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Making it right?
Social norms, handwriting and human capital

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Abstract:

Can early childhood interventions compensate for innate deficits? In this paper, I study the forced right-hand writing of left-handed children ("switching"). While previous literature has found that, due to innate cognitive deficits, left-handers obtain less human capital and lower wages than right-handers, I find that switched left-handers perform equally well or even better in the labor market than right-handers. Only non-switched left-handers exhibit the deficits of left-handers found in earlier studies. To address potential selection bias, I employ a difference-in-difference approach, where I exploit the rapid decline of switching across cohorts. Cohort trends of the outcome variables of right-handers, who were never switched, are used as a counterfactual for left-handers. Using rich data from the German Socio-Economic Panel (SOEP), I show that the observed differences in outcomes occur due to differential human capital accumulation, rather than cognitive or non-cognitive skills. My findings are consistent with switching compensating for the innate deficits of left-handers.

Zusammenfassung:

Können frühkindliche Interventionen angeborene Defizite ausgleichen? In diesem Papier untersuche ich die Umerziehung von linkshändigen Kindern zum rechtshändigen Schreiben. Während die bestehende Literatur gezeigt hat, dass Linkshänder durch angeborene kognitive Defizite weniger Bildung aufweisen und schlechter am Arbeitsmarkt abschneiden, finde ich, dass umerzogene Linkshänder ähnlich viel verdienen wie Rechtshänder. Nur die nicht-umerzogenen Linkshänder zeigen die bekannten Lohnlücken auf. Um Sorgen über mögliche Selbstselektion zu zerstreuen, verwende ich den Doppelten Differenzenschätzer, der das rasante Verschwinden der Umerziehungspraxis über die Zeit ausnutzt. Rechtshänder, die nie umerzogen wurden, dienen als Kontrollgruppe. Ich verwende Daten des Sozio-ökonomischen Panels (SOEP), um zu zeigen, dass diese Lücken auf eine unterschiedliche Humankapitalakkumulation zurückzuführen sind, anstatt auf Unterschiede in kognitiven und nicht-kognitiven Fähigkeiten. Insgesamt sind diese Ergebnisse konsistent mit der Interpretation von Umerziehung als ausgleichende Maßnahme für angeborene Nachteile.

Keywords:

Early childhood intervention, human capital formation, cognitive skills, lefthandedness

JEL Classification:

J24, J15, I20

Making it right? Social norms, handwriting and human capital

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September 16, 2017

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Keywords: Early childhood intervention, labor market performance, human capital formation, left-handedness

1 Introduction

Experimental evidence demonstrates that early childhood interventions at school entry age are followed by huge benefits later in life (Cunha et al., 2006; Heckman et al., 2013). Since then, economists and policy makers have become increasingly interested in ways to apply such programs to the general population (Cunha and Heckman, 2010). These interventions are often targeted towards socio-economically disadvantaged populations. Research investigating the impact of broader public policies, such as universal child care provision, report more mixed results on children's outcomes (Gupta and Simonsen, 2010; Havnes and Mogstad, 2011; Cornelissen et al., 2016). At the same time, there exist few studies that exploit naturally occurring interventions and that are able to look at long-term effects (see Currie and Almond, 2011 for an overview).

In this paper, I study forced right-hand writing of left-handers, called switching from now on, as a case where parents and teachers intervene on childrens' behavior at an early age. I analyze the long-run consequences on labor market outcomes in adulthood and investigate a set of potential channels, ranging from human capital accumulation to cognitive and non-cognitive skills.

Forced right-hand writing is motivated by stigma against left-handedness. To some extent, this stigma was institutionalized, in particular in schools. The disapproval of left-handedness and the advocacy for forced right-hand writing of children at the beginning of the 20th century is well documented for the US and UK, see Kushner (2012). For example, in 1946, the chief psychiatrist of the New York City Board of Education stated that "children should be encouraged in their early years to adopt dextrality...in order to become better equipped to live in our right-sided world." (Blau, 1946, as cited in Kushner, 2012). In Germany, the country under consideration, the *Guidelines for the consideration of left-handers in the school* of 1960 stated that children should be free in their choice of hand for painting or throwing a ball, except for writing as it is a "particular right-hand activity" (Braun, 1960, as cited in Noack et al., 2017). It was not until 1987, when teachers were instructed to support left-handed children in learning to write with their preferred hand (Sattler, 1996). However, compared to the implementation of public policies, change in the prevalence of the switching practice was much more incremental over time and to a significant extent occurred within the family.

My data come from the German Socio-Economic Panel (SOEP), a large and representative panel survey of the German population that provides a unique opportunity to observe this intervention. The data set covers a wide range of cohorts, individuals born between 1920 and 1997, with considerable variation in the prevalence of switching. Starting among cohorts born in 1950, switching rates decline monotonically from about 90% to 60% by 1960 and to nearly zero in 1990. Across all cohorts, 57% of left-handers are switched. In contrast, the share of individuals reporting to be left-handers remains fairly constant, at 9%, in particular from the 1940 cohort on.

To address potential selection bias, I employ a difference-in-differences approach, exploiting the variation in switching across cohorts and handedness. In effect, cohort trends of the outcome variables of right-handers, who were never switched, are used as a counterfactual for left-handers, thus allowing for a time-constant difference between left- and right handers. I argue that this strategy will deliver biased downwards estimates on the causal effect of switching, but observe that OLS and IV estimates differ only little from each other.

Left-handers are an interesting population for an early childhood intervention, as they also significantly differ from right-handers with respect to cognitive and non-cognitive skills caused by different brain structures. These traits turn out to be crucial for long-term economic performance (Mueller and Plug, 2006; Borghans et al., 2008; Heineck and Anger, 2010; Moffitt et al., 2011; Cobb-Clark and Tan, 2011; Heckman and Kautz, 2012; Caliendo et al., 2014). Recent literature finds that, on average, left-handers experience deficits in skills and human capital accumulation when compared to right-handers.

Using five comprehensive data-sets from the US and the UK, Goodman (2014) shows that left-handed children perform significantly worse in standardized math and reading tests, obtain fewer years of schooling, and are more likely to suffer from learning disabilities and behavioral problems. Left-handed adults earn lower wages because they select into occupations that require lower levels of cognitive skills. Johnston et al. (2009, 2013) find that left-handed children in the Longitudinal Study of Australian Children (LSAC) and in the National Longitudinal Survey of Youth (NLSY) perform worse on cognitive development test scores than right-handed children. On the other hand, Denny and O'Sullivan (2007) find a wage premium for left-handedness among males and a wage penalty for women in the National Child Development Study (NCDS), see also Ruebeck et al. (2007). The child samples in the above studies are drawn from countries and cohorts in which switching and stigma against left-handedness is rather rare. Thus, they demonstrate a natural difference between left- and right-handers at a young age.

This paper investigates whether an early intervention increases or compensates such innate deficits. One limitation to the generalizability of my results is that the disadvantages of left-handers arise due to physiological and cultural reasons and not through, e.g. the socio-economic status of their parents, which is a more wide-spread source of disadvantage. However, there exists no study concerning an intervention with the potential to have negative effects on those treated.

Surprisingly, I find that switched left-handers perform equally well or even better than right-handers in terms of labor market outcomes and human capital accumulation, while non-switched left-handers exhibit the previously documented deficits of left-handers. Cognitive skills, which are measured at adulthood, differ little, while non-cognitive skills are significantly different between left-(switched and non-switched) and right-handers. However, these differences explain only a small part of the observed gaps in labor market performance. The most important channel is human capital. Taking into account human capital accumulation, switched left-handers show about the same wage deficits as non-switched left-handers. These findings are consistent with switching as a compensatory investment for the innate deficits of left-handers.

This paper proceeds as follows. In the next section, I briefly review some of the literature on left-handedness and switching. Section 3 introduces the data and gives a descriptive analysis of left-handedness and switching across cohorts. In Section 4 I present differences between right-handers and switched and non-switched left-handers in labor market performance and discuss potential channels. I outline my strategy to identification the causal effect of switching on labor market outcomes in Section 5. Finally, I conclude in Section 6.

2 Handedness and Switching

Left-handers have faced discrimination in various areas of life (Harris, 1980, 1990). To a significant extent, prejudices about left-handers' inferiority have originated in religion, but not exclusively so. For example, in Christianity, the left hand was considered to be the devil's hand, and in Islam it is forbidden to use the left hand for eating and human interaction. Nonetheless, non-religious China has one of the lowest reported left-handedness rates worldwide, where right-hand writing is a social convention, rooted in the stroke order of Chinese characters (Kushner, 2013). Such attitudes may explain why switching the writing hand of left-handers is still common in developing countries in Asia, Africa, the Middle East, and South America (Medland et al., 2004; Zverev, 2006; Porac and Martin, 2007; Kushner, 2013). Depending on the country and cohort considered, the methods of switching range from friendly persuasion and positive incentives to threats, parental neglect, immobilization, beatings, and even breaking the left-arm (Perelle and Ehrman, 1994; Zverev, 2006). On more practical grounds, the world is primarily designed for right-handers, in particular, machinery, equipment and tools in everyday use.

For these reasons, forcing a left-handed child to use the right hand for writing and other daily activities may seem to be to the child's long-term benefit. Another, less benevolent, motivation may be that a child's legal guardian simply wants to conform to existing norms, despite potential harm. Today, parents and teachers are advised not to interfere with a child's natural handedness, as it can lead to stuttering (Sattler, 1996).[1]

The share of left-handers in the population is estimated at 10%–15%, with vari-

[1] King George VI is a well-known example from generations of left-handers affected in this way(Kushner, 2011, 2012).

ation in the country and cohort under study (Perelle and Ehrman, 2005).[2] A large literature on left-handedness, or laterality, exists in neuro-psychology, the neurosciences, and related fields (Coren, 2012). The precise origins of left-handedness are still unclear, however. Recent large-scale twin studies have shown that early theories based on a simple genetic model cannot be sustained (McManus et al., 2013). Satz (1972) proposes the idea of a pathological left-hander. According to this theory, even mild damage to the left brain hemisphere during the pre- or perinatal period can cause a shift of lateral dominance to the right hemisphere. Hence, lower cognitive skills, behavioral problems and left-handedness have the same cause. Goodman (2014) concludes that his findings are in line with the idea of a pathological left-hander.

In contrast to handedness, the consequences of switching are much less well researched, whether in psychology or any other field.[3] What consequences of switching can be expected? Sattler (1996) reports that in school, children forced to switch have to invest an over-proportional share of their energy and concentration in learning to write with the wrong hand. Hence they are quickly exhausted and are less able to follow the lessons.

Switching may also alter the brain's structure. Brain scans of switched Ger-

[2]See McManus (2009) for an overview of the prevalence of left-handedness across time and geography.

[3]Previous work in psychology includes, e.g., Porac et al. (1986); Porac and Searleman (2002).

man left-handed adults have shown that switching does not truly alter a person's handedness, as measured by the location of the higher order motor control areas. Klöppel et al. (2010) find that the volume of gray matter in the putamen, a part of the forebrain that contains the executive and cognitive aspects of motor control, is reduced among switched left-handers, compared to non-switched right- and left-handers. A positive effect of switching might stem from increasing the brain's connectivity, such as the corpus callosum, which is known to be larger among left-handers (Witelson, 1985).

To summarize, some aspects of switching suggest negative consequences, either via physiological (overtaxing of the non-dominant brain hemisphere) or psychological (social exclusion, violence) channels, while others could have a positive effect, such as stimulating brain activity and additional attention from parents and teachers.

3 Data and descriptives

3.1 Left-handedness and switching

My sample is drawn from the German Socio-Economic Panel (SOEP), a large and representative panel survey of the German population that started in 1984 (Wagner et al., 2007). As part of a grip strength measurement module conducted biannually between 2006 to 2014, respondents were asked "Are you a natural right- or left-hander?" and "With which hand do you actually write?"[4] I take a difference in the answers to these questions as an indication for switching of the writing hand. In this study, an individual is defined as being naturally left-handed if he reports so at least once. The reasoning for this approach is that no true right-hander has an incentive to ever report being left-handed. Similarly, an individual is defined as switched if she reports a difference between her innate and writing hand during the same interview at least once. Reassuringly, only 32 out of a gross sample of 13,442 individuals report being innately right-handed, but write with their left hand today. I drop these observations.

The analysis sample is restricted to individuals born after 1920 and before 1997, in order to avoid small cell sizes. The total sample size is 12,757, of which 1,129 observations are left-handed and 633 switched. The resulting share of left-handers is 8.85%, of which 56.06% are switched.[5] This share of left-handers is lower than the 10% to 15% reported in recent economic (Goodman, 2014; Johnston et al., 2013) or psychological (McManus, 2009) studies. One explanation for this is that

[4]In 2006 and 2014, individuals had "left- and right-hander" as a third answer option for both questions. I assign these 28 (13 for writing) individuals to the left-handed group (the writing hand is the left hand). Qualitatively, the findings do not change if I include them in the right-handed group. See Ambrasat and Schupp, 2011 (in German only) for further details on the grip strength measurement.

