Gender Aspects of the Intergenerational Persistence of Education in Austria *

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Abstract

In many societies, childrens' education levels are heavily dependent on their parents' education, but that result can differ by the gender of the child. Using a Markovian approach, along with uni- and multivariate econometric techniques, we employ the Austrian Household Survey on Housing Wealth to show strong persistence in educational attainment that differs by the gender of the parent and the child. We find that the size of educational persistence varies over time in Austria and that the relevance of one's father's education is generally higher than that of the mother, once controlling for distributional differences. Further, the relationship between parents and children of the same gender is stronger than the cross-gender parent/child relationship. The educational penalty for females has been shrinking over time while educational mobility for both genders has increased over time.

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1 Introduction

Gender-based differentials in educational attainment are an important part of the history of women's oppression and an important part of the analysis of women's rights and opportunities. We examine the stylised fact that descendants of parents with higher levels of education are more likely to achieve higher levels of education than descendants whose parents have less education, and we add an analysis of the results by the gender of the parents and children involved. In many instances, advantages and disadvantages are passed from one generation to the next. A society that is characterized by a high degree of transmission of social status may have problems in claiming meritocratic ideals. The same constraint is true regarding gender-based equality if the educational transmission is characterized by differences for men and women. We therefore look at the gendered aspects of the intergenerational transmission of educational attainment.
In the 1970's, the Austrian government introduced several measures to increase educational endeavors in general, but particularly for children from a low-income background. Given that females tended to have significantly lower educational attainment on average, they should have benefited more than males relative to the initial situation, especially under the assumption that marginal returns to education decrease with years of education. Indeed, this policy helped females increase their educational accomplishments. Our main focus lies on examining the differences in the educational transmission proccess between parents and children of the same gender compared to parents and children of different gender.

We test the following questions:

Q1. Is there an intergenerational persistence in educational outcomes, i.e. is the education of parents and descendants positively correlated?

Q2. What is the relevance of gender in determining intergenerational persistence? Are there any differences between same gender parent-children pairs and cross-gender parent-children pairs?

Q3. Has the strength of the persistence varied over time?

Q4. How does the persistence in Austria compare to that in other European countries?

We use a Markovian approach, along with univariate and multivariate econometric analyses to test those questions. The range of methods employed allows us to check the robustness of our results. Due to the absence of long panel data series for Austria, we use the Household Survey on Housing Wealth (HSHW), a cross sectional survey which collects information on the respondents' education along with data on the educational level of their parents.

While there is a strand of literature aimed at identifying total causal effects of the education of parents on the education of their children via twin datasets (Berhman and Rosenzweig, 2002), adoptee datasets (Plug, 2004), or school reforms (Black et al., 2005) to control for parents' unobserved endowments, we instead concentrate on the intergenerational correlation of education (Hertz et al., 2008; Mulligan, 1999).

There are numerous factors that shape intergenerational mobility:

Household income is a critical component of intergenerational transmission. Income poverty is related to bad health conditions and low levels of nutrition and housing. Such conditions negatively effect the future life-chances of children. Because it cumulates with other forms of disadvantages (such as health) low income mobility is especially harmful, and it tends to be perpetual in its nature. On the other hand, children coming from a high-income household not only have more material resources to aid their development, but they also have access to social networks, which will help their personal and professional development. Children in these households may also benefit from a transmission of verbal skills and non-cognitive abilities more so than children in low-income households.

Household wealth is clearly important, because wealth constrained parents cannot invest as much in the education of their children as can wealthy parents. Borrowing against future earnings is difficult, and liquidity constraints will affect investment in human capital (Becker and Tomes, 1979). Wealthy parents can pass gifts and bequests over to their children, deepening the connection between one's own situation and his or her family background. Such wealth transfers increase the asset holdings of only a portion of children and deteriorate the principle of equal opportunity.

Educational attainment is significantly correlated across generations. Educational traits persist between generations in all OECD countries, and the OECD claims that parental education is by far the most important background characteristic in determining a child's level of education (see OECD 2008, p. 216). Belzil and

Hansen (2003) argue that household background variables - particularly parents' education - account for 68% of the explained cross sectional variations in schooling.

Genetic factors might also matter. Children may inherit genetically based behavioral characteristics. However, the contribution of genetic factors in studies of intergenerational mobility remains rather unclear. Bowles et al. (2005) find that little intergenerational inequality is due to parents passing IQ on to their children.

Many additional factors are interwoven in the process of intergenerational transmission of inequality. Aside from wealth, income, parents' educational attainment, and genetics, a child's social environment and household structure relate to this phenomenon as well. A thorough assessment of every important characteristic would require a survey containing data on a wide range of individual and social characteristics of parents and children. Like most surveys, the HSHW does not include such extensive information. However, we do have data on parent's education, and as numerous studies have shown, this is a strong indicator for intergenerational inequality because it is closely related to income and wealth.

