couch and Dunn (1997, 1999) respectively, from 0.11 to 0.17 in Lillard (2001) and Couch and Lillard (2004), from 0.24 to 0.46 in Vogel (2006), from 0.28 to 0.37 in Eisenhauer and Pfeiffer (2008), around 0.26 and from 0.32 to 0.42 in Schnitzlein (2009, 2015) respectively. Thus results are highly sensitive to sampling and methodological procedures (Solon, 2002), specially concerning the method of treatment of biases. Methodological issues relative in particular to attenuation and life-cycle biases – investigated by Jenkins (1987), Solon (1989, 1992), Zimmerman (1992), Grawe (2006), Haider and Solon (2006) and Nybom and Stuhler (2011) – can indeed lead to severe misestimation of the persistence of inequalities, due to measurement errors of both generations' earnings. As lifetime measures of earnings are usually not available, current earnings have to be used instead. This errors-in-variables issue for parental earnings yields attenuation bias in the estimation of the IGE. Furthermore measurement error of both generations' earnings also leads to life-cycle bias since the association between current and permanent earnings evolves over the life-cycle.

The aim of this paper is to reassess intergenerational economic mobility in Germany. We first examine existing estimations of economic transmission in the recent literature about Germany. We also further investigate the impact of attenuation and life-cycle biases on the estimation of the IGE. In particular we estimate the evolution of the association between current and lifetime earnings over the life-cycle with data from the SOEP, the most frequently used data source in this literature. New estimates of the IGE in Germany are also presented, as well as the strong impact of uncorrected biases, from both sides measurement errors. The main analysis yields here an estimated IGE of 0.323. Not taking account of attenuation bias can lead to 30% lower estimates, whereas using averages of father's earnings over longer periods of time reduces this bias. Restricting son's age around 40 years old or adding interaction terms between son's age and father's earnings in the regression equation handles left-side life-cycle bias and thus leads to higher estimated IGE.

The remainder of this paper is organized as follows. Section 2 presents the estimation model and the issues faced when investigating IGE, as well as the estimation strategies implemented in the literature and here. Section 3 presents the methods and results found in the recent literature on intergenerational earnings mobility in Germany. Section 4 describes the data and sampling strategy. Section 5 presents the estimation results in terms of biases and IGE. Finally, Section 6 concludes.

2 Model and measurement

2.1 Estimation model

Among economists, intergenerational economic mobility is commonly measured by the link between the economic status of parents and children. The regression of son's earnings on father's one is estimated, using data expressed in logarithms for both generations, and the IGE is defined as the regression coefficient on father's income. A high elasticity suggests a strong impact of parental outcomes on children's ones, meaning little mobility inside the society. A low one on the contrary indicates a more mobile society and children's earnings less determined by parental ones.

The following regression model has typically been used to measure the IGE between fathers and sons, generally estimated by ordinary least squares (OLS):

$$lnY_{i,1} = \alpha + \beta lnY_{i,0} + \gamma Z_i + \epsilon_i. \quad (1)$$

Here $Y_{i,1}$ stands for the son's income[3] (generation 1) in family i, while $Y_{i,0}$ is the corresponding measure for the father (generation 0), and additional regressors Z_i can be included. The IGE β should not be given any causal interpretation: it includes all factors linked to income and transmitted across generations.[4]

[3]This method can also apply to other measures of socioeconomic status.

[4]The intergenerational correlation (IGC) is an alternative measure of the degree of association between parents' and children's earnings, which takes into account potentially different distributions of earnings for each generation. In this paper the focus is mainly on IGE, this measure being

2.2 Attenuation and life-cycle biases

One of the main difficulties in assessing the extent of economic persistence is that the regression equation should ideally be estimated using lifetime earnings measures for both sons and fathers. However in practice only short-run measures of earnings over a limited number of years are observed, since no data sets containing the required information are available. This exposes to two main types of biases. The first one is the attenuation bias (Altonji and Dunn, 1991; Solon, 1989, 1992; Zimmerman, 1992): using current earnings as proxies for permanent earnings for the explanatory variable leads to measurement error due to transitory fluctuations in measured earnings.

The second bias encountered in the estimation of the IGE is the life-cycle bias (Grawe, 2006; Haider and Solon, 2006). Indeed the previous attenuation bias is the only issue only if annual earnings as proxy for lifetime earnings follow the classical errors-in-variables model, for both generations. That is to say, there is no life-cycle bias only if the association between current and lifetime earnings does not evolve over the life-cycle and can be written:

$$lnY_{i,t} = lnY_i + \nu_{i,t}, \tag{2}$$

with $Y_{i,t}$ the current earnings observed for individual i in year t, Y_i the lifetime earnings and $\nu_{i,t}$ the measurement error. Otherwise, estimates of intergenerational earnings elasticity may be subject to inconsistency from both sides measurement errors.

Thus variation in the association between current and permanent earnings over the life-cycle also produces a bias in the estimation of the IGE, as reported by Jenkins (1987), and more recently by Haider and Solon (2006), Böhlmark and Lindquist (2006) and Nybom and Stuhler (2011). Haider and Solon (2006) provide evidence that indeed the slope coefficient λ_t in a regression of current on lifetime earnings

widely used in the literature and in particular in most of articles discussed here.

systematically varies over the life-cycle and generally does not equal 1, generalizing the errors-in-variables model:

$$lnY_{i,t} = \lambda_t lnY_i + \nu_{i,t}. \tag{3}$$

For the estimation of the IGE, in the case of left-side measurement error, the probability limit of the estimated coefficient is then $\lambda_t\beta$ instead of β. In the case of right-side measurement error, this probability limit becomes $\theta_t\beta$ instead of β, with θ_t also called "reliability ratio", the slope coefficient in the "reverse regression" of lifetime earnings on current earnings. According to the estimations of Haider and Solon (2006), Böhlmark and Lindquist (2006) and Brenner (2010) for the US, Sweden and Germany respectively, λ_t ranges from around 0 to 1.3 depending on the age at which son's earnings are observed and θ_t ranges from around 0 to 0.8 depending on father's age.