[5]The share of missing answers to the innate handedness question is 1.58% and 2.53% for the writing hand. Note that these questions were asked regardless of a successful grip strength measurement which followed afterwards.

these studies are able to create a more precise measure of handedness by combining statements on the preferred hand for writing, throwing, and eating, while my data set provides only one item on this trait. I now discuss the limitations of my measures.

One obvious concern is different reporting behavior by true handedness, true switching status and across cohorts. The way respondents interpret the term "natural right- or left-hander" may be directly influenced by these factors. Given the stigma of left-handedness, social desirability might lead to underreporting left-handedness or to missing values on the handedness questions. I use the left-to-right grip strength ratio to check whether true left-handers are less likely to answer the questions on innate handedness in the first place, but find no evidence for this.[6] Furthermore, if the switching practice disappears across cohorts, we would expect that the share of reported left-handers increases, since switching that occurred too early in life to be remembered decreases. As I will show below, this is not the case.

Another concern may be that older individuals are less likely to write at all

[6]Information on innate and writing hand is available for more than half of the individuals who refused the grip strength measurement. Similarly, for more than half of the individuals with missing information on handedness, information on grip strength measures are available. I compare the distributions of the left-to-right ratio of grip strength between those with and without missing information on handedness. The reasoning is that in my data, left-handers left-to-right grip strength ratio is on average more than one-third of a standard deviation higher than that of right-handers. A Wilcoxon–Mann–Whitney test does not reject the hypothesis that the two distributions (missing vs. non-missing information on innate handedness) of the grip strength ratio are equal (p-value 0.43), suggesting that left-handers are not over-represented among those with missing handedness information.

and hence report being right-handed. I offer two pieces of evidence against this hypothesis. First, Appendix Figure D.1 shows the share of non-response to the original handedness and writing hand questions. I find no evidence that certain cohorts are more or less likely to answer the questions. Linear or quadratic cohort trends are non-significant for either question. Second, in unreported fixed effects logit regressions, I make use of the panel structure of the grip strength measurement module and find that age is not a significant predictor of the writing hand. Nevertheless, in robustness checks, I adopt different assignment rules for left-handedness and switching and find that my results still hold.

3.2 Outcome, channel and control variables

Employment status and log-hourly wages observed between 2004 to 2014 are the primary outcomes of interest in this study. Labor market outcomes can be seen as a summary of long-term consequences from early interventions (Heckman et al., 2013). I then investigate human capital, cognitive and non-cognitive skills as potential channels of switching as an intervention, from early childhood to labor market outcomes (Heckman et al., 2006).

Channels: Human capital Human capital accumulation is measured by completed years of education and retrospective grades in Math and German from the last school certificate. Years of education includes time spent in apprenticeships, training, or tertiary education. I use the highest observed value for years of education in the panel, but individuals had to be at least 25 years old at this point to be included in the sample.

The school is an integral part in the switching process, as it is the primary place to develop writing skills. Teachers in Germany have considerable discretionary power over tracking, which starts very early, after elementary school at age 10. Only the highest track (*Gymnasium*) leads to college education. see Krueger and Pischke (1995) for a more detailed description. The East German schooling system had no such early tracking, but access to the higher education granting track was strongly limited and required alignment with the state's ideology, see Baker et al. (2007).

Math grades serve as the earliest available proxy for cognitive skills, before college or occupational choices are made. In addition, writing and verbal skills, which might be influenced by switching, are much less important in Math than in German. Individuals are only included in the sample of grades if they were at least of age 20 at the time of the interview and thus likely to have completed schooling. Note, however, that grades are self-reported and therefore subject to recall bias, which may differ by handedness or writing hand. For example, left-handers might report worse grades because their memories of schooling is tainted by discrimination they experienced.

Channels: Cognitive skills For cognitive skills, I use the symbol-digit test (SDT) and the animal naming task (ANT).[7] Both were elicited in 2006 and 2012 from a random sample of SOEP participants and have been used in other studies (Dohmen et al., 2010; Heineck and Anger, 2010). During the SDT, individuals had to match as many numbers to symbols as possible within 90 seconds and enter their answers in the interviewer's computer. This test intends to measure an individual's fluid intelligence, which is the ability to process and make use of new information that is not already stored in the memory (Cattell, 1987). The ANT is a mixture of fluid (word fluency) and crystallized (vocabulary) intelligence. It requires respondents to name as many distinct animals as possible in 90 seconds. I use the number of uniquely named animals, excluding repetitions.

Channels: Non-cognitive skills Cunha et al. (2006) document that IQ gains in the Perry Preschool Program were short-lived and faded out within six years after the intervention. In contrast, non-cognitive skills such as self-motivation were responsible for the program's positive effect on later life outcomes. In this study, non-cognitive skills are represented by the Big Five personality traits (McCrae and Costa Jr, 1999) and the external locus of control (Rotter, 1966). Personality traits were elicited in 2005, 2009, and 2013, using three items for each trait.[8]

[7] See Lang et al. (2007) for the validity and reliability of these tests in the SOEP.

[8] See Dehne and Schupp (2007) for the validity and reliability of these measures in the SOEP.

The external locus of control was elicited in 2005 and 2010 using six items. I do not use all items in constructing these variables, due to their low reliability. See Appendix C for an overview on the construction of these variables. The external locus of control has been found to be an important predictor of wages (Groves, 2005; Heineck and Anger, 2010) and job search strategies (Caliendo et al., 2015). The role of personality traits for labor market returns in the SOEP is analyzed in Heineck and Anger (2010). For both, cognitive and non-cognitive channels, I use the earliest available observation per individual.

Control variables My control variables comprise gender, year of birth, being born in East Germany (the former German Democratic Republic)[9], migration background (none, 1st generation, 2nd generation), mother's and father's education (none/basic, middle, high, and missing) and urbanization at age 15 (large city, mid-sized city, small town, countryside, and missing). Individuals whose country of birth is not Germany are referred to as migrants.

Table 1 shows descriptive statistics by handedness and switching status. Simple mean comparisons show that left-handers report worse grades in German and score lower on conscientiousness and extraversion than right-handers.

Unconditional differences between switched and non-switched left-handers are not very informative here, as they are strongly confounded with cohort effects,

[9]East German is defined by having lived in the GDR in 1989 or by being in sample C (D-Ost) in the SOEP.

which will be corrected for in regression analysis. It is noteworthy, however, that despite being born on average two decades earlier, switched left-handers have about the same average years of education than non-switched left-handers.

- Table 1 about here -

A more detailed analysis of reported left-handedness is deferred to Appendix A. Females, East Germans, and non-natives are less likely to report left-handedness. The fact that females are less likely to report left-handedness than males is well-known in the laterality literature (Harris, 1990) and I find no evidence that this difference changes across cohorts, suggesting a true biological cause. Differences by country of birth and between East and West Germany can be explained by past and prevailing anti-left attitudes, which are discussed in the Appendix A. Apart from these basic characteristics, there are no significant differences in socio-economic background.

Conditional on left-handedness, selection into switching is discussed in Appendix B. I set up a simple parental investment model based on Becker and Tomes (1994) that accommodates social norms to predict which parents are likely to switch their child. These predictions are then tested empirically. I conclude that among left-handed children, those switched are likely to be positively selected, for two reasons. First, parents that care stronger about their child's standing in society and future success are more likely to switch their child. Second, children who are able to make the switch are likely to be more motivated and have parents and teachers who support them throughout the process. Empirically, I find that maternal education positively predicts switching among left-handers, confirming the hypothesis that switched left-handers are positively selected. Another interesting finding is that East Germans are 7.5% more likely to be forced to switch their writing hand than West Germans. Anecdotal evidence suggests that in East Germany, as in other Eastern European ex-socialist states, left-handers were suspected of being more creative than right-handers and hence as more likely to be a threat to the ruling regime. This threat was supposed to be eliminated by switching the writing hand Sattler (1996).

3.3 Left-handedness and switching across cohorts

This section provides a description of switching and left-handedness in the data. The first panel in Figure 1 shows the share of innately left-handed individuals and left-hand writers across cohorts. The second panel uses only left-handers and shows the share of switched across cohorts. All curves are estimated by local linear regression with ROT bandwidth. Starting with the first graph, I find that the share of left-handers increases, though rather noisily, from 6% in the 1920 cohort to about 9% in 1940. It remains constant from then on. The initially lower share of left-handers was to be expected if the stigma of left-handedness and writing with the left hand has decreased over time. Although such a stigma was arguably no longer prevalent at the time of the hand grip measurement (2006 to 2014), the longer socialization of elderly individuals during times when prejudices were prevalent are likely to lead to the observed pattern.[10] In robustness checks, I exclude individuals born before 1950.

Over the same period, the share of individuals who at least once report writing with their left hand increases first only mildly until the 1950 cohort, before rising sharply from then on, and eventually equaling the share of left-handers in the cohorts of the late 1990s.

- Figure 1 about here -

Looking at the share of switched individuals, in the second graph of Figure 1, I find that about 90% of left-handers born before the end of World War Two write with their right hand today. This share rapidly decreased among those born in 1960 or later and reached zero by the late 1990's.

For at least 40 years (1920–1960), there existed a pooling equilibrium in which close to all left-handers were successfully switched and it can be reasonably assumed that a good fraction of non-switched left-handers at least were tried to switch. Within less than another 40 years this practice vanished. Why did the

[10]The competing and somewhat prominent hypothesis that left-handers have a lower survival rate than right-handers (Coren and Halpern, 1991; Halpern and Coren, 1988) was quickly refuted, because the authors did not take stigma and switching among older cohorts into account (Harris, 1993).

norm of right-hand writing disappear so quickly? Young (1996) argues that previously stable conventions can suddenly reach a tipping point and change due to some idiosyncratic shock. Although only few agents are initially affected by the shock, a new generation of agents samples from the behavior of the previous one and adopts their convention according to the majority observed. Here, such a shock may be the social upheavals of the 1960s, which found their climax in 1968 in Germany (*68er-Bewegung*) and elsewhere. The abandonment of conservative social norms, of which the correct writing hand is obviously just one, was initiated by this first generation of post-war raised parents.[11] This development then worked its way into schools (Sattler, 1996).

Another explanation may be technological change, for two reasons. First, labor became less manually intensive with a decline in the necessity to use tools and machinery which may be geared towards right-handers. Second, as production techniques became more flexible, goods whose functionality depends on manual handling (e.g., scissors and knives) were more and more produced for left-handers, making it unnecessary to switch hands.

[11] A similar observation has been made by Coudé et al. (2006), who find a sharp increase in reported left-handedness among individuals who entered school shortly after the events of May 1968 in France. I do not find this increase in the share of reported left-handers, but instead a steep decline in switching rates.

4 Results

In this section I investigate differences in adult life labor market outcomes between left- and right-handers and between the three groups, switched left-handers, non-switched left-handers, and right-handers. The latter group are the reference group in both cases. Though not the main focus of this paper, pure left–right differences are included for comparison with the existing literature.

For estimation I use OLS and random effects (RE) models. Thus, the results in this section do not allow for a causal interpretation, since the switching decision has to be made consciously by parents and teachers. It is thus a priori unlikely that the individual's characteristics that have been found (in Appendix B) to (weakly) correlate with the intervention are its sole predictors. In particular, a possible reverse causality with respect to innate cognitive and non-cognitive skills is worrisome. Furthermore, and as derived by my theoretical model in Appendix B, parents with higher altruism and involvement with their child's development may contribute to a positive selection bias.

I undertake two measures to address these concerns. First, I show in robustness checks that my results do not change significantly when including control variables that are strong predictors of the outcome variables, in particular parental education. Second, in the next section I discuss a difference-in-difference strategy to identify the causal effect of switching and find very similar results.

For now, the regression model takes the form

$$y_{it} = \alpha_L \, \textit{left-hander}_i + \beta_0 \, X_i + \epsilon_{it} \tag{4.1}$$

to investigate differences between left- and right-handers and

$$y_{it} = \alpha_N \, \textit{non-switched left-hander}_i + \alpha_S \, \textit{switched left-hander}_i + \beta_0 \, X_i + \delta_{it} \tag{4.2}$$

to investigate differences between switched and non-switched left-handers with respect to right-handers. The index t denotes the survey year and is irrelevant for all channel outcome variables, which are cross-sectional. My preferred specification includes all control variables X_i described in the previous section. Age fixed effects are included for labor market outcomes. All control variables are pre-determined before the intervention. I use linear probability models for binary outcomes.

4.1 Labor market outcomes

Table 2 shows regressions on employment status and log-hourly wages. Starting with general left–right differences in the first panel, I find that left-handers are 2.3% less likely to be employed and if they are, they earn about 7% lower wages, which is close to the wage gap of 6% reported by Goodman (2014).

- Table 2 about here -

The second panel in Table 2 splits left-handers into switched and non-switched. I find that it is the latter who perform significantly worse on both measures, being about 6% less likely to be employed, as well as earning 11% lower wages than right-handers. Switched left-handers earn a statistically insignificant 3% lower hourly wages.[12]

4.2 Channels

4.2.1 Human capital accumulation

I now investigate potential channels which could lead to the observed differences in long-run labor market outcomes. A natural start consists of measures of human capital, as writing is primarily learned in school and the "correct" writing hand might matter for school success. Table 3 shows the results.

