Making it right? Social norms, hand writing and cognitive skills

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Abstract

Forcing a left-handed child to use the right hand for writing was common practice in today's developed countries. Although rare now in these societies, it is still highly prevalent in developing countries and across various cultures. We study forced right-hand writing, called switching, as a case where social norms lead parents to fight against their child's nature. Such interventions are found in fundamental aspects of a persons identity, such as sexual orientation and skin color, with long-lasting effects on later life outcomes. We detect patterns of reported left-handedness and, conditional on left-handedness, switching that are consistent with known anti-left biases. Our data allow us to study this intervention across a wide range of cohorts with considerable variation in the right-hand writing norm. We find that, compared to right-handers, non-switched left-handers perform worse in terms of human capital accumulation, wages and overall life-satisfaction, while switched left-handers do not. We then propose an identification strategy to study switching as an early childhood intervention, based on right-handers as a counter-factual group.

Keywords: Early childhood intervention, human capital formation, cognitive skills, left-handedness

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1 Introduction

Throughout history, left-handers faced superstition, stigmatization and discrimination in various areas of life [Harris, 1980, 1990]. To a significant extent, prejudices on left-handers' inferiority originate in religion, but not exclusively. In Christianity, the left hand is considered to be the devil's hand and in Islam it is forbidden to use the left hand for eating and human interaction. On the other hand, non-religious China has one of the lowest reported left-hander rates worldwide, where right-hand writing is a social convention and tradition, rooted in the stroke order of Chinese characters [Kushner, 2013]. On more practical grounds, the world is designed for right-handers, in particular machinery, equipment and tools in everyday use. Forcing a left-handed child to use the right hand for writing and other daily activities thus seems to be for the child's long-term benefit.

In today's developed countries, parents and teachers are advised not to interfere with a child's natural handedness. Unfortunately, a child's natural handedness can be hard to determine at a young age, when handedness is not yet firmly established, in particular among the actual left-handed [McManus et al., 1988].[1] The most well-known effect of switching the writing hand is stuttering, with King George VI being an equally well-known example from generations of left-handers affected [Kushner, 2011, 2012]. 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 of the left-arm [Perelle and Ehrman, 1994, Sattler, 1996, Zverev, 2006].

Despite its potential harmful consequences and application, switching is still common practice in countries of Asia, Africa, the Middle-East, and South America where anti-left biases are prevalent [Medland et al., 2004, Zverev, 2006, Porac and Martin, 2007, Kushner, 2013]. A comparable, though maybe even more extreme case of such an intervention, is conversion, or, reparative therapy, which aims at changing a young person's sexual orientation from bi- or homosexual to heterosexual [Hicks, 1999]. Haldeman [1991, 1994] find that the effect of such "therapy" is basically zero, but that it could severely harm the treated person's mental well being. Similarly, brain scans of switched German left-handed adults have shown that switching does not truly alter a persons handedness, as measured by the location of higher order

[1] Whether switching is worse or even harmful at all when done at an early age, when brain plasticity is relatively high, than when the child learns to write, is unknown. Switching that occurred to early in life to remember, combined with past and present prejudices against left-handers may also be responsible for the range in the estimated share of left-handers, depending on the country, ethnicity and cohort under study [Perelle and Ehrman, 2005, McManus, 2009, Vuoksimaa et al., 2009].

motor control areas. Instead, one can see shifts of executive motor regions from the right to the left brain hemisphere [Siebner et al., 2002, Klöppel et al., 2007]. Both, switching and conversion therapy, are instances where parents try to fight the hard-wired nature of their child.[2] In both cases, they are motivated by the prevalent norms of their time and environment, and believe that it is in the child's own interest.