Intuitively, as explained in Haider and Solon (2006), workers with high lifetime earnings tend to also have high earnings growth rates. Thus if sons are observed shortly after entering the labor market and fathers shortly before leaving it – which is usually the case – the difference in lifetime earnings of skilled and unskilled sons (fathers) is under- (over)estimated (Reville, 1995). Therefore the age at which earnings are observed for both generations is an important issue and can lead to severe under- or overestimation of the IGE.

2.3 Estimation strategies

In order to decrease the magnitude of the attenuation bias consecutive to right-side measurement error, parental earnings can be averaged over several years to reduce the variance of the noise relative to the signal, as explained in Solon (1989, 1992) and Zimmerman (1992) and implemented in most of the recent literature. However according to Mazumder (2005), IGE estimated with father's earnings averaged over only five years could still be biased from around 30% in the US. The estimate $\hat{\beta}$ of β would then be biased toward 0 by an attenuation factor θ_t of 0.69. If the average covers 10 years, this ratio raises to 0.79. Earnings observations for 25 years would be necessary to reach a reliability ratio of 0.90.

Parental earnings can alternatively be instrumented by parents' education level and/or occupational status. Then the estimated IGE is unbiased only if the instrument is uncorrelated with son's earnings or perfectly correlated with father's ones. Because father's education and occupation have a positive impact on son's earnings, the IGE is presumably overestimated with instrumental variables (IV) estimation (Solon, 1992; Nicoletti and Ermisch, 2008). However the IGE being on the contrary underestimated with OLS estimation if attenuation bias is only reduced and not completely removed, the real IGE should lie in between. Björklund and Jäntti (1997) for instance find empirical results estimated at 0.39 and 0.52 using OLS and IV estimation respectively, for the case of the US. Nonetheless Nybom and Stuhler (2011) argue that IV estimates are not necessarily upper bounds for the IGE and that IV estimation is a less satisfactory way to handle attenuation bias in the estimation of the IGE than averaging father's earnings over several years (even if this method only reduces and do not completely correct the bias).

To handle left-side life-cycle bias, sons can be observed at ages for which the coefficient λ_t is around 1. Haider and Solon (2006) precisely estimate the association between annual and (the present value of) lifetime earnings over the life-cycle and find current earnings to be acceptable proxies for lifetime earnings "between the early thirties and the mid-forties" for the US, using nearly career-long Social Security earnings histories.[5] Böhlmark and Lindquist (2006) and Brenner (2010) make similar recommendations for Sweden and Germany respectively.

Based on Grawe (2006) and Haider and Solon (2006) explaining that the classical

[5]Haider and Solon (2006) have access to labor earnings data for the period 1951-1991 for people born between 1931 and 1933, i.e. aged 18-20 at the beginning of the period and 58-60 at the end. They restrict their sample to workers with earnings available in at least 10 years and obtain a sample of 821 individuals.

errors-in-variables model does not apply for the estimation of the IGE, Lee and Solon (2009) implement an alternative strategy to deal with life-cycle bias: they control not only for child's age but also for the interaction between child's age and parental income in the regression of child's log income on parental ones, to account for the systematic heterogeneity across individuals in income growth's rates over the life-cycle.[6]

Nybom and Stuhler (2011) highlight the limits of current empirical strategies used to correct life-cycle bias and based on the generalized errors-in-variables model. In particular they object that the coefficient λ_t "is merely a population parameter that reflects how differences in annual income and differences in lifetime income relate *on average in the population*. Individuals will nevertheless deviate from this average relationship, so that their annual income still over- or understates their lifetime income." They point out that for the estimation of the IGE, such deviations should not depend on family background, whereas it is likely the case. They evaluate at around 20% the remaining bias after correcting the estimates for left-side measurement error, using nearly complete Swedish income series,[7] and provide recommendations to reduce it. In particular they advise to average not only father's, but also son's earnings information in order to partially correct the left-side measurement problem.

In this paper, we first estimate λ_t and θ_t in order to investigate the extent of the biases encountered in the estimation of the IGE in Germany, and the ages of sons and fathers at which earnings should be observed to reduce them.

[6]Lee and Solon (2009) use PSID family income data for sons and daughters born between 1952 and 1975 and observed from age 25 to 48, i.e. for the period 1977-2000. Parental family income is calculated as the average over the three years when the child was 15-17 years old. This strategy yields samples of 1228 sons and 1308 daughters, with almost 10 observations per individual on average.

[7]Nybom and Stuhler (2011) use Swedish tax registry data for the years 1960-2007 for sons born 1955-1957 and their biological fathers. They restrict their sample to fathers and sons reporting total income in at least 10 years, which leads to a sample of 3,504 father-son pairs with son's income observed between age 22 and 50 and father's income observed between age 33 and 65.

For the investigation of the IGE, our main estimation strategy consists in the estimation of equation (1) with age and age squared for both generations as additional regressors Z_i, in order to control for the effects of changes in earnings during a career. We average both father's and son's earnings over time, as recommended in Nybom and Stuhler (2011).

To assess the effect of attenuation bias due to right-side measurement error, we average father's earnings over different periods of time, following Mazumder (2005). Concerning the investigation of the bias due to left-side measurement error, we implement two strategies. First we restrict the age range at which we observe son's earnings to values for which λ_t is supposed to be around 1. Alternatively we implement the method of Lee and Solon (2009), consisting in the addition of an interaction term between son's age and father's earnings in the estimation of the IGE.