Differences between left- and right-handers (upper panel) are rather small, and only significant for tracking in column two. Similar to labor market outcomes, the contrasts in human capital between switched and non-switched to right-handers are remarkably different. Non-switched left-handers report about one-third fewer years of education, or 0.12 standard deviations (column one). Column two shows that they are also 7.6 percentage points (12.5%) less likely to graduate from a schooling track which is higher than the lowest. Non-switched left-handers also report signif-

[12]The coefficients are significantly different from each other for employment (p-value$<$0.011) and log-wages (p-value$<$0.055).

icantly lower grades compared to right-handers and switched left-handers. Math grades are 0.16 standard deviations lower (column three) and German grades 0.06 standard deviations lower (column four), although the latter coefficient is insignificant.[13] It is unlikely that grades from the last school certificate are driven by discrimination by teachers, especially in Math.

While Table 3 used the full sample, results within the sample of individuals with positive wages are shown in Appendix Table D.1. The coefficients are largely similar, but switched left-handers have a significant 0.2 more years of education and a significant 0.1 standard deviation higher Math grades than right-handers.

- Table 3 about here -

4.2.2 Cognitive and non-cognitive skills

Next, I investigate whether left-handedness and, in particular, switching, is also correlated with cognitive and non-cognitive skills in adulthood. Again I use the same regression specification as for human capital measures. The results are displayed in Table 4. Starting with the two measures of cognitive skills in columns one and two, I find that there are no significant differences either between left- and right-handers, nor when I split up left-handers into switched and non-switched.

To some extent, this comes as a surprise since the previous literature found that

[13]The difference in Math grades is not driven by selection into different school tracks. Controlling for the latter leads to very similar results.

left-handers perform worse than right-handers in some of these tests. However, not in all of them. Johnston et al. (2009, 2013) find that left-handed children do not perform worse than right-handers in tests which require vocabulary and expressive language skills, which the animal naming test requires. Goodman (2014) reports that left-handers perform worse in reciting numbers backwards but not forwards, which requires short-term memory skills. Thus, the symbol-digit test might not capture the dimensions of cognitive skills in which left-handers perform worse. It is interesting to note, however, that the switching status is neither associated with a difference in these measures.

Roughly the same holds for the Big Five personality traits in columns three to seven of Table 4. Left-handers describe themselves as significantly less conscientious and extroverted, but as more neurotic. Less conscientiousness and a higher level of neuroticism could be correlated with the behavioral and learning problems in childhood which Goodman (2014) and Johnston et al. (2009, 2013) document for left-handers. Similar coefficients for switched and non-switched left-handers indicate that such behavioral problems arise for both types of left-handers and speak to the stability of personality traits (Cobb-Clark and Schurer, 2012, 2013). In contrast, there are significant differences in the external locus of control (LoC) (column eight). Switched left-handers have a significantly higher external LoC than right-handers. This is in line with Piatek and Pinger (2015), who find that the locus of control's influence on wages is mostly through education.

Appendix Table D.2 repeats the previous regressions for employed individuals. As was the case for human capital variables, I find similar results, but in this sample, the contrasts between left- and right-handers are mainly driven by switched left-handers. They report significantly less conscientiousness, extraversion, agreeableness, and more neuroticism. This is in line with the psychological literature documenting that switched left-handers often are introverted and tend to disagree with others (Sattler, 1996).

- Table 4 about here -

4.3 Channel analysis

I now set out to understand which of the channels considered in the previous section are responsible for the observed differences in labor market outcomes. To do this, I, step-by-step, include the channel variables which showed a significantly difference for either switched or non-switched left-handers to right-handers.[14] Thus, the regression model becomes

$$y_{it} = \alpha_L \, \textit{left-hander}_i + \beta \, X_i + \tau \, M_i + \epsilon_{it} \tag{4.3}$$

[14] I do not include Math grades as a channel, as the number of observations for this outcome is very low.

to investigate how the differences between left- and right-handers, but becomes

$$y_{it} = \alpha_N \, \textit{non-switched left-hander}_i + \alpha_S \, \textit{switched left-hander}_i + \beta \, X_i + \tau \, M_i + \delta_{it} \tag{4.4}$$

to investigate how the differences between switched and non-switched left-handers and right-handers change after inclusion of channel, or mediating, variables M.

To interpret the coefficients τ as causal would require that the sequential ignorability assumption holds (Imai et al., 2010): Conditional on values of some treatment T and pre-treatment covariables X the mediating variables M have to be independent of potential outcomes $Y(t,m)$.[15] Given that the mediating variables appeared as outcome variables in the previous section, this assumption is unlikely to hold here. Therefore, I do not attempt to conduct a fully elaborate mediation analysis, but provide a mere descriptive analysis on the role of schooling and skills for the observed differences in labor market performance by left-handedness and switching status.

Note that not all channel variables are observed for all individuals from Table 2. As a consequence, the sample size is reduced by about 20%, which raises worries about sample selection. However, I show that my baseline results still hold in the most restricted sample and in samples for which only one group of channel

[15]For completeness, the sequential ignorability assumption by Imai et al. (2010) also requires that T is independent of potential outcomes given X, which corresponds to a selection-on-observables assumption.

variables is observed.[16]

I start with log-hourly wages. Column one in Table 5 repeats column two of Table 2 in the sample where all mediator variables are observed. Similarly to the full sample, I find that non-switched left-handers earn 10% lower wages than right-handers, while the difference for switched left-handers is an insignificant -5%. Including years of education as mediator in column two leads both coefficients to become equal in size, -6%. Including only the Big Five personality traits (column three) instead of education leads to rather little change in the wage gaps, and so does adding only the external locus of control (column four). Inclusion of either set of channels reduces the wage gap of non-switched left-handers to 8%. Including all mediators in column five leads to the same result, qualitatively, as in column two: both switched and non-switched left-handers experience nearly the same wage gap of 5% to 6%. The overall difference between all left- and right-handers (upper panel) of -6% changes remarkably little throughout this exercise, while the overall R-squared increases from 0.171 to 0.281.

To check whether these results are driven by sample selection, I repeat the analysis for samples where either only years of education or only personality traits, or both, are non-missing in Appendix Table D.3.[17] I find that the main conclu-

[16]Furthermore, in an unreported logit regression, I find that, conditional on being in the baseline samples of Table 2, the probability of being included in the corresponding restricted sample does not differ significantly between right-handers, switched and non-switched left-handers after controlling for cohort effects.

[17]The external locus of control is not considered because it leads to the largest loss in

sions from Table 5 still hold: taking into account human capital, the wage gaps for switched and non-switched left-handers to right-handers become much more similar. These wage gaps do not react to the inclusion of personality traits.

- Table 5 about here -

The results for employment status are provided in Table 6. Comparable to the baseline results in Table 2, I find that non-switched left-handers are 4% less likely to be employed than right-handers. This gap becomes an insignificant 3% after controlling for years of education (columns two and five). Similarly to wages, non-cognitive skills do not matter as much as human capital.

- Table 6 about here -

4.4 Robustness checks

I start with robustness checks for table 2. Robustness checks with respect to the set of control variables and samples for wages are provided in Appendix Table D.4. Without any controls (column one), there are no significant differences between left- and right-handers. This is due to the variation of left-handedness in certain demographic groups, as discussed in Appendix A. Controlling for these basic characteristics (gender, migration status, East German) in column two, I find a wage gap of 6%. Further controlling for the remaining co-variables leads to

sample size.

a slight increase to 7% in column five, which is equal to column two of Table 2. This finding is reassuring, as it demonstrates the randomness of left-handedness within certain demographic groups. In particular, including cohort fixed effects and parental education changes the coefficient only marginally while raising the overall R-squared substantially, from 9.7% (column two) to 14.7% (column four). To address the issue of endogenous reporting behavior among individuals born before 1950, I restrict the sample to observations born in 1950 or later, but include all control variables (column five). The wage gaps remain unchanged. Excluding individuals with some migration background, who are less likely to report left-handedness than natives, leads to an even larger wage gap of roughly 8% (column six). On the other hand, excluding East Germans, who are also less likely to report left-handedness, leaves the baseline results unchanged (column seven).

Throughout all specifications and in all sub-samples, non-switched left-handers earn significantly lower wages than right-handers, while switched left-handers do not earn significantly less. Columns two to four show that basic demographic characteristics and cohort effects are the most important confounders for the switching status. Parental background again matters little. In the sample of natives (column six), the wage deficit for non-switched left-handers is even larger, at 14%.

The same robustness checks for employment status are provided in Appendix Table D.5. I find that the coefficients are very stable throughout this exercise, even more than they are for wages. However, the control variables are also less powerful in explaining variation in employment status than in wages.

Since human capital was found to be the main mediating factor between switching status and wages, I also conducted robustness checks for years of education in Appendix Table D.6. After including basic demographics, all coefficients become stable to the inclusion of further controls. It is noteworthy that including parental education nearly quadruples the adjusted R-squared, from 6.4% to 24.8%, but the coefficient for non-switched left-handers remains virtually unchanged (columns three to four). When excluding individuals born before 1950, I find a significantly positive difference of switched left-handers to right-handers (column five). One explanation could be that the "missing" left-handers in the older cohorts are actually switched left-handers who report right-handedness.

Finally, I investigate the sensitivity of my results with respect to the definition of being left-handed and switched. My preferred measure categorizes individuals as being left-handed (switched) if they ever report being a natural left-hander (ever report a difference between the innate hand and the writing hand) in any survey wave. As alternatives, I can assign an individual to the left-handed (switched) group if she reports left-handedness (a difference between innate and writing hand) at least half the time or every time when asked about her natural handedness and writing hand. I thus created two additional indicators, left-handed (50%) for the former and left-handed (100%) for the latter case, and analogous indicators for switching. Under the first (second) alternative definition, 7.6% (5.6%) of respondents in the full sample are left-handed, of which 52.2% (44.2%) are switched. Appendix Table D.7 contains these robustness checks. Compared with my baseline results from Table 2, the alternative definitions of my key variables make virtually no difference for labor market outcomes. The coefficients for employment status (columns one and two) are virtually unchanged and wage gaps between left- and right-handers and between non-switched left-handers and right-handers are even more pronounced (columns three and four). However, differences in human capital (columns five to eight) are lower than under my preferred assignment rule and less statistically significant. One possible explanation for this finding is positive selection bias. Left-handers, in particular those who were not switched, are more likely to report left-handedness every time they are asked if they had less experience of discrimination, e.g., in school which would also lead to lower years of education.

5 Identification

The analysis so far has been limited to comparing conditional means between endogenous groups defined by handedness and switching status; this precludes claims about causality. As discussed above, one worry is positive selection bias of switched left-handers due to unobserved parental characteristics, and another is reverse causality from endowed skills which increase the likelihood of a successful switching. As motivated from my theoretical model of parental investment in Appendix B, variation in the prevalence of the switching practice across cohorts can aid in developing an identification strategy.

Right-handers were never switched. At the same time, the share of switched individuals among left-handers decreased rapidly across cohorts, see Figure 1. Thus, the differences in the prevalence of switching across natural handedness and cohorts can serve as an instrument for switching, with a potentially strong first-stage relationship.

I formalize this idea of a difference-in-difference approach in the following two-equation model:

$$Y_{it} = \alpha\, switching_i + \gamma_1 left - hander_i + \theta_1\, \phi(t_i) + \beta_1\, X_i + \epsilon_{it} \tag{5.1}$$

$$switching_{it} = \delta\, \phi(t_i) \times left - hander_i + \gamma_0 left - hander_i + \theta_0\, \phi(t_i) + \beta_0\, X_{it} + \nu_{it}, \tag{5.2}$$

where α is the treatment effect of interest, X_i are control variables, and $\phi(t_i)$ is a function of the cohort trend, e.g., a linear or quadratic trend. The dummy $switching_i$ denotes switched individuals, $left - hander_i$ denotes reported left-handedness, and ϵ_{it} and ν_{it} are two correlated error terms. The set of control variables X_i is the same as in the previous section. The interaction of the cohort trend with left-handedness, $\phi(t_i) \times left-hander_i$, is the excluded instrumental variable. In what follows, I use a quadratic cohort trend, hence $\phi(t_i) = \nu_1 \, t_i + \nu_2 \, t_i^2$.

The identifying assumption in this approach is that cohort trends of the outcome variable for left- and right-handers would have developed in parallel in the absence of switching. Switching has to be the only reason for differing cohort trends for left- and right-handers.

I am not aware of any institutional change in schooling practices which applied only to left-handers. However, if trends would have changed for other reasons, I would falsely attribute this change to switching. For example, stigmatization and prejudices against left-handers in society may decline in general, leading left-handers to catch up over time. Decline of the pathological left-hander due to improvements in perinatal medical care over time could also be a confounding trend.