The paper is organized as follows: In section 2 we review selected literature on the inheritance of social status, including the literature on the transmission of educational attainment. Section 3 provides the empirical explorations of our study: in subsection 3.1 we describe the data; we use the Markovian approach to analyze our questions in subsection 3.2; and we use econometric techniques, namely a univariate Ordinary Least Squares and a multivariate Ordered Logit Model, in subsection 3.3. Section 4 concludes.

2 Literature Overview

The theoretical background of most empirical models on intergenerational transmission is the Becker-Tomes (1979, 1986) model, which is itself related to Galton's 1877 work (Mulligan, 1999). Both are heavily discussed in the literature on intergenerational transmission and transfers (Bowles and Gintis, 2001). Intergenerational correlation of income, wealth, consumption, and education is well documented in a tremendous number of empirical studies, as shown by Mulligan (1999, Table 1).

Of course, the reasons for the intergenerational correlation of various characteristics may be multidimensional. The literature identifies genetic transmission, parental care, parental abilities, parental role modeling, family income and wealth, pre-school and school facilities, and one's out of school environment as the most prominent factors in determining a child's educational achievements. A central discussion is the "Nature versus Nurture" question, i.e. whether the high correlation between parents' and descendants' characteristics is mainly due to the *genetic* transmission of ability or to the *social environment* of the descendants. No consensus exists on this question, but most researchers agree that the answer lies mainly in the child's given social environment, especially the resources endowed to the parents (Checchi et al., 2008).

Speaking specifically of educational attainment, the literature at hand concludes that parents' education is the most important factor explaining the educational attainment of children (Haveman and Wolfe, 1995). The main difficulty in testing the ubiquity of this result is the fact that many datasets do not provide adequate information; when we do have a dataset that contains educational information of both the parents and descendants, we often lack many human capital variables which we could use to control for abilities of descendants to estimate direct causal effects in educational transmission (Dardanoni et al., 2008). Nevertheless, it remains unclear if abilities - even if tested at a young age - are not already formed by the social environment and especially parental education. With regard to strategies to control parents' unobserved endowments in order to identify total causal effects[1], it remains unclear if the child rearing abilities of twins (Berhman and Rosenzweig, 2002) are identical or, in the case of adoptee datasets (Plug, 2004), if the process of adoption is random or if there is some selection going on which would be comparable to inheritable abilities. Furthermore different approaches for controlling for parental endowment can lead to different and contradicting results (Holmlund et al., 2008). Therefore, analyzing intergenerational correlation seems to be valuable even in the face of the possibility that the relationship between education of parents and children is in general overestimated and our estimates are to be interpreted as correlations, not as direct causal effects.

The authors know of only limited literature that looks specifically at the gendered aspects of the transmission of educational attainment. Dardanoni et. al (2008) found a significant father to son causal effect of parental schooling and a insignificant weak effect of mothers on daughters. Moen et al. (1997) investigate the transmission of

[1]For a discussion of the differences between controlling for parental endowments versus controling for children's endowments in order to estimate total causal effects, see Dardanoni et al. (2008).

gender roles from mothers to daughters, and find a positive correlation that has decreased since the 1960s. This finding could be relevant in our case; if a mother thinks that women do not need to be educated, she will not encourage her daughter to attend school. We hypothesize that the relationship between parents and children of the same gender will be stronger than the cross-gender relationship. Parents teach their own gender ideology (i.e. what is expected of men and women) to their children, and their own educational experiences could have affected their notions about gender expectations. We predict that both males and females will have had more mobility over time due to legislative changes and investments in the Austrian education system, but we expect females to have experienced greater educational gains over time that could be partly due to the feminist movement, which has changed gender ideology and encouraged females to pursue education.

3 Empirical Analysis

3.1 Data

To analyze intergenerational transmission processes, one needs to rely on data incorporating information on at least two generations, usually one descendant and his or her parents. There are few Austrian datasets containing this information for a representative sample of descendants. The dataset we use is the HSHW 2008 which incorporates questions on the educational level of the interviewee- in this case, the owner or tenant of a main residence of an Austrian household. The interviewee is asked to state the educational level of her mother and father. The survey question provides six different school levels[2] which we aggregated into three classes[3]. Table 1 shows the educational distributions of the relevant populations (descendants, fathers, mothers).