This paper studies the origin and consequences of an early intervention that is motivated by religious, social and political norms, and its associations with later life outcomes. Our data allow us to investigate the relationship between individual and parental characteristics with the switching decision across a wide range of cohorts with considerable variation in the right-hand writing norm. We then compare indicators of human capital accumulation, labor market outcomes and cognitive skills between right-handers and switched and non-switched left-handers. The discussion section provides an identification strategy to estimate the causal effect of switching on cognitive skills, using a difference-in-difference approach with right-handers as counterfactual group.

Our sample is drawn from the German Socio-Economic Panel (SOEP). As part of a grip strength measurement module, repeated biannually from 2006 to 2014, respondents were asked "Are you a natural right- or left-hander?" and "With which hand do you actually write?".[3] We take a difference in the answers to these questions as an indication for switching of the writing hand. To the best of our knowledge, the SOEP is the only large-scale data source that allows to differentiate between switched and non-switched left-handers.[4] The SOEP also contains rich socio-economic background and outcome variables for all individuals, as well as cognitive and non-cognitive skill measures for subsamples.

Our data show that the share of left-handers remains fairly constant at 9% from the 1930 cohort on. In contrast, the enforcement of the right-hand writing norm diminishes rapidly across cohorts. Our sample is a snapshot in the time of near-full to near-non switching practice in Germany. Starting among cohorts born in 1950, switching rates decline monotonically from about 90% to 60% by 1960 and to nearly zero in 1990 in Germany.[5] The downward trend is steepest among individuals born in the 1960's, whose parents were the first generation to be raised after the

[2] Another such attempt to change one's biological endowment is the whitening of skin color, which can be toxic [Easton, 1998].

[3] See Ambrasat and Schupp, 2011(in German only) for further details on the grip strength measurement.

[4] Other general or health surveys collect only one variable on the individuals handedness, usually the dominant hand, which may or may not be the hand used for writing.

[5] Note that the school entry age in Germany is 5 to 7, usually 6, and that children learn to write in first grade (corresponds to kindergarten in the US).

Second World War and who became increasingly reluctant to adopt the norms of their parents. On average, 57% of left-handers are switched.

At last, we discuss switching as an early childhood intervention and its effect on cognitive skills. To identify causal effects, we employ a difference-in-differences approach by assuming that outcome trends of right-handers, who were never switched, serve as a counterfactual for left-handers.

This paper addresses two strands of literature. The first one is the formation of cognitive and non-cognitive skills during childhood. The accumulation of human and social capital during this sensitive period is considered to be one of the most important determinants of future economic success in various dimensions, such as education, income, health, and criminality [Heckman, 2007, 2008, Currie and Almond, 2011]. Experimental evidence from the Perry Pre-school program [Schweinhart et al., 2005] and the Abecedarian program [Campbell et al., 2002] have shown that early childhood interventions at school entry age and before can enhance cognitive and non-cognitive skills permanently, and that these are followed by huge benefits later in life [Cunha et al., 2006, Heckman et al., 2013]. However, there exist few studies that are able to exploit natural experiments to study long-term effects of interventions. We add to this literature by studying an educational practice that was both early and an intervention, as it was performed at school entry age and was intended to significantly change the child's behavior. To the best of our knowledge, no study so far concerned a non-institutional intervention and one that has the potential to have negative effects on those treated. Also, the experiments cited above treated primarily children from disadvantaged socio-economic backgrounds, while switching applied was applied to considerable share of individuals in a general population.

The second branch of literature to which we contribute concerns the economic consequences of handedness and, more general, studies that exploit natural variation in supposedly hard-wired brain structures. Denny and O'Sullivan [2007] find a wage premium for left-handedness among males and a wage penalty for women in the NCDS, with similar observations being made by Ruebeck et al. [2007]. On the other hand, Johnston et al. [2009] and Johnston et al. [2013] find that left-handed children in the Longitudinal Study of Australian Children (LSAC) and in the NLSY perform worse on cognitive development test scores than right-handed children. Goodman [2014] continues to debunk the myth of the gifted lefty. Using five comprehensive data-sets from the US and UK, he showed that left-handed children have significantly lower cognitive skills, 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. We add to this literature by being able to differentiate between switched and non-switched left-handers, and considering a much wider range of cohorts than previous studies, with a larger variation in social stigma an discrimination. While this paper is limited to German data, we believe that it is representative of continental Europe with respect to social norms on handedness.