The prevalence of switching might thus only serve as an indicator for a positive development of attitudes towards left-handedness and liberal schooling practices. Violation of the exclusion restriction would lead to a downward bias of the IV estimate.[18] Since the OLS estimate is likely to be upward biased, OLS and IV estimates could serve as upper and respectively lower bounds on the true causal

[18]To see this, note that the reduced form coefficient, the difference in cohort trends between left- and righthanders, will be positive if e.g. stigmatization in school decreases over time. The first stage coefficient is negative as switching decreases over time. Thus, the IV estimate will be downward biased.

effect (Nevo and Rosen, 2012).

Table 7 shows estimates of α and γ_1 using OLS and 2SLS regressions for labor market outcomes. Note that the difference in the OLS coefficients between Tables 2 and 7 comes from the fact that all switched individuals are also left-handed. It follows that the coefficient on left-handedness in Table 7 corresponds to the non-switched left-hander coefficient in Table 2. I find that the OLS and 2SLS coefficients are very similar for both outcome variables. While the standard errors are higher from the 2SLS estimation, these results suggest only minor problems of selection bias for labor market outcomes. As expected, the first stage F-statistics are quite large, with a value of around 120.

Appendix Tables D.8 and D.9 contain robustness checks for the 2SLS estimation similar to those in section 4, for employment and wages respectively. Across all specifications, I again find that the effect of left-handedness is negative on both outcomes, while the effect of switching is positive. For employment, the effect size of switching is similar to that of left-handedness, while it is slightly smaller for log-wages as in table 7. However, despite large first stage F-statistics, the coefficient for switching is imprecisely estimated and never significant at conventional levels.

- Table 7 about here -

6 Conclusion

Recent research documents that left-handers have lower cognitive skills than right-handers, are more likely to have behavioral and learning problems as children, and perform worse on the labor market. These differences are likely to be of a pathological origin (Goodman, 2014). Does an early childhood intervention compensate or engrave such deficits?

I find evidence for the former hypothesis. In contrast to non-switched left-handers, those left-handers that write with their right hand today do not show lower measures of human capital than right-handers. If anything, I find that they perform slightly better. Labor market outcomes show a similar pattern: non-switched left-handers earn about 10% to 11% lower wages than right-handers and are less likely to be employed. There exist no statistically significant differences between those forced to switch and right-handers.

One explanation for this observation could be that switching the writing hand is a signal of conformism and ability, one that can be observed by teachers who would prohibit students' progression to higher tracking schools in the absence of this signal. Another explanation could be that these children receive additional attention and care by their teachers and parents. A successful switching of the writing hand may also induce a feeling of success and motivate children to improve their skills further in the future.

My findings are robust to applying different sets of control variables, excluding specific sub-samples and to the definition of left-handedness and switching. Furthermore, I use the cohort trends of right-handers as a counter-factual for the cohort trends of left-handers in a difference-in-difference approach. The interaction of left-handedness and cohort trends delivers a strong first stage as switching declines rapidly across time and was never performed on right-handers. My identification strategy requires that the cohort trends of labor market variables would have evolved in parallel between left- and right-handers. I argue that if they did not, IV estimates will deliver a lower bound on the true effect, while OLS estimates deliver an upper bound due to positive selection into switching. However, I find that the IV point-estimates are close to those using OLS, suggesting that selection bias is of minor concern.

I also document differences in the Big Five personality traits and external locus of control by handedness and switching status. However, these are not primarily responsible for the observed wage gaps. No significant differences were found for two measures of cognitive skills, which somewhat stands in contrast to the existing literature that reported left-right-hander differences among children (Johnston et al., 2009, 2013; Goodman, 2014). Including the intermediate variables step-by-step into the log-wage regression reveals that labor market gaps are driven by human capital accumulation.

My findings point to the importance and long run persistence of early infant endowments and the compensatory function of early childhood interventions in this population.

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Tables and Figures

Table 1: Descriptive statistics

	All		Left-handers			
	Right	Left	Non-switched	Switched	Total	N
Share in sample:	91.15%	8.85%	43.93%	56.07%		
Employed	0.821	0.812	0.775	0.839	0.820	53,213
	(0.383)	(0.391)	(0.417)	(0.367)	(0.384)	
Log-hourly wage	2.597	2.589	2.532	2.629	2.596	43,514
	(0.639)	(0.661)	(0.668)	(0.653)	(0.641)	
Years of Education	12.350	12.386	12.321	12.425	12.353	11,249
	(2.769)	(2.874)	(2.961)	(2.822)	(2.778)	
Math grade	0.005	-0.053	-0.245	0.078	0.000	7,541
	(1.002)	(0.981)	(1.067)	(0.896)	(1.000)	
German grade	0.006	-0.062	-0.158	0.004	0.000	7,265
	(1.001)	(0.990)	(1.035)	(0.955)	(1.000)	
Higher track	0.608	0.585	0.617	0.566	0.606	9,940
Symbol-Digit Test	-0.005	0.041	0.448	-0.214	0.000	5,033
	(0.993)	(1.061)	(1.021)	(1.006)	(1.000)	
Animal Naming Test	0.007	-0.071	0.027	-0.123	0.000	2,275
	(0.994)	(1.052)	(1.078)	(1.039)	(1.000)	
Openness	-0.003	0.031	0.076	0.001	0.000	11,037
	(1.002)	(0.974)	(0.966)	(0.979)	(1.000)	
Conscientiousness	0.006	-0.059	-0.131	-0.011	0.000	11,032
	(1.000)	(0.997)	(1.051)	(0.958)	(1.000)	
Extraversion	0.007	-0.070	-0.007	-0.112	0.000	11,038
	(0.999)	(1.009)	(0.995)	(1.017)	(1.000)	
Agreeableness	0.005	-0.049	-0.054	-0.045	0.000	11,041
	(1.000)	(0.997)	(1.011)	(0.988)	(1.000)	
Neuroticism	-0.004	0.036	-0.018	0.072	0.000	11,041
	(1.000)	(1.003)	(1.019)	(0.992)	(1.000)	
External locus of control	0.000	-0.000	0.026	-0.015	0.000	8,037
	(1.002)	(0.980)	(0.931)	(1.008)	(1.000)	
Year of birth	1962.2	1962.9	1975.2	1953.2	1962.2	12,757
	(18.949	(18.495)	(14.997)	(14.848)	(18.909)	
Female	0.533	0.477	0.488	0.469	0.528	12,757
East German	0.220	0.192	0.115	0.253	0.218	12,757
Migration background						
None/Native	0.791	0.827	0.788	0.858	0.794	12,757
1st Generation	0.090	0.093	0.123	0.070	0.090	12,757
2nd Generation	0.119	0.080	0.089	0.073	0.116	12,757
Father's education						
None/Basic	0.604	0.614	0.510	0.695	0.605	12,757
Middle	0.170	0.163	0.198	0.136	0.169	12,757
High	0.132	0.139	0.192	0.098	0.133	12,757
Missing	0.094	0.084	0.100	0.071	0.093	12,757
Mother's education						
None/Basic	0.632	0.637	0.524	0.725	0.633	12,757
Middle	0.211	0.205	0.258	0.163	0.210	12,757
High	0.087	0.096	0.147	0.055	0.088	12,757
Missing	0.070	0.063	0.071	0.057	0.069	12,757
Urbanization at age 15						
Large city	0.203	0.206	0.198	0.213	0.204	12,757
Mid-size city	0.168	0.201	0.226	0.182	0.171	12,757
Small town	0.230	0.224	0.258	0.197	0.230	12,757
Rural	0.380	0.352	0.292	0.398	0.377	12,757
Missing	0.019	0.017	0.026	0.009	0.019	12,757
Religious affiliation						
Catholic	0.313	0.321	0.314	0.326	0.313	10,189
Protestant	0.359	0.374	0.415	0.349	0.360	10,189
None	0.274	0.259	0.210	0.289	0.272	10,189
Other	0.055	0.046	0.061	0.037	0.054	10,189

Table displays means and standard deviations of non-binary variables in parenthesis below. Left-handed equals one if a respondent in the German SOEP reports at least once to be a natural left-hander during grip strength measurements performed in 2006, 2008, 2010, 2012 and 2014. Switched equals one if respondent reports at least once a difference between her natural and writing in the same year. All switched individuals are left-handers. Sample restricted to cohorts born between 1920 and 1997. SDT is the sum of correct entries in the symbol digit task within 90 seconds. ANT (90s) refers to the sum of uniquely named animals in the animal naming task within 90 seconds. SDT, ANT, grades, Big Five personality traits, and locus of control are standardized in full sample. Employment status and log(wage) applies for individuals observed at age 25 and 60 between years 2004 to 2013.

Table 2: Baseline results for labor market outcomes

Outcome:	(i) Employed	(ii) Log(Wage)
Pool left-handers:		
Left-handed	-0.023*	-0.069***
	(0.012)	(0.022)
Split up left-handers		
Switched left-hander	0.005	-0.033
	(0.016)	(0.028)
Non-switched left-hander	-0.057***	-0.115***
	(0.019)	(0.033)
Controls, cohort and age f.e.	yes	yes
N	53,213	43,514
N(cluster)	8,513	7,600
Overall R^2	0.061	0.164

Left-handed equals one if a respondent in the German SOEP reports at least once to be a natural left-hander during grip strength measurements performed in 2006, 2008, 2010, 2012 and 2014. Switched left-hander equals one if the respondent reports at least once a difference between her natural and writing in the same year. The upper panel regresses outcome variables on controls and an indicator for being left-handed. The lower panel differentiates between switched and non-switched left-handers. In both cases, right-handers are the reference group. Table uses a linear random effects model for all outcomes. All regressions control for cohort fixed effects, whether the individual grew up in West or East Germany, gender, migration background (none, 1st generation, 2nd generation), mothers' and fathers' education (low/none, middle, high, missing), and urbanization at age 15 (large city, mid-size city, small town, countryside, missing). Sample restricted to individuals between age 25 and 60. Pools observations between years 2004 to 2014. Standard errors clustered at individual level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Channels: Schooling, Full sample

	(i)	(ii)	(iii)	(iv)
Outcome:	Education	Higher track	Math grade	German grade
Unconditional mean	12.353	0.606	0.000	0.000
Pool left-handers:				
Left-handed	-0.069	-0.031**	-0.036	-0.029
	(0.083)	(0.015)	(0.039)	(0.039)
Adjusted R^2	0.251	0.252	0.033	0.113
Differentiate between switched and non-switched left-handers:				
Switched left-hander	0.091	-0.004	0.047	-0.008
	(0.101)	(0.019)	(0.046)	(0.048)
Non-switched left-hander	-0.339**	-0.076***	-0.159**	-0.062
	(0.141)	(0.025)	(0.067)	(0.063)
Controls	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes
N	11,249	9,940	7,541	7,265
Adjusted R^2	0.252	0.252	0.034	0.113

The upper panel regresses outcome variables on controls and an indicator for being left-handed. The lower panel differentiates between switched and non-switched left-handers. In both cases, right-handers are the reference group. Table uses linear regression for all outcomes. All regressions control for cohort fixed effects, whether the individual grew up in West or East Germany, gender, migration background (none, 1st generation, 2nd generation), mothers' and fathers' education (low/none, middle, high, missing), and urbanization at age 15 (large city, mid-size city, small town, countryside, missing). Sample restricted to cohorts born between 1920 and 1997. Years of education includes only individuals of age greater or equal to 25 at time of observation in survey. Higher track is a dummy variable equaling one if completed schooling track is higher than the lowest (*Hauptschule*). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Channels: Cognitive and non-cognitive skills, Full sample

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
	Cognitive skills		Non-cognitive skills					
	SDT	ANT	Openness	Conscient-iousness	Extra-version	Agreeable-ness	Neuro-ticism	Locus of control
Unconditional mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pool left-handers:								
Left-handed	-0.017	-0.073	0.013	-0.068**	-0.072**	-0.026	0.078**	0.024
	(0.042)	(0.073)	(0.032)	(0.033)	(0.034)	(0.033)	(0.033)	(0.038)
Adjusted R^2	0.306	0.114	0.049	0.027	0.026	0.040	0.058	0.047
Differentiate between switched and non-switched left-handers:								
Switched left-hander	-0.023	-0.087	0.015	-0.070*	-0.088**	-0.042	0.081*	-0.023
	(0.053)	(0.090)	(0.041)	(0.041)	(0.043)	(0.042)	(0.042)	(0.048)
Non-switched left-hander	-0.006	-0.045	0.010	-0.065	-0.046	-0.000	0.072	0.104*
	(0.066)	(0.122)	(0.049)	(0.054)	(0.052)	(0.053)	(0.052)	(0.059)
Controls	yes	yes	yes	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
N	5,033	2,275	11,037	11,032	11,038	11,041	11,041	8,037
Adjusted R^2	0.306	0.113	0.049	0.027	0.026	0.040	0.058	0.048

See the notes of Table 2 for table description and the list of control variables. SDT refers to the sum of correct entries within 90 seconds in the symbol-digit test. ANT refers to the sum of uniquely named animals within 90 seconds in the animal naming test. Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism comprise the Big Five personality traits. See text for further details. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Log(wage) including channels (Random Effects model)