Those in the descendant population generally have higher levels of education than their parents. Furthermore, fathers are generally more educated than mothers. Table 2 shows the educational distributions for female and male descendants. A larger fraction of males reach the highest level of educational attainment. However, com-

[2] 1. No degree; 2. Compulsory school level; 3. Apprenticeship or vocational school degree; 4. Medium-level or technical school; 5. Matura and higher level vocational school; 6. University, Fachhochschule

[3] We call the classifications "low" (1-3), "medium" (4-5) and "high" education (6). For a detailed discussion of the Austrian Educational System in an economic context, see Fersterer (2001).

	descendants			fathers			mothers		
	n	%	*c.%**	n	%	c.%	n	%	c.%
Low education	1234	59.3	59.3	1577	77.7	77.7	1695	82.9	82.9
Medium education	632	30.4	89.7	341	16.8	94.4	309	15.1	98.0
High education	215	10.3	100	113	5.6	100	40	2.0	100
Total	2,081	100		2,031[1]	100		2,044[2]	100	

Source: Author's calculations on HSHW 2008

* c.% denotes cumulative percent

[1] For 50 observations in the dataset, paternal educational levels are missing

[2] For 37 observations in the dataset, maternal educational levels are missing

Table 1: Distributions of Educational Levels for descendants', fathers' and mothers' populations

pared to the mothers' and fathers' distribution in Table 1, the gendered difference in educational attainment is substantially reduced in the descendant population.

	descendant=male			descendant=female		
	n	%	*c.%**	n	%	*c.%**
Low education	589	60.0	60.0	645	58.6	58.6
Medium education	273	27.8	87.8	359	32.6	91.2
High education	119	12.1	100	96	8.7	100
Total	981	100		1100	100	

Source: Author's calculations on HSHW 2008

* c.% denotes cumulative percent

Table 2: Distributions of Educational Levels for descendants by male and female descendants

To gain further evidence on intergenerational transmission, the next step is to look at joint distributions of parental and descendant populations. One well established approach to do so is the Markovian approach[4].

[4] For Markovian approach theory relevant to intergenerational transmissions and transfers, see e.g. Shorrocks (1978), Geweke (1986) and Van de Gaer (2001). See Norris (1997) for Theory on Markov Chains.

3.2 Markovian Approach

In this section we calculate right stochastic matrices for the transitions of the Markovian process which describes the intergenerational educational transmission. For the reader's convienience we recall the basic framework as well as the basic measurement issues concering the markovian approach for analysing intergenerational transmission of education.

Let $\mathcal{E}$ be a finite state space, where $e_i \in \mathcal{E}$ are the states and e is the number of states. Let $P = [p_{ij}] \in \mathbb{R}_{+}^{e \times e}$ be a stochastic matrix where the probability of moving from state e_i to state e_j is defined as $Pr(j|i) = p_{ij} \geq 0$, given by the element in row i and column j of the matrix P. Of course, $\sum_{j=1}^{e} p_{ij} = 1$, meaning that every origin state leads to some final state with probability 1.

In the present case, the states e_i are given by the set of different educational levels. E^f denotes the row vector which gives the marginal distribution of the education levels of the fathers, E^m denotes that of the mothers, and E^d is that of the descendants. Therefore, a row vector $p_{i1}, p_{i2}, \ldots, p_{ie}$ is the educational "lottery" faced by a descendant whose father or mother belongs to educational class i.

Example. To illustrate the intuition for this approach let us suppose a simple example in which we have a population of six fathers and six descendants. Education levels are only low or high. Three fathers have low education and three fathers have high education, while three descendants have low education and three descendants have high education. Let us assume that one descendant has more education than her father and one descendant has less education than her father. The transition probability is given by $Pr(j|i) = p_{ij} = w_{ij} / \sum_{j=1}^{e} w_{ij}$, where w_{ij} is the sum of the weights for father-descendant pairs associated with educational transition from educational class i to class j for $i, j = 1, 2, \ldots, e$. The associated transition matrix P is therefore given by

$$P = \begin{bmatrix} p_{1,1} & p_{1,2} \\ p_{2,1} & p_{2,2} \end{bmatrix} = \begin{bmatrix} 2/3 & 1/3 \\ 1/3 & 2/3 \end{bmatrix}$$

which gives the transition from the educational distribution of the fathers population to the educational distribution of the descendant population. In this case, it is

$$\underbrace{\begin{bmatrix} 3 & 3 \end{bmatrix}}_{E^f} \times \underbrace{\begin{bmatrix} 2/3 & 1/3 \\ 1/3 & 2/3 \end{bmatrix}}_{P} = \underbrace{\begin{bmatrix} 3 \\ 3 \end{bmatrix}}_{E^d}.$$

We use HSHW 2008 data to construct analogous vectors of educational distributions. The vectors E^f, E^m, and E^d and the corresponding transition matrices (by rows and columns) $P^{f\to d}$ and $P^{m\to d}$ are ordered from high (e_1) to low (e_3) education levels. The transition matrix for the educational transmission from fathers to descendants $P^{f\to d}$ is based on 1905 observations in the total sample of 2081 (128 descendants aged 24 and less are set to missing[5], 50 missings for fathers education, for two of the cases both is true).