This paper proceeds as follows. In the next section, we briefly review some literature on left-handedness and switching. Section 4 introduces the data and describes the prevalence of left-handedness and switching in our sample. Section 6 shows differences in outcome variables between right-handers and switched and non-switched left-handers in different cohorts. In Section 7 we discuss our findings so for and outline an identification strategy. Finally, we conclude in section 8.

2 Handedness and Switching

The share of left-handers in the population is estimated to be 10 to 15%, depending on the country and cohort under study [McManus, 2009, Perelle and Ehrman, 2005]. A large literature on the origins and consequences of left-handedness, or laterality, exists in neuro-psychology, neuro-sciences and related fields. The origins of left-handedness are still uncertain.[6] Recent large-scale twin studies show that early theories based on a simple genetic model cannot be sustained [Medland et al., 2009, McManus et al., 2013]. Psychologists are mostly concerned with the relation of left-handedness to mental health and cognitive functioning [Coren, 2012]. Many of these studies seem to confirm prejudices about lower cognitive capabilities and mental health among left-handers, but results are often mixed as the mode of measuring handedness and the sampled population vary greatly.[7] Goodman [2014] made similar and additional observations among children and adults in different cohorts of the NLSY, the National Child Development Study of 1958 and the British Cohort Study of 1970. His findings corroborate the theory of the pathological left-hander [Satz, 1972]. 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 might have the same cause.

In contrast to handedness, the consequences of switching are much less well researched, whether in psychology nor in any other field.[8] This comes as a surprise, because as Perelle and Ehrman [2005] and Vuoksimaa et al. [2009] note, switching may also be a cause for the mixed results in the laterality literature, as many studies

[6] See McManus [2009] for an overview on the prevalence of left-handedness across time and geography.

[7] See Medland et al. [2004] and Perelle and Ehrman [2005] for a discussion on this topic.

[8] Previous work in psychology was done e.g. by Porac et al. [1986], Porac and Searleman [2002].

do not concern this issue in their measurement of handedness. The disapproval of left-handedness and the advocacy for forced right hand writing by scholars around the beginning of the 20th century is well documented. However, there were also early proponents to the practice, in particular in the US and UK, see Kushner [2012] for an overview. Sattler [1996] reports how children are affected by switching. In school, those forced to switch writing hands have to invest an over-proportional share of their energy and concentration capacity in learning to wright with the wrong hand. Hence they are quickly exhausted, are less able to follow the lessons, and are more likely to become stigmatized as a problematic child by teachers and peers.

Switching may alter the brain structure. Using fMRI scans, it has been demonstratet that environmental inputs can alter the brains structure, even in adult age. For example, the hippocampi of taxi drivers is larger than that of other subjects and its size correlates with time spent in this profession [Maguire et al., 2000], and even a three month training in juggling leads to a visible increase of gray matter in visual areas of the brain [Draganski et al., 2004]. Klöppel et al. [2010] find that the volume of gray matter in the putamen, a part of the forebrain that contains executive and cognitive aspects of motor control, is reduced among switched subjects, compared to non-switched right- and left-handers. The difference was greater the less successful the right shift was, i.e. the stronger the subject actually still preferred the left-hand for uses apart of writing. Interestingly, this finding was driven by individuals who had at least one left-handed first-degree relative. Pruning of unused brain matter during childhood is normal, but may be accelerated due to the switching process. The putamen is part of the basal ganglia, which contribute to memory and learning capacities [Packard and Knowlton, 2002].