	(i)	(ii)	(iii)	(iv)	(v)
Outcome:			Log(Wage)		
Pool left-handers:					
Left-handed	-0.065**	-0.063***	-0.062**	-0.059**	-0.060**
	(0.026)	(0.024)	(0.026)	(0.025)	(0.024)
Overall R^2	0.171	0.262	0.177	0.203	0.281
Differentiate between switched and non-switched left-handers:					
Switched left-hander	-0.046	-0.063**	-0.044	-0.045	-0.064**
	(0.033)	(0.031)	(0.033)	(0.033)	(0.031)
Non-switched left-hander	-0.096**	-0.063*	-0.091**	-0.080**	-0.053
	(0.039)	(0.036)	(0.038)	(0.038)	(0.035)
Years of education		0.080***			0.075***
		(0.003)			(0.003)
Openness			0.020**		-0.012
			(0.009)		(0.008)
Conscientiousness			0.007		0.017**
			(0.009)		(0.008)
Extraversion			-0.008		0.006
			(0.009)		(0.008)
Agreeableness			-0.018**		-0.029***
			(0.008)		(0.007)
Neuroticism			-0.051***		-0.013*
			(0.008)		(0.007)
External locus of control				-0.125***	-0.090***
				(0.008)	(0.007)
Controls	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes
Age fixed effects	yes	yes	yes	yes	yes
N	34,836	34,836	34,836	34,836	34,836
N(cluster)	4,918	4,918	4,918	4,918	4,918
Overall R^2	0.171	0.262	0.177	0.203	0.281

See the notes of Table 2 for table description and the list of control variables. Coefficients of channel variables are not shown in the upper panel. Table uses a linear random effects model. Sample restricted to individuals between age 25 and 60, with positive wages, and with non-missing values for years of education, Big Five personality traits, and external locus of control. Pools observations between years 2004 to 2014. See text for further details. Standard errors clustered at individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Employment status including channels (Random Effects model)

	(i)	(ii)	(iii)	(iv)	(v)
Outcome:			Employed		
Pool left-handers:					
Left-handed	-0.005	-0.003	-0.001	-0.003	-0.000
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Overall R^2	0.059	0.073	0.073	0.071	0.093
Differentiate between switched and non-switched left-handers:					
Switched left-hander	0.020	0.016	0.022	0.019	0.017
	(0.018)	(0.017)	(0.018)	(0.018)	(0.017)
Non-switched left-hander	-0.043*	-0.034	-0.037*	-0.038*	-0.027
	(0.023)	(0.022)	(0.022)	(0.023)	(0.022)
Years of education		0.019***			0.017***
		(0.002)			(0.002)
Openness			0.000		-0.007
			(0.005)		(0.005)
Conscientiousness			0.040***		0.039***
			(0.005)		(0.005)
Extraversion			0.006		0.008*
			(0.005)		(0.005)
Agreeableness			-0.013***		-0.015***
			(0.004)		(0.004)
Neuroticism			-0.023***		-0.012***
			(0.004)		(0.005)
External locus				-0.044***	-0.030***
of control				(0.004)	(0.005)
Controls	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes
Age fixed effects	yes	yes	yes	yes	yes
N	41,876	41,876	41,876	41,876	41,876
N(cluster)	5,430	5,430	5,430	5,430	5,430
Overall R^2	0.060	0.073	0.074	0.071	0.093

See the notes of Table 2 for table description and the list of control variables. Coefficients of channel variables are not shown in the upper panel. Table uses random effects regression. Sample restricted to individuals between age 25 and 60, and with non-missing values for years of education, Big Five personality traits, and external locus of control. Pools observations between years 2004 to 2014 Standard errors clustered at individual level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 7: OLS and 2SLS estimates for labor market outcomes

	(i)	(ii)	(iii)	(iv)
	Employed		Log(Wage)	
	OLS	2SLS	OLS	2SLS
Unconditional mean	0.820	0.820	2.596	2.596
Left-handed	-0.049***	-0.050*	-0.096***	-0.101**
	(0.019)	(0.029)	(0.032)	(0.048)
Switched	0.054**	0.055	0.063	0.072
	(0.024)	(0.052)	(0.043)	(0.084)
Controls	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes
Age fixed effects	yes	yes	yes	yes
N	53,213	53,213	43,514	43,514
N(cluster)	8,513	8,513	7,600	7,600
Adjusted R^2	0.061	0.061	0.164	0.164
First stage F-stat		121.33		119.91

See table 2 for control variables and variable definition. The dummy variable switched is instrumented by the interactions of an indicator for being left-handed and a linear and quadratic cohort trend (two instruments). The first stage is visualized in the lower graph of Figure 1. Right-handers were never switched. In effect, cohort trends of right-handers serve as counterfactual. Standard errors clustered at individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

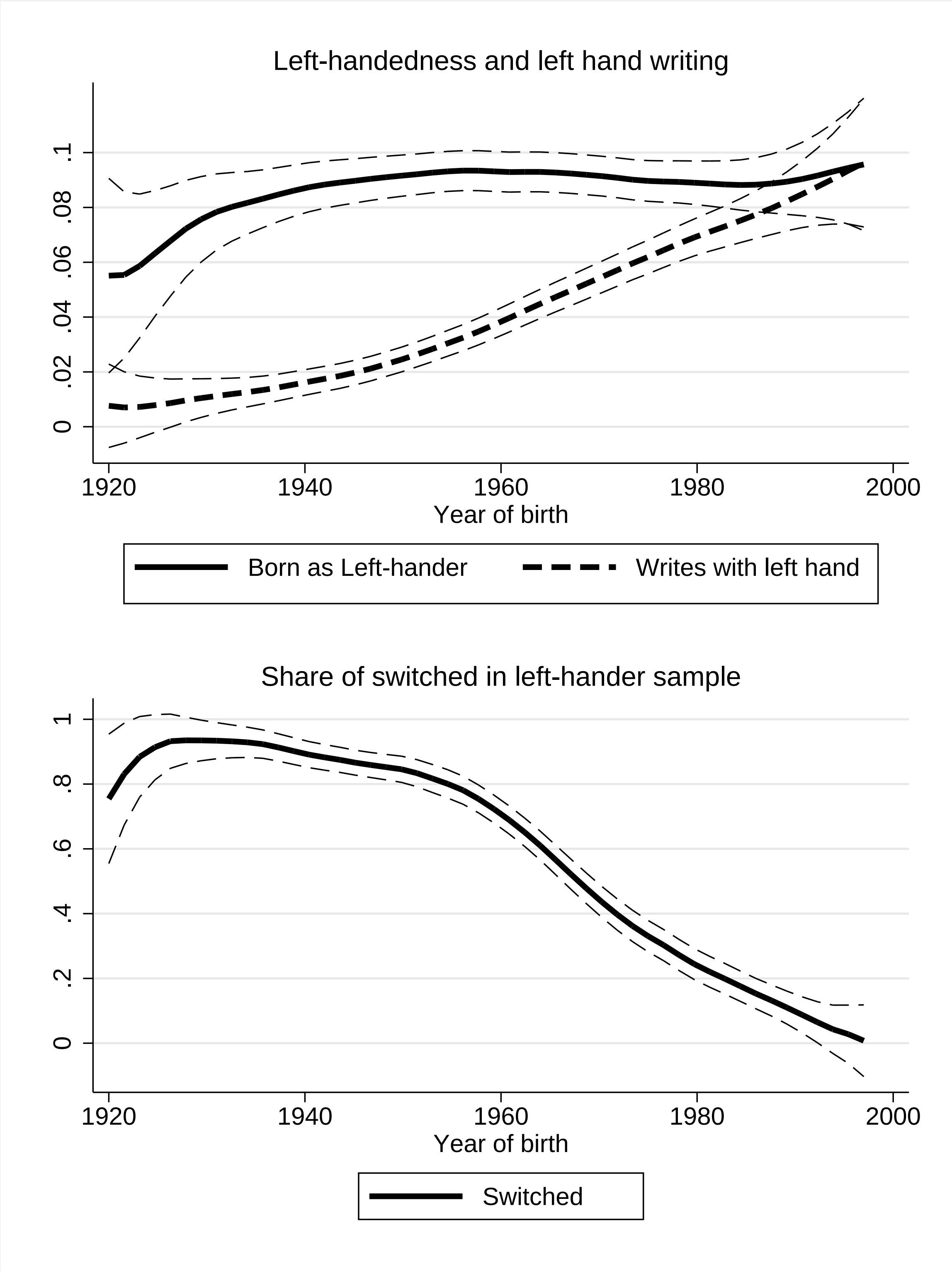

Figure 1: Upper panel: Share of respondents who report innate left-handedness and write with their left hand by year of birth. Lower panel: Share of switched (if left-handed) by year of birth. Includes 95% confidence intervals.

Online Appendix A: Reporting left-handedness

Although left-handedness is nearly random in the population (Johnston et al., 2009), self-reporting it is not. As mentioned in Section 3, the previous literature has used more and more sensitive measures to construct the variables for handedness than I are able to use. This section thus sets out to investigate which characteristics predict reported left-handedness and are thus important to avoid bias from measurement error. One additional predictor that I use is country of birth[19].

Cohort fixed effects are included in all regressions. Column one of Table A.1 demonstrates that females, East Germans, and migrants are significantly less likely to report left-handedness. Interestingly, 2nd generation migrants are not significantly less likely to report left-handedness, although about 50% report having at least one parent born in an Eastern European or Middle Eastern country.

- Table A.1 about here -

[19]Germany, Middle East (incl. central Asia), Eastern Europe (incl. Russia), Northern Europe, Southern Europe (Portugal, Greece, Italy, Spain), and other (incl. Africa and Asia). The Middle East includes Turkey, Iran, Syria, Afghanistan, Tunisia, Iraq, Morocco, Kazakhstan, Lebanon, Kirghiztan, Egypt, Tajikistan, Uzbekistan, Azerbaijan, Yemen, Palestine, and Turkmenistan. Eastern Europe includes former Yugoslavia, Romania, Poland, Hungary, Bulgaria, Czech, Russia, Albania, Ukraine, Estonia, Lithuania, Latvia, Croatia, Bosnia, Macedonia, Slovenia, Slovakia, Belarus, Kosovo, Georgia, Serbia, and other Eastern Europe countries. Northern Europe includes Austria, France, Denmark, the UK, Sweden, Norway, Finland, Switzerland, Ireland, Luxemburg, Belgium, and the Netherlands. Other includes all other countries, mainly the USA and Asian and African countries.

The fact that females are less likely to report left-handedness than males is well-known in the laterality literature (Harris, 1990). The explanations for this phenomenon range from a higher natural predisposition for males, females' increased ability to switch handedness, and stronger social pressure on females to align with norms (Porac et al., 1986; Papadatou-Pastou et al., 2008). Investigating this finding further, Figure A.1 repeats Figure 1, but splits the sample up by gender. The upper graph in Figure A.1 exhibits the level difference between males and females, and it appears that the share of left-handed females actually decreases after the 1960 cohort. However, there exists no significant upward trend among males. Linear or quadratic cohort trends in a logit regression for left-handedness among individuals born after 1930 are not significant at any conventional level. However, the interaction with gender is negative and significant (p-value 0.054).

- Figure A.1 about here -

Although migration decisions are highly endogenous, and might be directly related to left-handedness, I also investigate the heterogeneity of left-hander rates by country of birth (this only applies to 1st generation migrants) in column two. The lower rates among individuals from Middle Eastern and Southern European countries can be explained by religious norms. In Islam, the left hand is the unclean hand, not to be used in human interaction or eating. The Southern European countries are predominantly Catholic (Spain, Italy, Portugal) or Orthodox and considered to be more religious than Northern European countries (Hank and Schaan, 2008). At the same time, the left hand or left side has negative associations in Christianity. Obviously, these cross-country differences are subject to a highly endogenous migration decision, in which left-handedness may play a role. However, the observed cross-country pattern here has been reported in previous studies (Perelle and Ehrman, 1994; Medland et al., 2004). I find no significant differences in left-hander rates between Germans and migrants from its Northern European neighbors, the majority of which come from Austria, France, the United Kingdom, or the Netherlands. Whether there exist differences in religious affiliation is investigated in column three, which excludes migrants.

No significant difference in reported left-handedness exist between Catholics, Protestants, or non-denominational, among German natives (column three). In columns one to three of Table A.1, parental education is never a significant predictor of left-handedness and neither is urbanization at age 15. Excluding East Germans in column four does not change any of the previous findings.