3 Recent literature on intergenerational earnings mobility in Germany

For the case of Germany, and in particular in all studies discussed here, the question of intergenerational economic mobility has been assessed relying on data from the German Socio-Economic Panel (SOEP) and mainly estimating intergenerational elasticities or correlations. The summary Table 1 reports recent results obtained for Germany in the literature and the way authors addressed the issues of attenuation and life-cycle biases.

3.1 Couch and Dunn (1997, 1999)

Little attention had been paid to intergenerational economic transmission in Germany before the article of Couch and Dunn (1997) and their comparison of intergenerational mobility in Germany and in the US in terms of earnings, work hours and

Table 1: Recent results and treatment of biases in the German literature

Authors	**Year**	**Est.**	**Sampling strategy**	**Treatment of attenuation bias**	**Treatment of life-cycle bias**
Couch	1997	0.16	s. from age 18	up to 6 year average (1)	
& Dunn		0.30	s. from age 25	up to 6 year average (1)	s.' age restriction
	1999	0.18	s. from age 22	min 3 years average	
		0.24	s. from age 22	min 4 years average	
		0.19	s. from age 22	min 5 years average	
		0.28	s. from age 25	min 3 years average	s.' age restriction
		0.36	s. from age 25	min 4 years average	s.' age restriction
		0.36	s. from age 25	min 5 years average	s.' age restriction
Lillard	2001	0.11	18-60	average	
Couch	2004	0.13	s. from age 18	average	
& Lillard		0.17	s. from age 25	average	s.' age restriction
Vogel	2006	0.24	25-60	min 5 years	no groups
		0.31	25-60	min 5 years	skill groups (2)
		0.41	25-60	min 10 years	no groups
		0.45	25-60	min 10 years	skill groups (2)
Eisenhauer	2008	0.20	30-50	single-year	(3)
& Pfeiffer		0.28	30-50	5 year averages	(3)
		0.36	f. 30-65	5 year averages	(3), f. up to 65 yo
		0.24	s. 20-50	5 year averages	(3), s. from 20 yo
		0.37	30-50	IV estimation	(3)
Schnitzlein	2009	0.26	f. 30-55, s. 30-40	min 5 year average	
	2015	0.33	f. 35-55, s. 35-42	min 5 year average	s.' age restriction

Notes: Abbreviations: s. for sons, f. for fathers
(1) mean of all estimations from single-year and up to six-year averages of parental observations
(2) four skill groups with different wage growth ; (3) a unique pair of father/son observations is kept:
with the smallest father/son age difference to observe them at the most similar stage of life-cycle possible

education. For the case of Germany, they use data from the 1984 to 1989 surveys of the SOEP to observe annual labor earnings for sons and their fathers, and average these earnings over the six survey years for sons. For fathers, the economic outcome is alternatively defined as the average over one year, two years, and so on up to six years. Excluding observations for years during which sons were in school or fathers in school or retired, they obtain a sample with on average 22.8 years old sons and 51.0 years old fathers.

They find extremely low estimates of intergenerational earnings correlation in their main analysis: around 0.16 for both Germany and the US, when they take the average of all estimates obtained with parental outcome defined as single-year observation and two to six-year averages of observations.[8] However the large difference

[8]Couch and Dunn (1997) find an estimated IGC of 0.121 – and an estimated IGE of 0.112 –

between these results and those of Solon (1992) for instance can be explained by different sampling procedures. In particular Couch and Dunn (1997) include sons from age 18 as long as they are out of school – versus 25 in Solon (1992) – and thus face a severe underestimation bias due to life-cycle effects. When Couch and Dunn (1997) observe sons only from age 25, the correlation rises to around 0.30 for Germany (and 0.26 for the US) since it yields partial correction of the bias.

Couch and Dunn (1999) add the United Kingdom to their comparison of intergenerational mobility in a subsequent paper and reassess their previous results with more recent data. For Germany, they use the waves 1991-1995 of the SOEP and average both son's and father's available earnings observations over this period. Restricting the analysis to sons from age 22 and fathers until age 65 (again out of school and retirement), they obtain a sample of 388 father-son pairs with sons aged 27 and fathers 54 on average, reporting respectively 3.5 and 4.2 available earnings observation on average. They find estimated elasticities (resp. correlations) ranging from 0.18 to 0.24 (resp. 0.21 to 0.28) when imposing minimum 3 to 5 available earnings observations for both sons and fathers. The estimated elasticities (resp. correlations) range from 0.28 to 0.36 (resp. 0.33 to 0.40) when the sample is restricted to sons from age 25.[9]

3.2 Lillard (2001), Couch and Lillard (2004)

Lillard (2001) and Couch and Lillard (2004) also compare the extent of intergenerational earnings persistence in Germany and in the US. For Germany, they use data from the waves 1985-1998 of the SOEP. They select men reporting earnings between the ages of 18 and 60, and as in Couch and Dunn (1997) they also exclude earnings observations for men who were in school, retired or not in the labor force. Couch and

when they use an average of all available observations over the six survey years as the outcome for both generations, with a sample of 272 father-son pairs.

[9]The sample size is reduced to 218, 144 and 102 father-son pairs when 3, 4 and 5 available observations are required for both sons and fathers, for the sample with sons from age 22. For the sample with sons from age 25, the corresponding sample sizes are 150, 104 and 64.

Lillard (2004) then raise the lower age restriction to 25, as in most of the literature. Earnings are calculated as the average of all available annual observations.

In Lillard (2001), this sample strategy yields a sample of 1,061 father-son pairs, with sons aged 26 and reporting 6 earnings observations on average, and fathers aged 52 and reporting 8 earnings observations on average. In Couch and Lillard (2004), the sample including sons aged 18 and older consists of 657 father-son pairs[10], with fathers aged 50 and sons 26 on average, and earnings computed from 11 years for fathers and 8 years for sons on average. In the sample of 549 father-sons pairs including sons aged 25 and older, fathers are 51 years old and sons 29 on average, and earnings are computed from 11 years and 6 years on average, for fathers and sons respectively.