3 A Model of Social Norms

We consider a simple model based on Becker and Tomes [1994] which involves social norms and relates future child outcomes with the parents decision to perform some treatment when the child is still young. As shown by Attanasio and Kaufmann [2009], parental expectations on returns to schooling matter for educational investments. We need to consider only parents of innately left-handed children. Let x be equal to one if the child's handedness has been switched. As in Becker and Tomes [1994], parents utility at time t depends on their own consumption of a good z_t minus immediate treatment costs k plus their child's utility u_c. Then

$$u_t = u(z_t - kx) + \delta\, u_c(y_{t+1,x}), \tag{3.1}$$

where δ is the parents degree of altruism and $y_{t+1,x}$ is some (discounted) future outcome of the child such as its human capital.[9] Consider only two points in time t and $t+1$ and assume all utility functions are concave. We now incorporate parents social norms when making investment decisions, as proposed by Cunha and Heckman [2008], but for simplicity we do not make use of the full capacity of the model formulated in Cunha and Heckman [2007]. Parents may not know whether $y_{t+1,1}$ or $y_{t+1,0}$ is larger, but form expectations about it based on a given social norm $\bar{x}_t$ at t:

$$\tilde{y}_{t+1,x} = a_t - d\,|\bar{x}_t - x|, \tag{3.2}$$

where d 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]. Our formulation reflects the idea that parents think non-conformity to existing norms leads to a possibly life-long penalty for the child due to discrimination by teachers, peers and employers. This is similar to Lindbeck and Nyberg [2006], who study the imposition of work norms by parents on their children. The decision whether to switch the child's handedness is based on (3.1) where $y_{t+1,x}$ is replaced with (3.2). In times when $\bar{x}_t = 1$ parents will switch their child if

$$u(z_t - k) + \delta\, u_c(a_t) \geq u(z_t) + \delta\, u_c(a_t - d) \tag{3.3}$$

$$\Leftrightarrow \delta\,(u_c(a_t) - u_c(a_t - d)) \geq u(z_t) - u(z_t - k). \tag{3.4}$$

Switching will thus be performed when the present forgone utility of doing it is smaller than the child's future gain. Obviously, no switching will take place if parents are selfish ($\delta = 0$), sardistic ($\delta < 0$), non-conformists ($d \leq 0$) or simply do not know that $\bar{x}_t = 1$. If $\bar{x}_t = 0$, these relations are reversed. While this is the parents decision model, the actual future outcome $y_{t+1,x}$ truly develops according to some function $f(\cdot)$ which does involve endowments a_t and switching x, but not the norm $\bar{x}_t$:

$$y_{t+1,x} = f(a_t, x). \tag{3.5}$$

What can we learn form this model for our empirical analysis? First, it is informative on which parents are likely to switch, or let switch, their child. Consider how parental resources from the set a_t relate to other factors that influence the switching decision. As seen from (3.4), the threshold to switch the child is lower

[9] For simplicity we let human capital directly influence utility, without considering the standard way over wages and then consumption goods.

when parents already 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. If the correlation between consumption and parental resources is positive, then wealthier parents are more likely to apply the treatment. Put differently, parents with low consumption levels have other worries than their child's human capital accumulation. Altruism δ in general induces parents to invest in to their child's future well-being. Hence, switching is just one in a range of measures that parents undertake to foster their child's capabilities. On the other hand, the difference $u_c(a_t) - u_c(a_t - d)$ decreases in a_t and the switching costs k may be negatively related to a_t, because of higher opportunity costs (raising the child vs working). In addition, stronger conformism to norms (expressed in a higher d) is likely to lead to a negative selection of switched individuals.

However, the parent's switching decision may not be perfectly implementable. Instead its success probability depends on the child's already developed cognitive skills and motivation at time t. Empirically, this would link switching and cognitive skills in adult age through 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 72% of the cases.