If stigmatization against left-handers has been changing over time, it could be the case that certain characteristics predict reported left-handedness in different cohorts. For example, more progressive parents may be more tolerant towards a left-handed child, even when there is discrimination in society as a whole. To investigate this, I split up the sample into four cohort groups of roughly equal size. The first cohort group covers individuals born between 1920 and 1949. These cohorts are most likely to be subject to survival bias, as they lived through World War Two (see Kesternich et al., 2014). Underreporting of left-handedness, as suggested in Figure 1, is also most likely to occur in this group. The next three groups comprise respondents born between 1950 and 1960, 1961 and 1970, and 1971 and 1997. However, the overall share of left-handers in all four groups does not differ significantly. Among the left-handed, the share of switched individuals decreases from roughly 91% in the first group, to 83% in the second, 51% in the third, and only 16% in the fourth. Although the enforcement of the right hand writing norm diminishes, the association between parental education and reported left-handedness remains very low, even in the first cohort group. Dummies for parental education are never jointly significant in any sample. The same holds for degree of urbanization. Inclusion of either only maternal or only parental education, and exclusion of urbanization dummies, does not change these findings. This is important, as it suggests there were no significant compositional changes of left-handers with respect to these covariates over time.

The level difference between East and West in the full sample is driven by cohorts born after 1960. The Berlin Wall was built in 1961 and brought a new wave of oppression. As dissidents could no longer simply leave the country, the regime aimed to stigmatize non-conformists to the socialist ideology, starting early in school. Thus, the liberal movement of the 1960s was much less developed in East Germany than in West Germany (Ohse, 2010).

To summarize, I find that left-handedness is only poorly predicted by my covariates, as indicated by the adjusted R^2s of less than 1%. A low correlation of handedness with family background characteristics has been observed by Johnston et al. (2009) in a sample of Australian children and with a broader range of variables. They find no differences between left- and right-handers with respect to either maternal or paternal income, labor force participation, or education. Left-handedness is so nearly random that some studies have employed it as an instrumental variable for the cognitive skills of children (Frijters et al., 2009, 2013).

Furthermore, Goodman (2014) found that perinatal health and maternal handedness are important predictors of left-handedness, while maternal education is not. While I can confirm the latter, my data contain no measure for infant health, such as birth weight. However, I have information on parental handedness for some individuals, because their parents reside in the same household and participated in the grip strength measurement. This sample comprises 1,646 relatively young individuals, who were on average 26 years old at the time of the survey. I find that having a left-handed mother nearly doubles the chance of being left-handed (15.32% vs. 8.48%, p-value 0.007), while the father's handedness is statistically unrelated to own-handedness (9.08% vs. 8.75%, p-value 0.888). These results are robust to controlling for the parent's year of birth and education. Either a left-handed gene is inherited only via the mother, or, more plausibly, children are more keen to use the left hand if they observe their mother doing so, as suggested by Goodman (2014).

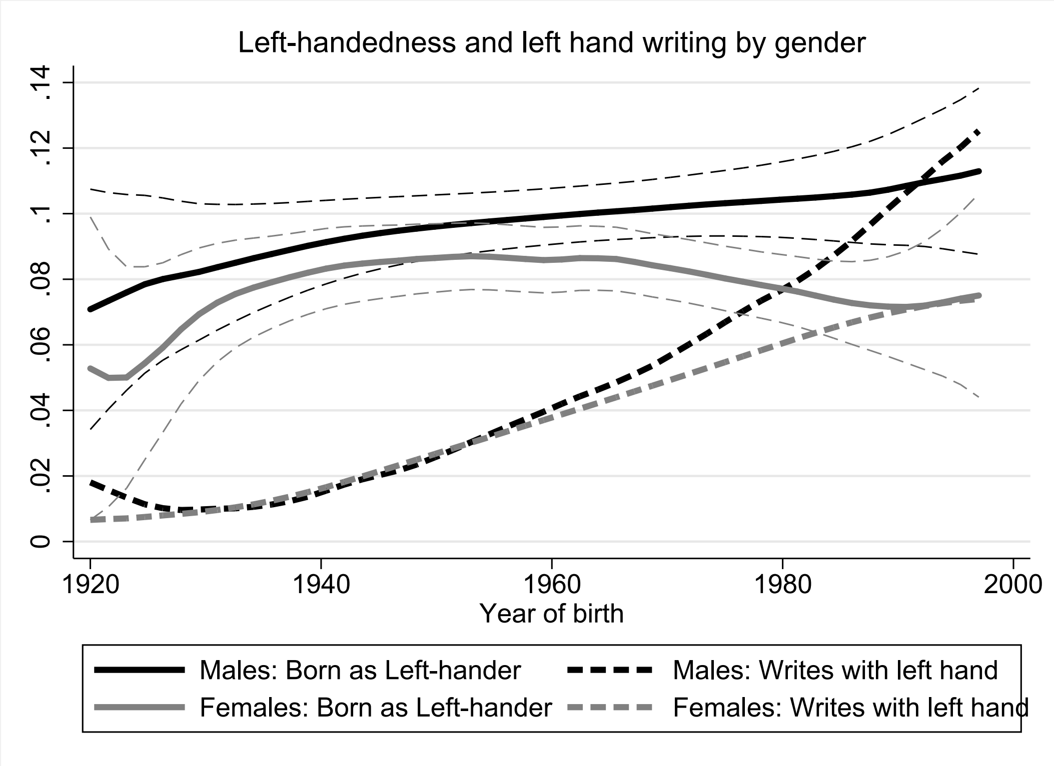

Figure A.1: Includes 95% confidence intervals.

Table A.1: Regressions on left-handedness

	Linear regression for left-handedness							
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Sample restrictions:			Non-migrants only	Exclude East Germans	By cohort 1920-1949	1950-1960	1961-1970	1971-1997
Share of left-handers:	8.95%	8.95%	9.49%	9.21%	8.47%	9.12%	9.45%	8.72%
Female	-0.018***	-0.018***	-0.020***	-0.019***	-0.002	-0.016	-0.016	-0.035***
	(0.005)	(0.005)	(0.007)	(0.006)	(0.011)	(0.011)	(0.011)	(0.010)
East German	-0.016**	-0.015**	-0.010		0.004	-0.006	-0.025*	-0.042***
	(0.007)	(0.007)	(0.009)		(0.013)	(0.014)	(0.014)	(0.014)
Mothers education								
Basic/none	(ref.)							
Middle/other	-0.004	-0.004	-0.005	0.003	0.037	-0.040**	0.014	-0.004
	(0.008)	(0.008)	(0.011)	(0.009)	(0.023)	(0.019)	(0.016)	(0.013)
High	0.007	0.008	0.001	0.012	-0.001	-0.028	0.001	0.022
	(0.012)	(0.012)	(0.015)	(0.013)	(0.034)	(0.026)	(0.024)	(0.018)
Fathers education								
Basic/none	(ref.)							
Middle/other	-0.006	-0.006	-0.003	-0.001	-0.009	0.026	-0.021	-0.005
	(0.008)	(0.008)	(0.011)	(0.010)	(0.022)	(0.022)	(0.016)	(0.013)
High	-0.005	-0.007	-0.003	-0.002	-0.009	0.014	-0.015	-0.011
	(0.009)	(0.009)	(0.012)	(0.011)	(0.023)	(0.021)	(0.019)	(0.016)
Urbanization at age 15								
Large city	(ref.)							
Mid-size city	0.012	0.012	0.012	0.015	0.018	-0.006	0.019	0.012
	(0.009)	(0.009)	(0.012)	(0.010)	(0.020)	(0.019)	(0.019)	(0.017)
Small town	-0.006	-0.006	-0.012	-0.002	0.004	-0.019	-0.014	0.002
	(0.008)	(0.008)	(0.010)	(0.009)	(0.017)	(0.018)	(0.017)	(0.016)
Countryside	-0.011	-0.011	-0.007	-0.008	0.001	-0.007	-0.022	-0.018
	(0.008)	(0.008)	(0.010)	(0.008)	(0.014)	(0.016)	(0.015)	(0.015)
Migration background								
none	(ref.)							
direct	-0.036***			-0.036***	-0.024	-0.030*	-0.038**	-0.052***
	(0.008)			(0.008)	(0.018)	(0.017)	(0.015)	(0.015)
indirect	-0.008			-0.015	0.019	-0.021	-0.013	-0.019
	(0.010)			(0.011)	(0.025)	(0.022)	(0.022)	(0.015)
Country of origin								
Germany		(ref.)						
Middle East		-0.043***						
		(0.013)						
Eastern Europe		-0.036***						
		(0.011)						
Northern Europe		0.020						
		(0.034)						
Southern Europe		-0.067***						
		(0.017)						
Other		-0.024						
		(0.029)						
Religious affiliation								
Catholic			(ref.)					
Protestant			0.006					
			(0.009)					
Denomination free			-0.003					
			(0.010)					
Other			0.019					
			(0.035)					
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
N	11,153	11,133	7,341	8,748	2,588	2,624	2,807	3,134
Adjusted R^2	0.002	0.002	0.002	0.002	0.001	0.003	0.000	0.006

Left-handed is a dummy equal to one if the individual self-reports at least once in any survey wave that he is born as a left-hander. Full sample restricted to cohorts between 1920 and 1997. Middle eastern countries include Central Asian countries. Eastern Europe includes Russia. All regressions include cohort fixed effects. Robust standard errors in in parenthesis below. *** p<0.01, ** p<0.05, * p<0.1.

Online Appendix B: Parental investment decisions

B.1: Theory

This section sets up a simple child investment model based on Becker and Tomes (1994). It incorporates social norms to deliver predictions about the relation between switching and parental characteristics.

Let d be a parental investment (switching). As in Becker and Tomes (1994), the parents' utility at time t depends on their own consumption of a good z_t minus the immediate treatment costs k plus their child's utility u_c. They try to maximize

$$u_t = u(z_t - kd) + \delta\, u_{ch}(y_{t+1}^d), \tag{6.1}$$

with respect to d, where δ is the parents' degree of altruism and y_{t+1}^d is some (discounted) future outcome of the child, such as its human capital. Consider only two points in time, t and $t+1$, and assume all utility functions are concave. I now incorporate the parents' social norms when making investment decisions, as proposed by Cunha and Heckman (2007, 2008). The parents may not know whether y_{t+1}^1 or y_{t+1}^0 is larger, but their expectations $\tilde{y}_{t+1}^d$ are influenced by a social norm $\bar{d}_t$ at t:

$$\tilde{y}_{t+1}^d = y(a_t) - c\,|\bar{d}_t - d|, \tag{6.2}$$

where $y\prime > 0$, c is a penalty term corresponding to the degree of conformity to the norm and a_t is a set of other important factors, such as parental education and resources, institutional policies, and innate ability. This formulation of conformity is borrowed from the model of social distance by Akerlof (1997). It reflects the idea that parents think that non-conformity with the existing norms leads to a possibly life-long penalty for the child due to stigmatization by teachers, peers and employers.[20] Note that I assume here that parents expect the norm to also exist at time $t+1$. The decision whether to switch the child's handedness is based on (6.1), where y^d_{t+1} is replaced with $\tilde{y}^d_{t+1}$. If $\bar{d}_t = 1$, then parents will switch their child if

$$u(z_t - k) + \delta\, u_c(y(a_t)) \geq u(z_t) + \delta\, u_c(y(a_t) - c) \tag{6.3}$$

$$\Leftrightarrow \delta\left(u_c(y(a_t)) - u_c(y(a_t) - c)\right) \geq u(z_t) - u(z_t - k). \tag{6.4}$$

Switching will thus be performed when the present forgone utility of doing it is smaller than the child's future gain, scaled by altruism. Obviously, no switching will take place if parents are selfish ($\delta = 0$), sardistic ($\delta < 0$), non-conformists ($c \leq 0$), or simply do not know that $\bar{d}_t = 1$.

What predictions can be derived from this simple model? As seen from (6.4),

[20] This is similar to Lindbeck and Nyberg (2006), who study the imposition of work norms by parents on their children.

the threshold for switching the child is lower when parents have a high level of consumption, because then the difference $u(z_t) - u(z_t - k)$ is relatively lower for low levels of consumption. Altruism δ in general induces parents to invest in their child's future well-being. Hence, switching is merely one from among a range of measures that parents can undertake to foster their child's capabilities and standing in society. On the other hand, the difference $u_c(y(a_t)) - u_c(y(a_t) - c)$ decreases in endowments a_t. A stronger conformism to norms (expressed in a higher c) could lead to a negative empirical selection mechanism of switched individuals.

Lastly, the parent's switching decision may not be perfectly implementable. Instead, its probability of success depends on the child's already developed cognitive skills and motivation at time t. This concern is confirmed by Sattler (1996), who notes that it is usually the brighter and more motivated children on which switching attempts are successful. Empirically, this would link switching and skills in adulthood through a reverse causality. This step in the switching process is non-negligible. Using a world-wide survey of more than 11,000 individuals, Perelle and Ehrman (1994) find that switching attempts were successful in only 72% of the cases.

In summary, my parental investment decision model gives us some reasons to expect a positive selection of switched left-handers and some reasons to expect a negative. I now investigate these predictions empirically. Since I do not directly observe parental endowment, altruism, or conformism, I resort to parental education (endowment, altruism), degree of urbanization at age 15, and religious affiliation (conformism) as proxies.

B.2: Empirics

Table B.1 shows the results from a linear probability model regression of switching on control variables in the sample of left-handers. Starting with the basic demographic variables in column one, I find that females are 5.5% less likely to be switched. This difference is stable across cohorts, as shown in the upper graph of Figure B.1.