Elasticities are estimated at 0.11 in Lillard (2001), and in Couch and Lillard (2004) at 0.13 when sons from age 18 are selected, 0.17 when the sample is restricted to sons from age 25. As in Couch and Dunn (1997), the estimates are extremely low, in particular when sons from age 18 are included in the sample. The estimate is again higher when the sample is restricted to sons at older ages, however the increase is much smaller than in Couch and Dunn (1997, 1999) and the estimate remains lower than expected.

3.3 Vogel (2006)

Vogel (2006) reassesses the comparability of intergenerational economic mobility in Germany and in the US, further investigating life-cycle issues discussed by Jenkins (1987) and more recently Grawe (2006) and Haider and Solon (2006), and presenting an estimation strategy to correct it. For Germany, he uses data from the waves 1984-2005 of the SOEP to observe annual labor earnings of fathers and sons between 25 and 60 years old, when they are available for minimum five years. This yields a

[10] Variation in the sampling strategy can yield the sample size difference. Couch and Lillard (2004) only include men who worked at least 850 hours in one of the years with reported earnings, which can lead to a smaller sample as in Lillard (2001), where such restriction is not imposed.

sample of 525 sons from 421 fathers, respectively 30.4 and 50.4 years old on average.

In order to estimate the IGE, Vogel (2006) implements a two-step estimation strategy. First, he estimates life-cycle earnings profiles, based on an income-generating function linearly increasing in time and with a quadratic age effect. Since earnings of sons (resp. fathers) are mostly observed in the early (resp. late) stages of their careers but not at he end (resp. beginning), the assumption is made that earnings profiles of sons and fathers are identical. This allows to use observations from all men aged 25 to 60 and with at least five available earnings observations, yields a large data set of 5,089 individuals and limits measurement error and thus attenuation bias (see Section 2.2). Then lifetime earnings of sons and fathers are computed based on the previous estimation and used to obtain an estimate of the IGE.

A seen in Section 2.2, a comparison of current earnings of workers with high and low lifetime earnings tends to under- (resp over-)estimate their gap in lifetime earnings at early (resp. late) stages of the career. Therefore to correct life-cycle bias, Vogel (2006) considers four types of workers, allowing different wage growth profiles. Estimating income-generating functions separately for these skill groups indeed reveals very different earnings growth rates, greater for higher educated individuals. The benchmark estimation leads to an estimated IGE of 0.24 in Germany, much lower than the estimate of 0.31, when differences in wage growth rates are taken into account.[11]

Vogel (2006) presents an alternative method to handle life-cycle bias to the generalized errors-in-variables model and finds a strong impact of this bias on German estimates of the IGE. However Nybom and Stuhler (2011) explain that even within educational groups, other determinants of income linked to family background can lead to deviation from the mean income growth rate (see Section 2.3), and thus that this strategy does not eradicate life-cycle bias as Vogel (2006) argues, even if it improves the estimation.

[11]The same estimations when earnings observations are required for at least ten years are 0.41 and 0.45 respectively, attenuation bias being further reduced.

3.4 Eisenhauer and Pfeiffer (2008)

Eisenhauer and Pfeiffer (2008) estimate the IGE in Germany using the waves 1984 -2006 of the SOEP. Their measure of economic status is real monthly earnings of full-time employed workers between 30 and 50 years old, with only the oldest sons included into the sample. Moving averages of earnings observations over five years are implemented for fathers, to reduce the attenuation bias. IV estimation is also implemented with parental years of education as instrument for long-run parental status, as in Solon (1992) and Dearden et al. (1997).

To reduce life-cycle bias, Eisenhauer and Pfeiffer (2008) compute a sampling procedure leading to observe father-son pairs at the most similar stage in their lives as possible. Therefore father's and son's observations are matched in all possible combinations and a unique pair is identified: the one with the smallest absolute age difference between father and son (and then associated with the lowest father age, if needed). This yields a sample of 180 father-son pairs, with 35.7 years old sons and 44.4 years old fathers on average.

The main analysis leads to an estimated elasticity of 0.28. Investigating biases, the estimated IGE increases with the number of years averaged and when IV estimation is implemented (IGE estimated at 0.37), as attenuation bias declines. It also increases when the upper age limit for fathers is raised, presumably due to a reduction of transitory fluctuations, and decreases when the age requirement for sons is lowered, life-cycle bias rising. This leads to estimated IGE of 0.36 when the upper age-limit for fathers is 65 and 0.24 when the downer age-limit for sons is 20 years old.

Eisenhauer and Pfeiffer (2008) suggest a point estimate of the IGE in Germany at one third. However their strategy is to observe fathers and sons at the closest stage in life as possible, which contradicts the results of Brenner (2010) who recommends to observe older fathers than sons. In pratice their sample follow the suggested age ranges. Then they only investigate the extent of life-cycle bias by changing age restrictions for sons and fathers. One could argue that part of the effect can be driven by an evolving IGE across cohorts, and not only by a reduction of the bias.[12]

3.5 Schnitzlein (2009, 2015)

Schnitzlein (2009) uses the classical OLS estimation of IGE to measure the extent of intergenerational mobility in Germany, with the waves 1984-2005 of the SOEP. He handles the issue of attenuation bias by averaging labor earnings observations for fathers over minimum five years. Only one available observation is required for children (sons and daughters), but all earnings observations are also averaged. Fathers are observed between age 30 and 55, and children between age 30 and 40. Additionally, a lower income limit of 1,200 euros per year is implemented for both generations. For sons, this leads to a sample of 439 father-son pairs, with 34.3 years old sons and 47.1 years old fathers on average. The IGE is estimated at 0.26.