$$P^{f\to d} = \begin{bmatrix} 0.50 & 0.45 & 0.05 \\ 0.24 & 0.54 & 0.22 \\ 0.06 & 0.24 & 0.70 \end{bmatrix}$$

The transition matrix for the educational transmission from mothers to descendants, $P^{m\to d}$, is based on 1917 observations of the total sample of 2081 (128 descendants aged 24 and less are set to missing, 37 missings for mothers education, for one of the cases both is true).

$$P^{m\to d} = \begin{bmatrix} 0.47 & 0.48 & 0.05 \\ 0.29 & 0.52 & 0.19 \\ 0.07 & 0.26 & 0.67 \end{bmatrix}$$

The transition matrix $P^{f\to d}$ shows that, for example, a descendant whose father holds the highest degree ($e_1 = university$) has a 0.50 probability of holding a university degree, and a 0.95 probability of obtaining at least a medium level education. For a descendant of a father with a "low" level of education, the same probabilities are 0.06 and 0.30, respectively. The transition matrix $P^{m\to d}$ appears to exhibit fairly similar trends. However, summing up the diagonal of the matrices gives 1.74 for $P^{f\to d}$ and 1.65 for $P^{m\to d}$, providing the first hint for stronger persistence of descendants' education coming from fathers' level of education.

One way of ordering the lotteries that any two descendants are facing given their parents' education is the stochastic dominance ordering. Let p_i denote the row vector of the ith row of a right stochastic transition matrix P. Let us assume an "at least as good as" preference relation $\succeq$ on educational lotteries. In the sense of stochastic dominance the lottery p_i is "at least as good as" lottery p_j if

[5]We exclude descendants aged 24 and less because they may not have been able to finish their schooling which could lead to disturbances in the transmissional patterns. Nevertheless including them doesn't change the results significantly

$p_{i,1} + p_{i,2} + \cdots + p_{i,k} \geq p_{j,1} + p_{j,2} + \cdots + p_{j,k}$ $\forall$ $k = 1, 2, \cdots, e-1$ and "better" ($\succ$) if at least one inequality holds. In the case of $P^{f \to d}$ (and $P^{m \to d}$) this translates to $p_1 \succ p_2 \succ p_3$. Therefore, the transition matrix is said to be monotone because $\forall$ $i = 1, 2, \cdots, e-1$, $\sum_{j=1}^{k} p_{i,j} \geq \sum_{j=1}^{k} p_{i+1,j}$, $\forall$ $k = 1, 2, \cdots, e-1$. Put simply, let us choose two people from the descendant population whose fathers have different education levels. The following statement is always true: The one with the more highly educated father faces a "better" lottery in the stochastic dominance sense.
To further investigate the transmission of educational attainment, we calculate the following transition matrices, all of which turned out to be monotone: $P^{f \to d_d}$, $P^{f \to d_s}$, $P^{m \to d_d}$ and $P^{m \to d_s}$ where d_d and d_s are the female (daughters) and male (sons) subsets, respectively, of the set of the descendants population.

Mobility Measures. Shorrocks (1978) provides a general framework for measuring mobility when data are provided in the form of a transition matrix. In general, those measures can be defined as continous real functions of the form $M(\cdot) : P \mapsto \mathbb{R}$ over the set of transition matrices $\mathcal{P}$.

Generally, there are two ways of analyzing mobility: mobility as *movement* and mobility as *independence*. In the former, a measure of mobility prefers those mobility matrices which incorporate more movement to those which incorporate less movement. If mobility is defined as independence, on the other hand, a mobility measure prefers those mobility matrices which incorporate less unequal lotteries to those which incorporate more unequal lotteries. In this sense, independence can also be interpreted as "equality of opportunity".

To follow an independence approach, which requires that the highest mobility is achieved if a matrix induces perfect origin independence, it is convenient to assert that $M(I) \leq M(P) \leq M(\bar{P})$, where $I \in \mathcal{P}$ is the identity matrix, $P \in \mathcal{P}$ is any transition matrix, and $\bar{P} \in \mathcal{P}$ is a transition matrix whose rows are identical. The identity matrix generates no transition between states and should be assigned with the least level of mobility. The matrix $\bar{P} \in \mathcal{P}$, on the other hand, should be assigned the highest level of mobility, because it induces perfect origin independence (Fields and Ok, 1996; Prais, 1955). Of course, this property is not always desirable-especially when mobility is defined as movement. However, for an intergenerational framework, such a conception is relevant because we consider mobility to be independence. For convenience, the measures are normalized to the intervall $[0, 1]$. Van de Gaer et al. (2001) show that because the axioms introduced by Shorrocks (1978) are inconsistent on the full domain of $\mathcal{P}$[6], the standard measures are not appropriate to measure mobility defined as independence on the full domain of $\mathcal{P}$. Van de Gaer et al. (2001) introduce suitable measures for the full domain of $\mathcal{P}$ but since we only have to deal with monotone transition matrices, we can restrict our set to $\Xi \subset \mathcal{P}$, which contains only monotone transition matrices in order to be able to use conventional measures (Fields and Ok, 1996, van de Gaer et al., 2001).