East Germans are 7.5% more likely to be forced to switch their writing hand. Anecdotal evidence suggests that in East Germany, as in other Eastern European ex-communist states, left-handers were suspected of being more creative than right-handers and hence as more likely to be a threat to the ruling regime. This threat was supposed to be eliminated by switching the writing hand Sattler (1996). I illustrate switching trends between West and East Germany in the lower graph of Figure B.1. I find that the level difference between East and West is driven by cohorts born after 1960. The Berlin Wall was built in 1961 and brought a new wave of oppression. As dissidents could no longer simply leave the country, the regime aimed to stigmatize those who did not conform to the socialist ideology, starting early in school. Thus, the liberal movement of the 1960s was much less developed in the East than in the West (Ohse, 2010).

- Table B.1 about here -

High paternal education negatively predicts switching, but the coefficients are not significant. In contrast, higher maternal education is significantly positively associated with switching. This finding relates to one theoretical prediction from Section B.1. Mothers who care more about their offspring's later life outcomes will make investments to improve it and anticipate a bias against left-handers. Alternatively, highly educated mothers may also have higher reputational concerns and like to see their children conform to existing norms.

Both coefficients of migration background are negative, but not significantly so. Column two of Table B.1 excludes migrants from the sample and uses religious affiliation as an alternative explanatory variable. Individuals belonging to the Protestant Evangelical denomination are 7.6% less likely to be switched than Catholics. The dummy for 'other' affiliations (Islam and other Christian denominations) exhibits a large and positive coefficient which is not significant due to a low number of cases. The degree of urbanization at age 15 is never a significant predictor.

- Figure B.1 about here -

In conclusion, the regression analysis shows that gender, being East German, and maternal education are significant predictors of successful switching, confirming some predictions of the theoretical model.

Table B.1: Regressions on switching indicator in left-hander sample

	(i)	(ii)
Sample restrictions:		Non-migrants only
Share of switched:	56.07%	58.14%
Female	-0.044*	-0.033
	(0.024)	(0.030)
East German	0.099***	0.075**
	(0.031)	(0.038)
Mothers education		
Basic/none	(ref.)	
Middle/other	0.077**	0.059
	(0.039)	(0.051)
High	0.103*	0.091
	(0.054)	(0.076)
Missing	-0.035	-0.133
	(0.066)	(0.094)
Fathers education		
Basic/none	(ref.)	
Middle/other	0.025	0.033
	(0.038)	(0.050)
High	-0.064	-0.075
	(0.049)	(0.063)
Missing	-0.017	0.026
	(0.056)	(0.084)
Urbanization at age 15		
Large city	(ref.)	
Mid-size city	-0.011	0.002
	(0.039)	(0.050)
Small town	-0.037	0.047
	(0.037)	(0.046)
Countryside	-0.001	0.027
	(0.035)	(0.043)
Missing	-0.061	0.128
	(0.104)	(0.176)
Migration background		
none	(ref.)	
1st Generation	-0.032	
	(0.037)	
2nd Generation	-0.039	
	(0.052)	
Religious affiliation		
Catholic		(ref.)
Protestant		-0.076**
		(0.035)
Denomination free		-0.011
		(0.046)
Other		0.158
		(0.111)
Missing		-0.077
		(0.047)
Cohort fixed effects	yes	yes
N	1,129	934
Adjusted R^2	0.399	0.401

Switched is an indicator equal to one if an individual self-reports at least once that he is born as a left-hander and writes with the right hand within one interview in any survey year. Sample restricted to cohorts between 1920 and 1997. All regressions include cohort fixed effects. Robust standard errors in in parenthesis below. *** p<0.01, ** p<0.05, * p<0.1.

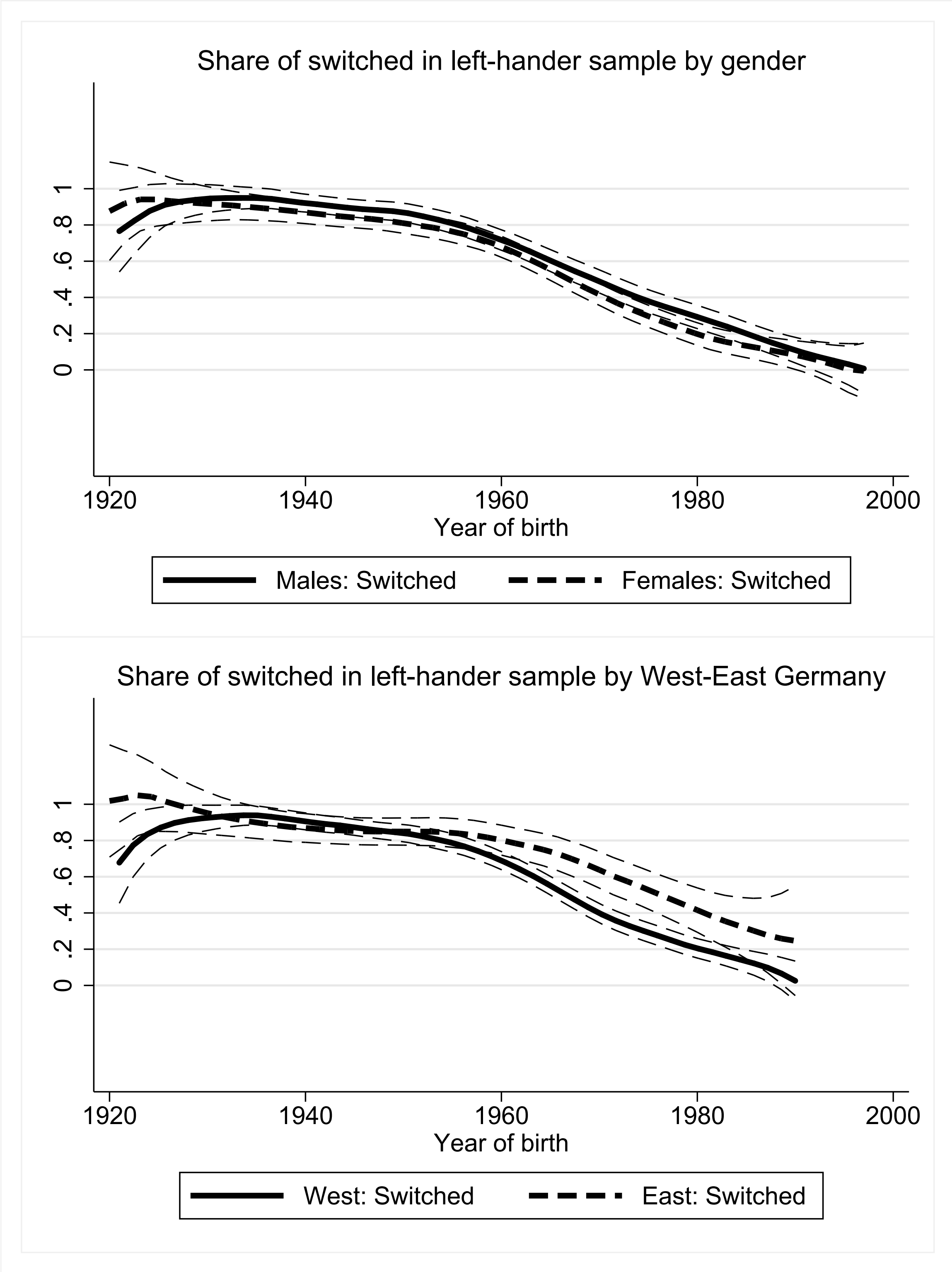

Figure B.1: Upper panel: Share of switched (if left-handed) by gender and year of birth. Lower panel: Share of switched (if left-handed) by East/West Germans and year of birth. Includes 95% confidence intervals.

Online Appendix C: Personality and the Locus of Control

Table D.1 shows the wording of the items that were used to construct the Big Five personality traits and the external locus of control. Respondents could answer on a Likert-type scale ranging from 1 (does not apply at all) to 7 (applies completely). The corresponding answers were averaged and standardized in the analysis sample.

Table D.1: SOEP items used to construct Big Five personality traits and locus of control

Item label	Trait
Big Five: I see myself as someone who...	
is original, comes up with new ideas	Openness to experience
values artistic experiences	Openness to experience
has an active imagination	Openness to experience
does a thorough job	Conscientiousness
does things effectively and efficiently	Conscientiousness
is rather lazy (reversed) [not used]	Conscientiousness
is communicative, talkative	Extraversion
is outgoing, sociable	Extraversion
is reserved (reversed) [not used]	Extraversion
is sometimes somewhat rude to others (reversed)	Agreeableness
has a forgiving nature	Agreeableness
is considerate and kind to others	Agreeableness
worries a lot	Neuroticism
gets nervous easily	Neuroticism
is relaxed, handles stress well (reversed)	Neuroticism
Locus of control	
Compared to other people, I have not achieved what I deserve.	External LOC
What a person achieves in life is above all a question of fate or luck.	External LOC
I frequently have the experience that other people have a controlling influence over my life.	External LOC
The opportunities that I have in life are determined by the social conditions.	External LOC
Inborn abilities are more important than any efforts one can make.	External LOC
I have little control over the things that happen in my life. [not used]	External LOC

Note: Table follows Heineck and Anger (2010)

Appendix D: Additional figures and robustness checks

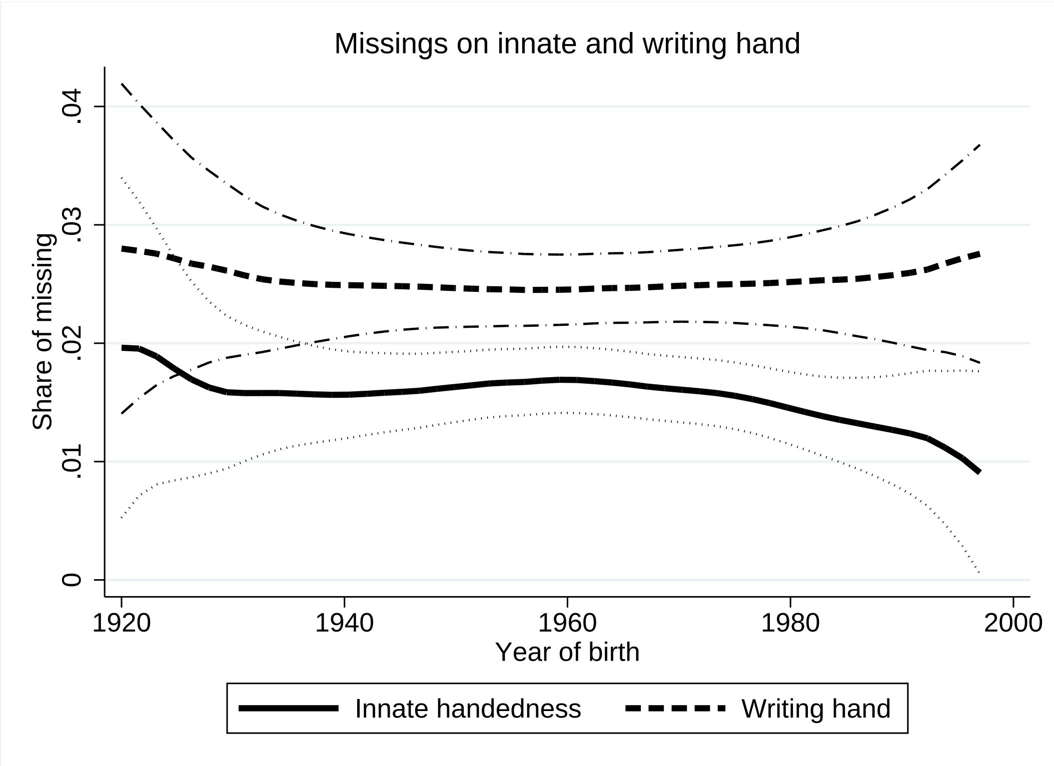

Figure D.1: Share of missing observations on handedness and writing hand by year of birth. Includes 95% confidence intervals.