In a subsequent paper, Schnitzlein (2015) conducts a cross-country comparision of levels of intergenerational earnings mobility in Germany and in the US. For the German part, he observes annual labor earnings from the waves 1984-1993 of the SOEP for fathers and 1997-2011 for sons. Fathers are again observed at age 30 to 55 but sons when they are between 35 and 42 years old, based on the findings of Haider and Solon (2006), to limit life-cycle bias. Here earnings observations have to be available for more than five years for fathers and only one for sons, and are averaged. Different lower annual earnings limits are alternatively computed: 1,200 euros in the main estimation, then 4,800 and 9,600 euros.

This yields a sample of 408 father-son pairs, with 37.4 years old sons and 47.3 years old fathers on average. IGE is estimated at 0.32 for Germany (with the lower annual income limit of 1,200 euros, results varying substantially with income restrictions, up to 0.42). In line with the findings of Couch and Dunn (1997) but contrary

[12] See among others for trends in the IGE Hertz (2007), Lee and Solon (2009) and Aaronson and Mazumder (2008) for the US, Nicoletti and Ermisch (2008) and Erikson and Goldthorpe (2010) for Britain, Lefranc (2011) for France and Björklund et al. (2009) for Sweden.

to those of Vogel (2006), Schnitzlein (2015) finds similar estimates of the IGE in Germany and in the US.

It seems that estimates of intergenerational mobility are not very robust against differences in sampling procedure and are especially highly sensitive to the treatment of attenuation and life-cycle biases. In the papers presented here the methods to handle these biases are various, particularly for life-cycle issues. However the IGE in Germany seems to be consistently estimated around 0.3 when attenuation and life-cycle biases are taken into account, even if these biases may remain partly uncorrected.

4 Data

4.1 SOEP data and main variables

This paper uses data from the German Socio-Economic Panel (SOEP) (Wagner et al., 2007), a nationally representative household survey started in 1984 and conducted annually. All adult members of each household are part of the survey and followed as long as possible and in other locations, in particular when children leave parental home and form their own households. It is thus possible to relate children's economic status as adults to their parents' status. However as the survey only started in 1984 the panel is still relatively short, and as children have to still live in the household when their parents are interviewed to become a member of the survey, sons who left late the parental home are potentially overrepresented. This would lead to keep more highly educated sons who therefore achieve better economic success and thus to underestimate the IGE.

In this study, the SOEP panel is separated in two equal parts of 15 waves each: waves 1984 to 1998 are used to observe fathers and waves 1999 to 2013 to observe sons. We choose to use as variable of interest the individual annual labor earnings[13] from the SOEP and included in the Cross-National Equivalent File (CNEF) (Frick et al., 2007). All earnings information are deflated by the Consumer Price Index (CPI), base year being 2005.

4.2 Sample selection and descriptive statistics

In a first attempt to reproduce the results of recent literature, we implement the same sampling procedure as in Schnitzlein (2015). A very similar sample is obtained, reported in Table 2[14].

Table 2: Descriptive statistics with Schnitzlein's empirical strategy

	Mean/Median	**Std Dev.**	**Min**	**Max**
son's earnings	37,911	22,563	2,370	227,625
father's earnings	32,063	17,516	9,129	145,762
son's age	37.41	1.30	35	41
father's age	47.33	4.19	33.5	52.5
son's number of observations	5.40	2.41	1	8
father's number of observations	9.16	1.27	6	10

Notes: 408 observations; Earnings in 2005 euros; Median of earnings, mean for all other variables

Then for the main analysis, we observe sampled fathers between 30 and 55 years old, as in Schnitzlein (2009, 2015), and whose earnings observations have to be available for at least five years, following the recommendations of Solon (1989, 1992). We compute the average of these earnings observations to reduce attenuation bias, as seen in Section 2.2. We observe sons alternatively when they are aged 30 to 55 or 35 to 42, to investigate the extent of potential life-cycle bias, since restrincting sons' age range should reduce it, as explained in Haider and Solon (2006) and confirmed in Böhlmark and Lindquist (2006) and Brenner (2010). We also average their earnings observations overtime to reduce potential measurement error,

[13]The variable includes wages and salary from all employment including training, primary and secondary jobs, and self-employment, plus income from bonuses, over-time, and profit-sharing.

[14]See Table A.1 (Full SOEP Sample) in the Additional Supporting Information which can be found in the on line version of the article at the publisher's website for the corresponding information obtained in Schnitzlein (2015).

following Nybom and Stuhler (2011) as seen in Section 2.2, without any restriction on the minimum number of available annual observations. If more than one son are matched to a father, we use all father-son pairs (with standard errors corrected for family clustering). In order to investigate possible sample homogeneity arising from the potential overrepresentation of sons who left late the parental home, we also estimate IGE computed with only sons still young when fathers are interviewed: with an alternative sample restricted to sons who were younger than 18 years old in year 1984.

The main sample procedure yields a sample of 652 father-son pairs with sons observed between 30 and 55 years old, 448 pairs when sons are only observed between 35 and 42 years old. When restricting the analysis to sons younger than 18 years old in 1984, the sample is reduced to 202 father-son pairs. The main descriptive statistics are reported in Table 3 and show sons are observed at age either 35 or 37.5 on average, depending on the sampling strategy. Fathers are observed around 47-48 years old on average. Averaged earnings are computed using more than five annual earnings observations for sons and more than ten for fathers, with a required minimum of five available observations.