Pursuing an analysis of the independence measurement in our transition matrices, we turn to four related but unique tools. One widely used measure of the independence family of indices is the Second Eigenvalue Index. The eigenvalues of a given transition matrix ordered by the absolute value of their real part are given by $\lambda_i = |\lambda_1| \geq |\lambda_2| \geq \ldots, \geq |\lambda_n|$. Every transition matrix has $\lambda_1 = 1$. The Second Eigenvalue Index measures the distance of any given transition matrix to the origin independent matrix $\bar{P}$; it is given by $M^{SE}(P) \equiv 1 - |\lambda_2|$. If λ_2 is equal to zero, then the transition matrix is equivalent to the limiting origin independent matrix. Therefore M^{SE} equals 1 when the outcome distribution is independent of the original distribution. If, on the other hand, M^{SE} equals 0, then the educational attainment of the descendant population is perfectly determined by the educational attainment of the parent population.

A second measure in this family of indices is the measure proposed by Shorrocks (1978)[7]. Based on the trace of the transition matrix, this index evaluates the concentration arround the diagonal of the matrix: $M^S(P) \equiv \frac{e - trace\ P}{e-1}$. We use the Determinant Index, given as $M^D(P) \equiv 1 - |det(P)|^{1/n-1}$ as our third index fullfilling Shorroks axioms on Ξ. It is related to the average magnitude of the moduli of the eigenvalues of P.

The three indices above provide no indication of the number of classes an average descendant stands away from the educational class of his or her parent. Therefore we also take a look at an ad-hoc measure which does so. The so called absolute average jump $AAJ(P)$ gives the mean number of classes moved in absolute value.

[6]The relevant axioms are
(i) *Monotonicity*: $P \succ P'$ when $p_{ij} \geq p'_{ij} \forall i \neq j$ and $p_{ij} > p'_{ij}$ for some $i \neq j$. Therefore $M(P) > M(P')$.
(ii) *Immobility*: $M(I) = 0$. Minimum should be reached for identity matrix.
(iii) *Perfect Mobility*: Let $P'' = (1/n)uu'$ where u is an n-dimensional vector of ones. Then $\forall P \neq P'' \in \mathcal{P}$ it follows that $M(P'') > M(P)$
Clearly (i) and (iii) are inconsistent on the domain of $\mathcal{P}$

[7]Sometimes referred to as Shorrocks Mean Exit Time or Prais Index.

In our case, $AAJ(P) \in [0,2]$. Table 3 shows the selected mobility indices[8] for all described transition matrices.

	$M^{SE}(P)$	$M^{S}(P)$	$M^{D}(P)$	$AAJ(P)$
$P^{f\to d}$	0.42 (5)	0.63 (4)	0.69 (4)	0.46 (4)
$P^{m\to d}$	0.45 (2)	0.68 (2)	0.77 (2)	0.49 (2)
$P^{f\to d_s}$	0.40 (6)	0.58 (6)	0.63 (6)	0.44 (6)
$P^{f\to d_d}$	0.44 (3)	0.66 (3)	0.74 (3)	0.47 (3)
$P^{m\to d_s}$	0.46 (1)	0.74 (1)	0.90 (1)	0.54 (1)
$P^{m\to d_d}$	0.44 (4)	0.63 (5)	0.68 (5)	0.45 (5)
Indices with rank in parentheses (1 is most mobile)				

Table 3: Mobility Indices of selected transition matrices of educational transmission

Aside from the Second Eigenvalue Index, all of the indices lead to the same ranking. The most mobile, and therefore the most independent descendants are sons in relation to their mothers. The next highest independent are overall descendants in relation to their mothers. Third come female in relation to their fathers. The ordering of overall descendants in relation to their fathers and female descendants in relation to their mothers is unclear. The strongest dependence is between male descendants and their fathers. Clearly, males are more dependent on their fathers than on their mothers and females are more dependent on their mothers than on their fathers[9]. There is a strong gender-specific trend in educational attainment: children are likely to follow in the footsteps of their same-gender parent.

3.3 Econometric Evidence

As discussed above, the education level of a child depends on many factors. However, most studies exploring the intergenerational transmission of education concentrate

[8]Of course there exists a wide range of further indices within the family of indices which fullfill Shorrocks (1978) axioms on Ξ and also a number of further ad-hoc indices and other measures of rank-correlation. For better clarity we decided to use a very restricted set of them. Most of the indices we tried led to a equal or very similar ranking and all ranked identical over the set $\{P^{f\to d_s}, P^{f\to d_d}, P^{m\to d_s}, P^{m\to d_d}\}$.