Second, the model provides us with a possible identification strategy. From (3.2) and (3.4) we see that the social norm $\bar{x}_t$ influences the decision to switch the child and it varies across t. We can use this variation in social norms, because individuals in our data-set belong to different cohorts. At the same time, the norm has no direct effect on the realization of $y_{t+1,x}$, other than through x as indicated in (3.5). This makes cohort based social norm variation a valuable candidate for an instrumental variable.[10] Clearly, norms gradually change over time and do not suddenly disappear. The empirical challenge then is to separate the change in norms from other cohort effects in a_t. We further illustrate our identification strategy and set up an econometric model in the discussion section.

Summarizing, our parental investment decision model gives us some reasons to expect a positive selection of switched left-handers and some to expect a negative. It seems plausible to assume that in times when the norm was to switch a left-handed child, non-switched children are negatively selected, because parents or teachers didn't care much about the child's standing in society. When this norm became out-dated however, we expect parents that nevertheless switch their child to be con-

[10] Note that, the utility function of the child may be extended to be $u_c(y_{t+1,x}, x)$ such that the writing hand itself provides direct intrinsic utility [Akerlof, 1997] and not only via $y_{t+1,x}$, reflecting stigma towards left-handers. However, this does not influence our outcome of interest $y_{t+1,x}$ directly and thus keep the exclusion restriction unviolated.

servative and less focused on their child's well-being. We investigate implications of this model in section 5.

4 Data and descriptives

4.1 Key Variables

The German Socio-Economic Panel (SOEP) biannually conducted grip strength measurements on parts of its sample from 2006 to 2014. As described in the introduction, the module includes two questions on natural handedness and actual writing hand.[11] We take a difference in the answers to these questions as an indication for switching of the writing hand. The gross sample comprises 13,240 individuals that participated at least once in the grip strength measurements. Among those that were matched to the remaining SOEP variables, 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. Information on innate and writing hand is available for more than half of individuals that refused the grip strength measurement or for which no valid values could be obtained. Similarly, for 55% (N=115) of individuals with missing information on handedness, information on grip strength measures are available. We use these measures to test whether left-handers are less likely to answer the questions on innate handedness in the first place. To do this, we 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 our 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 there are not more left-handers among those with missing handedness information.

The share of innate left-handers and left-hand writers does not vary significantly between survey years. About 43% of individuals participate once, 23% two times, 11% three times, 9% four times, and 14% five times in the grip strength module. We find that the answer to the innate and writing hand questions varies within individuals. On average, 23.02% (28.70%) of individuals that identify themselves as innate left-handers (write with left hand) in one year, report being right-handed

[11] In 2006 and 2014, individuals had "left- and right-hander" as a third answer option for both questions. We assign these 28 (13 for writing) individuals to the left-hander group (writing hand left group). Qualitatively, your findings do no change if we include them to the right-hander group.

(write with right hand) in the next year. The transition rate from right to left is only 1.79% (0.88%). Observations from individuals that participated only once in the grip strength module are thus most unreliable as we cannot observe if they would change their answer if asked again. In this study, we define an individual as being naturally left-handed, respectively forced to switch, if he reports so at least once in any wave. The reasoning for this approach is that no true right-hander has an incentive to ever report being a left-hander. Similarly, no non-switched individual would conscientiously report a difference between her innate and writing hand, except by error. Therefore, it is likely that some false positives are included, which leads differences between the two groups to be biased towards zero.