Table 3: Descriptive statistics for the main analysis

	Mean	**Std. Dev.**	**Min.**	**Max.**
Sons aged 30 to 55, father's earnings averaged over at least 5 years - 652 pairs				
sons' earnings	37,492	22,488	524	248,740
fathers' earnings	37,165	19,504	6,359	230,479
sons' age	35.20	3.85	30	48.5
fathers' age	47.02	4.72	32.5	53
sons' number of observations	7.79	4.83	1	15
fathers' number of observations	11.21	3.26	5	15
Sons aged 35 to 42, father's earnings averaged over at least 5 years - 448 pairs				
sons' earnings	42,136	23,579	418	227,625
fathers' earnings	37,045	18,217	9,129	155,788
sons' age	37.64	1.40	35	42
fathers' age	48.14	3.80	34.56	53
sons' number of observations	5.45	2.39	1	8
fathers' number of observations	10.88	3.23	5	15

Note: All earnings in 2005 euros

5 Results

As a first observation, we are able to accurately reproduce the results found in Schnitzlein (2015), when implementing the same empirical strategy. Indeed the IGE is estimated at 0.318 (standard error: 0.072) on a sample of 408 father-son pairs in Schnitzlein (2015) and our estimation is 0.325 (standard error: 0.071) also on a sample of 408 father-son pairs.

5.1 Estimation of biases

To investigate the bias induced by both sides measurement errors in terms of lifetime earnings, and to assess the age at which sons' and fathers' earnings should be observed to reduce it, we estimate the coefficients λ_t and θ_t defined in Section 2.2. Using 30 waves of the SOEP (1984 to 2013), we regress log annual earnings for each age from 20 to 60 on the log of the present discounted value of lifetime earnings to estimate λ_t, following the method of Haider and Solon (2006).[15] Using the same strategy, we also compute the "reverse regressions" of the log of the present discounted value of lifetime earnings on log annual earnings to estimate θ_t.

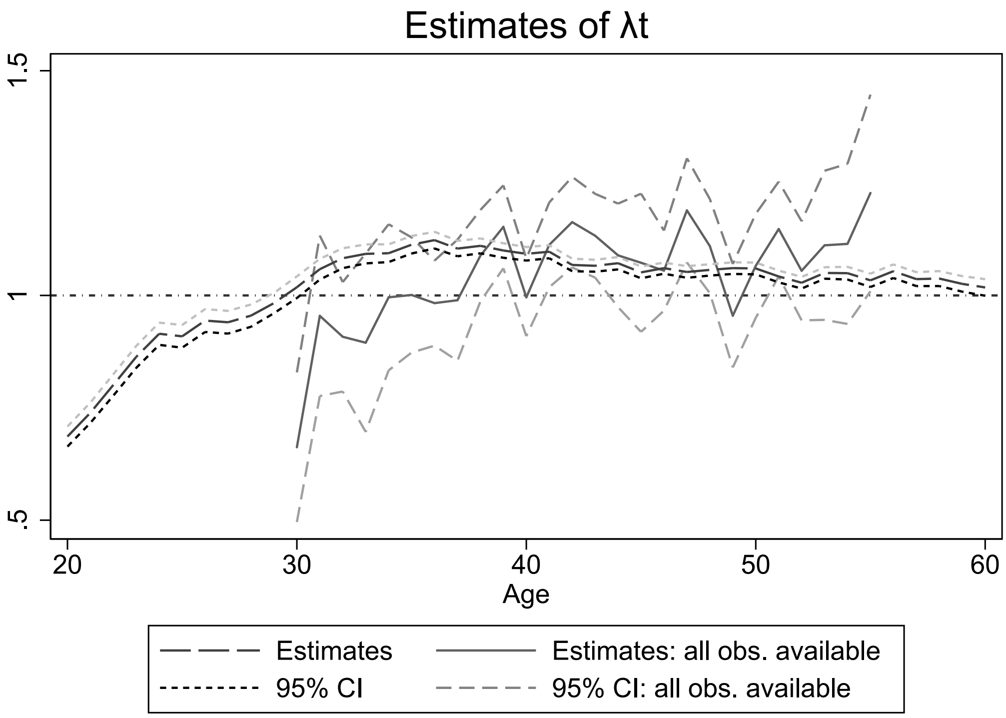
We compute here lifetime earnings with all available earnings information, but with no restriction on the minimum number of available observations. Ideally we would need career-long earnings history as in Nybom and Stuhler (2011), which is nearly the case in Haider and Solon (2006), Böhlmark and Lindquist (2006) and Brenner (2010), but not possible with our data. So additionally, we estimate the coefficients for the restricted group of individuals with all 26 observations available from age 30 to 55, assuming this should yield a good indicator of lifetime earnings. These coefficients λ_t and θ_t, for the whole and the restricted groups, are represented in Figure 1 and 2 respectively.

Brenner (2010) estimates λ_t and θ_t also for Germany, but uses data from the

[15] The present discounted value of lifetime earnings is calculated using the CPI to convert each year's nominal to real earnings, and assuming a constant real interest rate of 2 percent to maintain comparability to the literature.

Vollendete Versichertenleben of the Research Data Centre of the German Statutory Pension Insurance, and not from the SOEP which is more widely used in the intergenerational mobility literature. He selects individuals born between 1939 and 1944, observes their earnings between age 19 and 59, and restricts the sample to individuals with at least 10 available income observations. Thus we observe individuals essentially for the same age range, but use different restrictions for the minimum number of available information. Furthermore his economic outcome is gross annual income subject to social insurance contribution, which comes with two drawbacks we do not have: the information is censored as it is only reported up to a contribution ceiling and neither civil servants nor most of self-employed are represented.