[9]Of course in any approach where the educational outcome of a descendant only depends on either hi or her mother or father we can't control for assortative mating. This is done in the ordered logit approach.

on the correlation between parents' and descendants' educational attainment. This is because most data do not include good measures of social environment, parental care, or wealth. As a result, most studies have to assume that educational achievement includes the other aspects, at least in part. The general functional form of the following estimations will therefore be $E_i^d = E_i^d(E_i^f, E_i^m, C_i^d)$ for $i = 1, 2, \ldots, N$, where E_i^d, E_i^f, E_i^m describes the individual educational attainment of an individual from the descendant pool and her father's or mother's education respectively, and C_i^d are additional characteristics of an individual belonging to the descendant population.

Univariate Analysis - OLS and Correlation. In order to be able to compare our results with those of other countries, we use univariate methods. Such techniques have been heavily used to analyze intergenerational transmission of educational attainment for a large number of countries (Chevalier et al., 2003). Following the approach by Checchi et. al (2008) we estimate OLS regressions of the form,

$$E_i^d = \alpha + \beta E_i^p + \varepsilon_i \text{ for } i = 1, 2, \ldots, N, \tag{1}$$

where $p = f$ in the first estimation and $p = m$ in the second estimation. Furthermore ε_i is assumed to be a normally distributed error term with zero mean and σ^2 variance. The OLS estimate for each regression is

$$\hat{\beta} = \frac{\sigma_{dp}}{\sigma_p^2} = \rho_{dp}\frac{\sigma_d}{\sigma_p},$$

where $\sigma_d, \sigma_f, \sigma_m$ are the standard deviations of education of the relevant populations and ρ_{dp} is the correlation coefficient between descendants and fathers $(p = f)$ or mothers $(p = f)$ education. A decreasing $\hat{\beta}$ over time represents greater descendant independence in their educational outcomes vis-à-vis their parents. To ensure that a possible decrease or increase in $\hat{\beta}$ is not due solely to an evolution of the distributions of the educational attainments - namely the term $\frac{\sigma_d}{\sigma_p}$- one can normalize the individual educational attainment variables by the corresponding standard deviations. This process provides an intuitive correlative interpretation, and leads to

$$\frac{E_i^d}{\sigma_d} = \alpha + \gamma\frac{E_i^p}{\sigma_p} + \varepsilon_i \text{ for } i = 1, 2, \ldots, N \tag{2}$$

where the changes in γ over the separately estimated subsets of the descendant population according to the time that they began primary school $(< 1960, 1960-1980, >$

1980) can be interpreted as the evolution of the correlation between parents' and descendants' education levels. Table 4 shows the estimation results of Models 1 and 2 with (i) fathers' education level as the independent variable ($p = f$) and (ii) mothers' education level as the independent variable ($p = m$). Note that for this exercise we had to transfer the categorical variables into statutory schooling years, i.e. the years which are at least necessary to complete a certain educational degree[10]. Furthermore, as our data do not allow for instrumental variable estimation, the interpretation of the level of the estimates may be biased in relation to a causal interpretation due to the lack of controls for parental care, parental ability, social environment and other related but missing factors. Regardless, a causal interpretation of the changes over time would be valid under the assumption that the influence of the possible biasing factors are time invariant. Of course this assumption is highly speculative and therefore a correlative interpretation is in order.

The coefficients in all estimations are clearly lower for the younger descendant subset (who began primary school after 1980) than for the subset with the oldest descendants (those who started primary school before 1960). The dependence of the educational attainment of the descendants on their parents' educational accomplishments decreased significantly over time. In other words, children starting school more recently have had greater educational mobility. The fact that we find higher β coefficents for the mothers regressions than for the fathers' regressions but the reverse for the γ coefficients shows that a large portion of the β coefficient is due to differences in the distributions[11].

Overall, fathers' as well as mothers' education correlates significantly with their descendants' education. The correlation decreased over time with the exception of the β coefficient for the mothers distribution, which increased slightly from the

[10]In doing so we use all the categorical information available and replace them with appropriate statutory schooling years: maximum compulsory school=9, apprenticeship and vocational school=10, medium technical school=11, Matura and higher vocational school=12.5, University and Fachhochschule=16. Due to the complex educational system it is not unambigously clear which values would be the most appropriate. However we tested a set of reasonable values and the results are fairly robust.

[11]The starting level (< 1960) of the standard deviations is clearly lower for the mothers' population than for the fathers' population, and the standard deviation of all populations (mothers, fathers, and descendants) is rising over time. The standard deviation of the mothers' population remains the lowest in all three subsets but is rising faster (the change from the subset < 1960 to the subset > 1980 is 19% for mothers and 9% for fathers), which explains the evolution of the differences between the β and γ coefficients.