Table D.1: Channels: Schooling, Wage sample

Outcome:	(i) Education	(ii) Higher track	(iii) Math grade	(iv) German grade
Unconditional mean	12.799	0.723	-0.008	-0.045
Pool left-handers:				
Left-handed	-0.050	-0.023	-0.019	-0.001
	(0.105)	(0.018)	(0.050)	(0.049)
Adjusted R^2	0.227	0.159	0.0287	0.127
Differentiate between switched and non-switched left-handers:				
Switched left-hander	0.205	0.009	0.110*	-0.009
	(0.135)	(0.024)	(0.061)	(0.065)
Non-switched left-hander	-0.372**	-0.062**	-0.170**	0.007
	(0.160)	(0.027)	(0.077)	(0.071)
Controls	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes
N	7,434	6,609	4,940	4,739
Adjusted R^2	0.228	0.159	0.030	0.127

See the notes of Table 2 for table description and the list of control variables, and Table 3 for the definition of the outcome variables. In contrast to the sample in Table 3, the sample in this table is restricted to individuals included in the regression on wages from column two of Table 2. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table D.2: Channels: Cognitive and non-cognitive skills, Wage sample

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
	Cognitive skills		Non-cognitive skills					
	SDT	ANT	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	Locus of control
Unconditional mean	0.238	0.186	0.056	0.092	0.027	-0.032	-0.038	-0.075
Pool left-handers:								
Left-handed	-0.052	-0.034	-0.004	-0.063*	-0.099**	-0.085**	0.083**	0.058
	(0.055)	(0.102)	(0.039)	(0.038)	(0.043)	(0.042)	(0.041)	(0.047)
Adjusted R^2	0.156	0.048	0.034	0.014	0.023	0.028	0.050	0.033
Differentiate between switched and non-switched left-handers:								
Switched left-hander	-0.033	-0.088	-0.048	-0.092*	-0.136**	-0.134**	0.091*	0.010
	(0.071)	(0.127)	(0.052)	(0.049)	(0.057)	(0.055)	(0.053)	(0.062)
Non-switched left-hander	-0.077	0.051	0.055	-0.024	-0.049	-0.018	0.072	0.130*
	(0.084)	(0.161)	(0.056)	(0.059)	(0.062)	(0.065)	(0.063)	(0.068)
Controls	yes	yes	yes	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
N	2,965	1,397	6,596	6,596	6,595	6,597	6,597	5,046
Adjusted R^2	0.156	0.048	0.035	0.014	0.023	0.029	0.050	0.033

See the notes of Table 2 for table description and the list of control variables. See the notes of Table 4 for the definition of the outcome variables. In contrast to the sample in Table 4, the sample in this table is restricted to individuals included in the regression on wages from column two of Table 2. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table D.3: Log(wage) including channels years of education and personality (Random Effects model)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Outcome:				Log(Wage)			
Sample	Education only		Personality only		Education + Personality		
Pool left-handers:							
Left-handed	-0.067***	-0.064***	-0.060***	-0.057**	-0.059**	-0.058***	-0.054**
	(0.022)	(0.021)	(0.023)	(0.023)	(0.024)	(0.022)	(0.022)
Overall R^2	0.164	0.255	0.161	0.167	0.161	0.252	0.256
Differentiate between switched and non-switched left-handers:							
Switched left-hander	-0.037	-0.054**	-0.027	-0.025	-0.032	-0.049*	-0.046*
	(0.029)	(0.027)	(0.030)	(0.030)	(0.030)	(0.028)	(0.028)
Non-switched left-hander	-0.106***	-0.077**	-0.105***	-0.102***	-0.099***	-0.071**	-0.066**
	(0.034)	(0.031)	(0.036)	(0.035)	(0.037)	(0.033)	(0.033)
Years of education		0.079***				0.079***	0.079***
		(0.002)				(0.003)	(0.003)
Openness				0.014*			-0.018**
				(0.008)			(0.007)
Conscientiousness				0.007			0.022***
				(0.008)			(0.007)
Extraversion				-0.008			0.010
				(0.008)			(0.007)
Agreeableness				-0.019***			-0.025***
				(0.007)			(0.007)
Neuroticism				-0.054***			-0.037***
				(0.007)			(0.007)
Controls	yes	yes	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes
Age fixed effects	yes	yes	yes	yes	yes	yes	yes
N	42,974	42,974	40,042	40,042	39,548	39,548	39,548
N(cluster)	7,434	7,434	6,595	6,595	6,448	6,448	6,448
Overall R^2	0.164	0.255	0.161	0.167	0.161	0.252	0.256

See the notes of Table 2 for table description and the list of control variables. Sample restricted to individuals between age 25 and 60, and with positive wages. Pools observations between years 2004 to 2014. Coefficients of channel variables are not shown in the upper panel. In columns one and two the sample is restricted to observations with non-missing years of education. In columns three and four the sample is restricted to observations with non-missing personality traits. The sample in columns five to seven is restricted to observations with non-missing values of both, years of education and personality traits. Table uses random effects regression. Standard errors clustered at individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table D.4: Robustness checks for log-hourly wages (Random Effects model)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Outcome:				Log(Wage)			
Sample		Full			Born $\geq$ 1950	Non-migrants	West-Germans
Pool left-handers:							
Left-handed	-0.017	-0.059***	-0.064***	-0.065***	-0.068***	-0.078***	-0.068***
	(0.024)	(0.023)	(0.022)	(0.022)	(0.022)	(0.024)	(0.024)
Overall R^2	0.000	0.096	0.122	0.147	0.161	0.173	0.154
Differentiate between switched and non-switched left-handers:							
Switched left-hander	0.041	0.017	-0.030	-0.031	-0.027	-0.030	-0.031
	(0.032)	(0.029)	(0.029)	(0.029)	(0.029)	(0.030)	(0.032)
Non-switched left-hander	-0.088**	-0.153***	-0.105***	-0.108***	-0.114***	-0.142***	-0.105***
	(0.035)	(0.034)	(0.034)	(0.033)	(0.033)	(0.038)	(0.034)
Controls:							
Demographics	no	yes	yes	yes	yes	yes	yes
Cohort fixed effects	no	no	yes	yes	yes	yes	yes
Parental education	no	no	no	yes	yes	yes	yes
Age fixed effects	no	no	no	no	yes	yes	yes
Urbanization at 15	no	no	no	no	yes	yes	yes
N	43,514	43,514	43,514	43,514	41,894	35,291	32,971
N(cluster)	7,600	7,600	7,600	7,600	7,104	6,003	5,857
Overall R^2	0.000	0.097	0.122	0.147	0.161	0.174	0.155

Robustness check to regression on log-wages in Table 2. See the notes of Table 2 for table description and the list of control variables. Table uses a linear random effects model. Sample restricted to individuals between age 25 and 60. Pools observations between years 2004 to 2014. Demographic controls are gender, migration background (none, 1st generation, 2nd generation) and an East German dummy. Standard errors clustered at individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table D.5: Robustness checks for employment status (Random Effects model)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Outcome:	Employed						
Sample	Full				Born $\geq$ 1950	Non-migrants	West-Germans
Pool left-handers:							
Left-handed	-0.009	-0.022*	-0.024*	-0.024*	-0.029**	-0.025*	-0.021
	(0.013)	(0.013)	(0.012)	(0.012)	(0.013)	(0.014)	(0.014)
Overall R^2	0.000	0.029	0.053	0.058	0.056	0.050	0.073
Differentiate between switched and non-switched left-handers:							
Switched left-hander	0.024	0.008	0.004	0.003	-0.004	0.001	-0.003
	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.018)	(0.019)
Non-switched left-hander	-0.048**	-0.058***	-0.058***	-0.056***	-0.056***	-0.060***	-0.040**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.021)	(0.019)
Controls:							
Demographics	no	yes	yes	yes	yes	yes	yes
Cohort fixed effects	no	no	yes	yes	yes	yes	yes
Parental education	no	no	no	yes	yes	yes	yes
Age fixed effects	no	no	no	no	yes	yes	yes
Urbanization at 15	no	no	no	no	yes	yes	yes
N	53,213	53,213	53,213	53,213	50,885	42,335	40,390
N(cluster)	8,513	8,513	8,513	8,513	7,838	6,648	6,574
Overall R^2	0.001	0.030	0.053	0.059	0.056	0.051	0.074

Robustness check to regression on employment in Table 2. See the notes of Table 2 for table description and the list of control variables. Table uses random effects regression. Sample restricted to individuals between age 25 and 60. Pools observations between years 2004 to 2014. Demographic controls are gender, migration background (none, 1st generation, 2nd generation) and an East German dummy. Standard errors clustered at individual level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table D.6: Robustness checks for years of education (OLS)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Outcome:	Years of education						
Sample	Full				Born ≥ 1950	Non-migrants	West-Germans
Pool left-handers:							
Left-handed	0.036	-0.035	-0.068	-0.062	-0.053	-0.138	-0.071
	(0.096)	(0.095)	(0.093)	(0.084)	(0.101)	(0.092)	(0.094)
Adjusted R^2	0.000	0.022	0.064	0.248	0.234	0.238	0.281
Differentiate between switched and non-switched left-handers:							
Switched left-hander	0.075	-0.014	0.116	0.094	0.234*	0.009	0.126
	(0.117)	(0.116)	(0.114)	(0.102)	(0.134)	(0.108)	(0.116)
Non-switched left-hander	-0.029	-0.069	-0.379**	-0.326**	-0.369**	-0.411**	-0.355**
	(0.157)	(0.155)	(0.155)	(0.140)	(0.148)	(0.162)	(0.152)
Controls:							
Demographics	no	yes	yes	yes	yes	yes	yes
Cohort fixed effects	no	no	yes	yes	yes	yes	yes
Parental education	no	no	no	yes	yes	yes	yes
Urbanization at 15	no	no	no	no	yes	yes	yes
N	11,249	11,249	11,249	11,249	7,707	9,001	8,635
Adjusted R^2	0.000	0.025	0.064	0.248	0.235	0.238	0.282

Robustness check to regressions in Table 3. See the notes of Table 2 for table description and the list of control variables. Demographic controls are gender, migration background (none, 1st generation, 2nd generation) and an East German dummy. *** p<0.01, ** p<0.05, * p<0.1.

Table D.7: Robustness checks by definition of left-handedness and switching

Outcome:	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(vi
	Employed (RE)		Log-wage (RE)		Education (OLS)		Higher track (C	
Pool left-handers:								
Left-handed(50%)	-0.024*		-0.080***		-0.075		-0.026	
	(0.013)		(0.024)		(0.090)		(0.016)	
Left-handed(100%)		-0.027*		-0.071**		-0.040		-0.02
		(0.015)		(0.028)		(0.105)		(0.01
Overall/Adjusted R^2	0.061	0.061	0.164	0.163	0.251	0.251	0.252	0.25
Differentiate between switched and non-switched left-handers:								
Switched left-hander (50%)	0.002		-0.028		0.037		-0.005	
	(0.018)		(0.032)		(0.110)		(0.021)	
Non-switched left-hander (50%)	-0.050***		-0.133***		-0.238		-0.055**	
	(0.019)		(0.035)		(0.150)		(0.025)	
Switched left-hander (100%)		-0.006		-0.004		0.035		-0.00
		(0.023)		(0.040)		(0.133)		(0.02
Non-switched left-hander (100%)		-0.046**		-0.120***		-0.095		-0.04
		(0.021)		(0.038)		(0.162)		(0.02
Controls	yes	yes	yes	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
N	53,213	53,213	43,514	43,514	11,249	11,249	9,940	9,94
N(cluster)	8,513	8,513	7,600	7,600	11,249	11,249	9,940	9,94
Overall/Adjusted R^2	0.061	0.061	0.164	0.164	0.251	0.251	0.252	0.25

Robustness checks with respect to the definition of being left-handed and switched. See the notes of Table 2 for table descri and the list of control variables. Left-handed(Switched) (50%) indicates individuals that self-report to be naturally left-ha (report a difference between their innate and writing hand) at least half the time across survey waves. Left-handed (Swit (100%) indicates individuals that always self-report to be naturally left-handed (always report a difference between their innat writing hand) across all survey waves. Table uses linear random effects models in columns (i) to (iv) and OLS in columns (viii). Sample restricted to individuals between age 25 and 60. Pools observations between years 2004 to 2014. Clustered sta errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table D.8: Robustness checks for 2SLS estimation

	(i)	(ii)	(iii)	(iv)
Outcome:		Employed		
Sample	Full	Born $\geq$ 1950	Non-migrants	West-Germans
Left-handed	-0.050*	-0.044	-0.054	-0.032
	(0.030)	(0.031)	(0.034)	(0.029)
Switched	0.054	0.041	0.046	0.030
	(0.053)	(0.056)	(0.059)	(0.055)
Controls:				
Demographics	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes
Parental education	no	yes	yes	yes
Urbanization at 15	no	yes	yes	yes
N	53,213	50,885	42,335	40,390
N(cluster)	8,513	7,838	6,648	6,574
Adjusted R^2	0.053	0.056	0.050	0.073
First stage F-stat	121.04	109.92	97.97	111.09

Robustness checks for 2SLS regression on employment from Table 7. Demographic controls are gender, migration background and an East German dummy. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table D.9: Robustness checks for 2SLS estimation

	(i)	(ii)	(iii)	(iv)
Outcome:	Log(Wage)			
Sample	Full	Born $\geq$ 1950	Non-migrants	West-Germans
Left-handed	-0.085*	-0.105**	-0.122**	-0.103**
	(0.049)	(0.050)	(0.057)	(0.050)
Switched	0.050	0.082	0.089	0.088
	(0.086)	(0.089)	(0.093)	(0.091)
Controls:				
Demographics	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes
Parental education	no	yes	yes	yes
Urbanization at 15	no	yes	yes	yes
N	43,514	41,894	35,291	32,971
N(cluster)	7,600	7,104	6,003	5,857
Adjusted R^2	0.122	0.161	0.173	0.154
First stage F-stat	119.49	109.95	94.58	105.23

Robustness checks for 2SLS regression on log-wages from Table 7. Demographic controls are gender, migration background and an East German dummy. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.