The resulting share of left-handers is 8.95% of which 57.76% are switched. This share of left-handers is lower than 10 to 15%, the rate reported in recent economic [Goodman, 2014, Johnston et al., 2013] or psychological [McManus, 2009] studies. One explanation for this is that these studies usually create a continuous measure of handedness by combining statements on the preferred hand for writing, throwing, and eating, which is then cutoff at some point (often 0.5) to create a binary variable for handedness. In addition, respondents can often answer on a Likert-type scale with more than two points. The availability of several and more sensitive indicators for handedness allows to identify true lefties more easily, because it is less exposing to state a preference for the left hand in e.g. opening a can, than to state that one is born with the sin of left-handedness. Thus, our sample of left-handers may be positively selected, if reporting left-handedness correlates with unobserved predictors of our outcome variables. International comparable figures on switching rates are provided by Perelle and Ehrman [1994], from a worldwide survey of handedness with 11,074 observations. They find that the share of individuals that prefer the left as the writing hand varies greatly, from 2.47% in Mexico to 12.8% in Canada. While the overall share of individuals that report to have experienced an attempt to switch their writing hand is 7.00%, it is 20.19% among left-hand writers and 5.61% among right-hand writers. Assuming that all right-hand writers that report a switching attempt were actually left-handed, these data imply a switching success rate of 72.50% and a share of individuals that were actually born as left-handers of 15.15%.[12]

In total, only 31 (0.24%) individuals report being innately right-handed, but write with their left hand.[13] We assume measurement error for these observations and drop

[12] Note however, that sample recruitment in Perelle and Ehrman [1994] was based on voluntary distribution of questionnaires by psychology departments addressed by the authors. Also, individuals that are concerned with handedness and switching may be more likely to respond.

[13] Two-thirds of these individuals participated only once in the grip-strength module. It is theoretically possible that these individuals use the left-hand because they imitated their parents [Sattler,

them from the analysis, which leaves 12,775 observations.

4.2 Outcome and control variables

We consider various outcome variables, making use of their rich availability in the SOEP. Human capital measures include years of education and retrospective grades in math from the last school certificate. The school is an integral part in the switching process, being the primary place to develop writing skills. At the same time, teachers in Germany have considerable discretionary power over school type tracking. In West Germany, after 4 years of elementary school, children are recommended to go either to *Hauptschule* (basic, 4-5 years), *Realschule* (middle, 6 years) or *Gymnasium* (high, 9 years), which grants access to college education that last for another 4 years. Years of education includes time spent in apprenticeships or tertiary education.[14] Thus, teachers might punish children that do not align with their norms or see them unfit to progress to higher tracks. We use the highest observed value for years of education in the panel, but individuals had to be at least 25 at this point to be included in the sample. We see math grades as the earliest available correlate to cognitive skills, before college or occupational choices are made. In addition, writing and verbal skills are much less important in math than e.g. in German. Individuals are only included in this sample if they were at least 20, i.e. likely to have completed schooling, when math grades were surveyed. Note however, that math grades are self-reported and therefore subject to recall bias. Our estimates will be biased if left- and right-handers, or switched and non-switched left-handers, differ in their reporting behavior. For example, left-handers might report worse grades, because their memory on schooling is taunted by anti-left bias they experienced. For later life cognitive skills outcomes, we use the symbol-digit-test (SDT) and the animal naming task (ANT).[15] Both were elicited in 2006 and 2012 among a random sample of SOEP participants and have been used in other studies before us [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 intents to measure an individual's fluid intelligence, i.e. the ability to process and make use of new information, which is not already stored in memory [Cattell, 1987]. The ANT is a knowledge-based word fluency test which

1996].

[14]The figures and types of schools reported here are just a rough sketch of the German schooling system, but which apply for the overwhelming majority of individuals in our sample. See Piopiunik [2014] for a more detailed description.

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

required respondents to name as many distinct animals as possible in 90 seconds. We use the number of uniquely named animals, i.e. without repetitions. Both tests are utilized sub-modules in intelligence testing, such as the WAIS [Wechsler, 2008], which currently comprises ten modules. The ANT is a mixture of fluid (word fluency) and crystallized (vocabulary) intelligence. Both, SDT and ANT were measured after 30, 60 and 90 seconds and we use the measure after 90 seconds. Our last outcomes of interest are employment status and log-hourly wages from 2004 and 2013. The SDT, the ANT and math grades are standardized in the full sample.