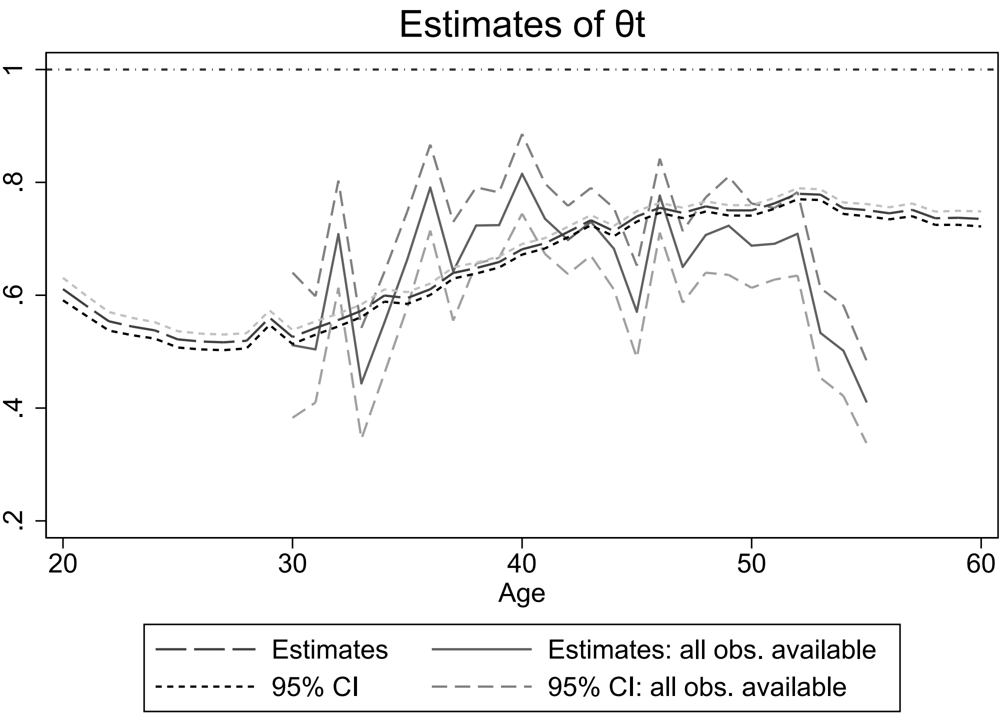
Figure 1: Estimates of λ_t for all individuals aged 20 to 60 and restricted to individuals aged 30 to 55 with all 26 earnings observations available



The graphic representation of λ_t in Figure 1, for all individuals aged 20 to 60 and without restriction on the number of available earnings observations, shows a substantial bias if earnings are observed in the early stage of the career. This bias then decreases until around age 30, when λ_t reaches 1. After this, the bias slightly increases during the early thirties with λ_t exceeding 1, but remains low and then slowly decreases without falling again below 1, contrary to the findings of Haider and Solon (2006) for the US. When we restrict the sample to individuals observed between age 30 and 55 and with all earnings observations available for this period, we estimate λ_t below 1 until a few years later in the mid-thirties, near 1 until the forties and then above 1, without the previous decreasing trend. These results on the restricted sample are very similar to those of Brenner (2010), which are also close to the results of Böhlmark and Lindquist (2006) for Sweden. This depiction of λ_t confirms observing son's earnings at young ages leads to a strong underestimation of the IGE due to left-side life-cycle bias, and it seems the IGE can be satisfactorily estimated if sons are observed around 35 or 37.5 years old on average, as it is the case in this study (depending on whether sons are observed from 30 to 55 years old or from 35 to 42 years old).

Concerning right-size measurement error, as depicted in Figure 2, we always estimate θ_t below 1, for both samples, as in Brenner (2010), Haider and Solon (2006) and Böhlmark and Lindquist (2006). For all individuals aged 20 to 60, θ_t slightly decreases until the late twenties, increases until the mid-forties then remains stable until the early fifties, and finally shows a slow decreasing trend. When we restrict the sample to individuals with career-long earnings observations, θ_t also seems to increase until the forties, then remains almost stable before falling in the early fifties. Again our estimations of θ_t for the restricted sample are relatively close to the one found in the literature. They confirm a severe bias if fathers are observed early in their career or at its very end, and show fathers should be observed later than sons for the estimation of the IGE. Observing them around 47-48 years old on average, as in this paper, appears adequate. Some bias however still remains, as we estimate θ_t around 0.75 at these ages.

Figure 2: Estimates of θ_t for all individuals aged 20 to 60 and restricted to individuals aged 30 to 55 with all 26 earnings observations available



5.2 Estimation of the IGE

In the first part of the estimation of the IGE, based on the empirical strategy presented in Sections 2 and 4, we observe earnings for fathers and sons between 30 and 55 years old. We investigate the magnitude of the attenuation bias by averaging father's earnings over shorter or longer periods of time, since the potential bias might be high, as highlighted in Mazumder (2005). We present in Table 4 the estimated IGE without any restriction on the number of available earnings observations and then averaging over minimum 5 and minimum 10 years. Mazumder (2005) suggested to average parental earnings over even longer periods, but the SOEP is not a long enough survey for us to do so.

With no minimum on the number of earnings observations, the IGE is estimated at only 0.194, with a sample of 818 father-son pairs.[16] This estimate is much lower

[16]The corresponding IGC amounts 0.324, with standard deviations of log earnings of 0.677 and

Table 4: Estimated IGE with average of father's earnings over different periods of time - unbalanced panel

	no min.	min. 5 years	min. 10 years
β	0.194 ***	0.286 ***	0.337 ***
std err.	(0.049)	(0.061)	(0.075)
fathers' age	47.87	47.02	45.79
fathers' nb of obs.	9.43	11.21	13.17
obs.	818	652	434

Significance levels : $*$: 10% $**$: 5% $***$: 1%

than the one obtained when we average father's earnings over minimum five years: 0.286, obtained from 652 father-son pairs. If father's earnings observations are averaged over minimum ten years, the estimated IGE amounts to 0.337, from 434 father-son pairs.[17]

These results underline the importance of removing or at least reducing attenuation bias due to right-side measurement error, to avoid serious underestimation of the IGE. Using more or less father's earnings observations yields estimates depicting completely different images of intergenerational mobility, even if more than 9 years on average are already used without any required minimum.