	Model 1		Model 2	
	$\hat{\beta}_{father}$	$\hat{\beta}_{mother}$	$\hat{\gamma}_{father}$	$\hat{\gamma}_{mother}$
< 1960	0.674***	0.744***	0.588***	0.648***
	(0.049)	(0.075)	(0.043)	(0.065)
R^2	0.35	0.21	0.35	0.21
$1960 - 1980$	0.640***	0.821***	0.524***	0.453***
	(0.037)	(0.057)	(0.030)	(0.032)
R^2	0.27	0.20	0.27	0.20
> 1980	0.542***	0.576***	0.455***	0.381***
	(0.039)	(0.052)	(0.033)	(0.034)
R^2	0.21	0.14	0.21	0.14

Source: authors calculations on HSHW 2008 data.
Notes: *,**,*** denotes significance at 10%, 5%, 1% level
Standard errors are given in parentheses.

Table 4: Estimation Results for Models 1 (OLS) and 2 (OLS, corrected for varying standard deviations) with fathers or mothers as independent variable

subset < 1960 to the subset $1960 - 1980$ and then decreased sharply in the subest > 1980. The slight increase was due to distributional issues, as one can see upon examination of the corrected γ coefficient. Disregarding distributional differences of the population and their changes over time, in the last decades the correlation between fathers and descendants is higher than between mothers and descendants. For the subset < 1960 this is not the case. That may be connected to rather equal educational distributions of mothers and fathers populations for this subset, which could be related to the second world war and the subsequent lower education for fathers.

With respect to the trend and magnitude of the evolution of the coefficients, our results are in line with those of Checchi et al. (2008) for Italy. Compared to measures estimated[12] by Hertz et al. (2008) our results seem to be quite reasonable as well. Their estimated β coefficient for Italy is 0.67, 0.58 for Sweden and the Netherlands, 0.54 for Slovenia, 0.48 for Finland, and 0.46 for the USA. The Correlation estimate γ (disregarding distributional changes) is 0.54 for Italy, 0.52 for Slovenia, 0.46 for

[12]For their estimation, Hertz et al. used the average years of school of fathers and mothers and calculated overall coefficients by averaging cohort coefficients.

the USA, 0.40 for Sweden, 0.36 for the Netherlands and 0.33 for Finland.

We also ran the regressions presented in table 4 which include a gender dummy variable equal to one if the descendant is female and zero if male. For the descendants starting primary school before 1960, being female has a significant (at the 1% level) negative effect in each of the separate regressions with the mothers' and fathers' education as independent variables. In the regressions where the descendant started school between 1960 and 1980, the model including the mother's educational attainment gives an insignificant gender dummy variable. It is statistically significant (at the 10% level) in the regression with the fathers' education. For the regression on descendants starting primary school after 1980, the effect is still negative but insignificant in both models. This implies that the penalty for being female in the intergenerational educational transmission has been reduced in the last decades.

Multivariate Analysis - Ordered Logit. In order to obtain further evidence on the gender issue as well as to check for robustness of results, we conduct a multivariate ordered logit estimation[13], similar to the method of Bauer and Riphan (2004) and Daouli et al. (2008). Educational attainment of the descendant (E^d) split by gender are the dependent variables, while educational attainment of the fathers (E^f) and mothers (E^m) along with the age of the descendant are the independent variables. For the sake of including as many observations as possible, we pool the ages of the descendant instead of estimating the different descendant population subsets ($< 1960, 1960 - 1980, < 1980$)[14]. The modes of the educational attainment are excluded for fathers' and mothers' education to serve as reference category. For both mothers and fathers, the mode is e_3, the lowest educational category in our classification. Table 5 shows the marginal effects of the ordered logit estimation evaluated at the means and modes.

The probabilities for an average descendant to obtain educational levels e_3, e_2, e_1 are given in the first row of table 5. Having a father with high education level (e_1) (university, fachhochschule) instead of low education level (e_3) increases ceteris paribus the probability (in absolute terms) of holding a high educational degree (e_1) by 0.403 for sons and 0.249 for daughters. Having a mother with high education level

[13]The possible use of a multinomial logit or generalized ordered logit approach which could be favored leads to similarly interpretable results.

[14]If one uses the subsets for estimation transmissional coefficients are, as expected, lower for the younger subsets.

(e_1) instead of low education level (e_3) has insignificant effects for sons and increases the probability of holding a medium or high educational degree for daughters by 0.267 (significance at 1% level) and 0.110 (significance at 10% level) respectively. All the significant marginal effects have the expected signs: descendants with more highly educated parents are more likely to have high levels of education themselves. Being older leads to a lower probability of higher education and higher probability of lower education, although the effects are quite small. Fathers' education has a stronger effect than mothers' education on descendants of both genders. The effects of mothers on their daughters are substantially higher than their effect on their sons. The effect of fathers' education on their sons are higher than on their daughters.