However the large differences between these estimates can come from the different samples used and are probably also driven by the differences in father's age, not only in the number of earnings observations averaged. Therefore we keep the sample of 434 individuals with father's earnings known for at least 10 years and reestimate IGE with only one father's earnings observation and with father's earnings averaged over 5 and 10 years. We choose the observations used so that father's age remains as stable as possible, that is close to 45.79 years old. The results reported in Table 5 still show the importance of handling attenuation bias, the IGE being estimated at 0.224, 0.292 and 0.332 with the three different specifications. In the rest of the

0.406 for sons and fathers respectively. Further only estimated IGE are reported, IGC being always higher due to a higher dispersion of sons' earnings distribution than fathers' one, but yielding similar conclusions.

[17] When an average over all fifteen years is used, the estimated IGE is no longer significant and falls to 0.209 with a sample reduced to only 179 father-son pairs. However fathers are less than 44 years old on average in this sample, and around 46, 47 and 48 years old with a minimum of 10 years, 5 years, and no minimum, respectively.

paper, we average father's earnings observations over minimum five years to reduce the magnitude of attenuation bias, following most of the literature on this subject.

Table 5: Estimated IGE with average of father's earnings over different periods of time - balanced panel

	1 year	5 years	10 years
β	0.224 ***	0.292 ***	0.332 ***
std err.	(0.060)	(0.074)	(0.073)
fathers' age	45.54	45.55	45.71
obs.	434	434	434

Significance levels : $*$: 10% $**$: 5% $***$: 1%

As seen previously, notably through our estimation of λ_t in Section 5.1, observing sons' earnings when they are not in a certain range of ages in midlife can lead to life-cycle bias. In order to investigate the magnitude of this bias, we compare the IGE resulting from the previous analysis to an IGE estimated with sons observed from age 35 to 42. This age restriction, also applied in Schnitzlein (2015), is chosen according to the results of Haider and Solon (2006) and in line with ours. With this sampling strategy we estimate the IGE at 0.323, as reported in Table 6, which is in range with the recent literature on intergenerational economic transmission in Germany, and very close to the one found using the empirical strategy of Schnitzlein (2015), estimated at 0.325.

Table 6: Estimated IGE with sons observed at different ages and the addition of an interaction term between son's age and father's earnings (coefficient δ)

	sons at age 30 to 55	sons at age 35 to 42	with interaction term
β	0.286 ***	0.323 ***	0.356 ***
std err.	(0.061)	(0.069)	(0.089)
δ			0.013
std err.			(0.016)
obs.	652	448	652

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Lee and Solon (2009) suggest another way to treat life-cycle bias. They add interaction terms of polynomials of son's age and father's earnings in the regression equation. Here we include as regressor an interaction of son's age with father's earnings. We again observe sons between 30 and 55 years old. Because of likely multicollinearity between ages and the interaction term, we remove son's and father's age squared from the equation. This alternative procedure yields an estimated IGE of 0.356, as reported in Table 6, thus even higher (even if not significantly higher) than the one found with the age restriction. However the interaction term coefficient is not significant.

As a last concern about the sampling procedure, the SOEP started in 1984 and is a rather short data set, with only 30 waves currently available. Moreover children had to live in the parental household when their parents were interviewed to be part of the survey as they formed their own household. Thus some of the sampled sons probably stayed in the parental home until an advanced age.

To investigate this possible sample homogeneity, we estimate the IGE with a sample excluding sons older than 18 years old in 1984 (using sons aged 30 to 55 years old, to avoid a too small sample and a not significant estimate). This procedure yields a smaller sample of only 202 father-son pairs and the results are reported in Table 7. Excluding sons too old in 1984 increases the value of the estimated IGE from 0.286 to 0.339. This supports the idea that the homogeneity bias arising from the overrepresentation of high achieving sons would lead to an underestimation of the IGE. However our estimates are not significantly different and it is complicated to draw more than caution conclusions due to the small size of the sample.

Table 7: Estimated IGE without sons who stayed late in the parental household

	all sons	younger than 18 in 1984
β	0.286 ***	0.339 ***
std err.	(0.061)	(0.115)
fathers' age	47.02	45.46
fathers' nb of obs.	11.21	11.81
obs.	652	202

Significance levels : $*$: 10% $**$: 5% $***$: 1%

6 Conclusion

This paper investigates intergenerational earnings transmission in Germany, using data from the SOEP and estimating the IGE. Uncertainty indeed remains about the extent of mobility in this country, as well as concerning a satisfactory way to choose sampling strategy and handle biases. In the main analysis, earnings observations are collected for sons between 35 and 42 years old to reduce left-side life-cycle bias, whereas father's earnings information, observed at ages 30 to 55, are averaged over minimum five years in order to reduce attenuation bias due to right-side measurement error. This leads to an estimated IGE of 0.323 for Germany. This estimate is in range with the recent literature, and in particular very close to the estimated IGE obtained by Schnitzlein (2015) with a similar estimation strategy.

The magnitude of attenuation and life-cycle biases is also examined. First graphically, a depiction of the coefficients λ_t and θ_t representing left-side and right-side life-cycle biases respectively, support the observation of sons aged around 38 and fathers around 48. Then, focusing on attenuation bias due to right-side measurement error, father's earnings are averaged over different periods of time, and serious potential attenuation bias is revealed. Using a single father's earnings observation or an average over too few years yields severe underestimation of the IGE. Concerning left-side life-cycle bias, reducing the range of ages at which sons are observed from 30-55 to 35-42 years old slightly increases the estimated IGE, thus eliminating some of the bias. Including an interaction term into the regression equation is another way to treat life-cycle bias.

Besides, the SOEP is a rather short survey. It started in 1984 and spans only three decades, which is too short to contain career-long information for two successive generations. A larger sample could enable to observe earnings for longer periods of time and at suitable ages for both generations, and thus to get more precise and reliable results. To further investigate the extent of intergenerational mobility in Germany, more waves of the SOEP should be used when available.

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