4 Conclusions

ad Q1. We find that there is persistence in educational outcomes, i.e. there is positive and significant correlation between educational attainment of fathers and descendants as well as mothers and descendants. The evidence is robust in relation to the use of different approaches, namely the Markovian approach and econometric techniques. These results suggest that a more equitable society will provide resources for children from less fortunate families so that they may catch up with their peers educationally.

ad Q2. We find that being female has a negative impact on educational outcomes of descendants. Further, the educational attainment of the father has a stronger effect on educational outcomes than the educational attainment of the mother (disregarding distributional differences). The result that the educational attainment of a parent has stronger impact on his or her same-gender descendant than on his or her cross-gender descendant is clear and consistent over the approaches used. From the Markovian approach, we see that the educational attainment of a descendant depends more on their same-gender parent than on their different-gender parent. This fact maybe due to the inability to control for assortative mating in this approach. The ordered logit approach in which we are able to include both parents, leads to the result that the education of the father is more influential for both sons and daughters, in absolute terms. Still, the effect of mothers on their daughters are substantially higher than their effect on their sons and the effect of fathers' education on their sons are stronger than on their daughters.

ad Q3. We find that the dependence of the educational outcome of the descen-

	$descendant_{low}$		$descendant_{medium}$		$descendant_{high}$	
	male	female	male	female	male	female
	$Pr(Y\|X) = 0.72$	$Pr(Y\|X) = 0.70$	$Pr(Y\|X) = 0.23$	$Pr(Y\|X) = 0.27$	$Pr(Y\|X) = 0.05$	$Pr(Y\|X) = 0.03$
$father_{medium}$	-0.388***	-0.341***	0.213***	0.249***	0.176***	0.091***
	(0.046)	(0.043)	(0.0217)	(0.289)	(0.035)	(0.020)
$father_{high}$	-0.570***	-0.532***	0.167***	0.283***	0.403***	0.249***
	(0.046)	(0.048)	(0.045)	(0.030)	(0.084)	(0.064)
$mother_{medium}$	-0.151***	-0.256***	0.104***	0.198***	0.046**	0.058***
	(0.055)	(0.050)	(0.035)	(0.036)	(0.020)	(0.017)
$mother_{high}$	-0.145	-0.377***	0.100	0.267***	0.044	0.110*
	(0.148)	(0.111)	(0.095)	(0.052)	(0.054)	(0.062)
$descendant_{age}$	0.001	0.004***	-0.001	-0.003***	-0.000	-0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)

male regression: No.obs.=900; Log likelihood=-722.857; $LR(5)$=218.25; $Prob > \chi^2$=0.000
Cox-Snell R^2=0.22; Nagelkerke R^2=0.26; McFadden R^2=0.12

female regression: No.obs.=992; Log likelihood=-762.989; $LR(5)$=269.04; $Prob > \chi^2$=0.000
Cox-Snell R^2=0.24; Nagelkerke R^2=0.28; McFadden R^2=0.14

Source: authors calculations on HSHW 2008 data.
Notes: *,**,*** denotes significance at 10%, 5%, 1% level
Standard errors are given in parenthesis.

Table 5: Marginal Effects at Means (Modes) for Ordered Logit Estimation

dants on the education of parents is decreasing over time, a result which is robust over the applied approaches. This is true for the gendered aspects of educational transmission as well, indicating that women have made significant breakthroughs in escaping the intergenerational bind of educational achievement. We think that the policy changes which promoted educational attainment were particularly helpful for women, who were educationally left behind men for decades.

ad Q4. We find that to the extent that the results are comparable, the level of correlation seems to be higher in Austria than in Northern European countries such as The Netherlands, Finland, and Sweden and closer to Southern European countries like Italy or Slovenia.

In the few years from 1970 onwards, the Austrian government changed the university system dramatically. Not only were all costs for studying abolished (at least for Austrian citizens) but scholarship funding was also heavily inrcreased. Furthermore, schooling materials became free and students benefited from a tremendous discount system (e.g. in public transportation). Along with those changes, the structure of university organization was notably democtratized. It seems that women especially benefited from these policy measures, perhaps because the new policies were especially helpful for low-income households and those that spent less on education in general. Given the lower average educational attainment of women in the 1970's it is clear that the parents of this generation invested more in the education of their sons than in their daughters, so the educational reforms allowed women to receive higher education without a monetary strain on their families. However, although it appears clear that the reforms had an effect on women's educational attainment, the magnitude of the causal effect of the reform cannot be measured by our approach and we call for further research on the effect of these policies.

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