Our control variables comprise basic demographic characteristics such as year of birth gender, an indicator for being born in East Germany (the former German Democratic Republic), migration background and country of origin.[16] The latter comprises six categories: Germany, Middle East (incl. central Asia), East Europe (incl. Russia), North Europe, South Europe (Portugal, Greece, Italy, Spain), and other (incl. Africa and Asia).[17] We refer to individuals whose country of origin is not Germany as direct migrants, which comprise 8.6% of the sample. 11.05% of individuals have an indirect migration background, i.e. they are born in Germany but their parents are not. Socioeconomic background is proxied by mothers and fathers education (three categories: none/basic, middle and high) and by the size of the town the individual primarily grew up until the age of 15 (four categories of urbanization: large city, mid-sized city, small town, countryside). Except for country of origin, these control variables are always included in our regressions if not stated otherwise and we drop all individuals with missing entries on them. Maternal and parental education education are responsible for most observations being dropped, with a share of missings of about 10%. For 80% of the remaining sample we have information on religious affiliation. Germany is almost equally split into three main denomination categories, namely catholic, protestant and none, and with about 5% in a residual category.[18] The analysis sample is further restricted to individuals born before 1920 and after 1997, in order to avoid small cell sizes and potential survival

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

[17]Middle East includes Turkey, Iran, Syria, Afghanistan, Tunisia, Iraq, Morocco, Kazakhstan, Lebanon, Kirghistan, 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. North Europe includes Austria, France, Denmark, UK, Sweden, Norway, Finland, Swiss, Ireland, Luxemburg, Belgium and Netherlands. Other includes all other countries, mainly USA and Asian and African countries.

[18]The 'other' group comprises Islam and other Christian denominations. Two-thirds of East Germans are in the 'none' group.

bias. This gives us a total sample size of 11,083 observations of which 992 are left-handed.

Table 1 shows means and standard deviation of all variables by handedness and, among left-handers, by switching status. We investigate differences between these two groups systematically using linear regression in the next section. None of the outcome variables in table 1 exhibit a significant difference between left- and right-handers. It is noteworthy that, despite being born 23 years earlier, switched left-handers have the about same average number of years of education as non-switched left-handers.

- Table 1 about here -

5 Selection

5.1 Left-handedness

Figure 1 shows the share of innate left-handed individuals and left-hand writers across cohorts in the first panel and the share of those forced to use write hand among left-handers in the second. The figures are drawn using local linear regression with ROT bandwidth. The share of left-handers increases, though rather noisily, from 6% in the 1920 cohort and then remains flat at about 9% from 1940 on. At the same time, the share of individuals who at least once report to write 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 late 1990's cohorts. These patterns were to be expected if stigma against left-handers and writing with the left hand decreases over time.[19] Although stigma against left-handers was arguably not prevalent at the time of the hand grip measurement anymore, longer socialization of elderly individuals in times when prejudices were prevalent are likely to lead to the observed pattern. 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].

[19] Cohort trends and age are obviously collinear here. However there is no evidence why elderly people should be more successful in re-learning to write than younger individuals. Another concern may be that older individuals are less likely to write at all and hence report being right-handed. Figure 7 shows the share of non-response to the original handedness and writing hand questions. We 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.

- Figure 1 about here -

Looking at the share of switched individuals in the lower graph of figure 1, we find that about 90% of left-handers born before the end of the Second World War write with their right hand today. Similar to the historical development of the swichting practice in many European countries, switching was very common in Germany among older cohorts and rapidly decreased from 1960 on[Harris, 1990]. As described in the introduction, the abandonment of conservative social norms, of which the writing hand is just one, was induced by the first generation of post-war parents. This movement found its climax in 1968, but started in the early 1960's. A similar observation has been made by Coudé et al. [2006], who find a sharp increase in reported left-handedness among individuals that entered school shortly after the events of May 1968 in France. We do not find this increase in the share of reported left-handers but instead a steep decline in switching rates.

- Table 2 about here -

We now regress the left-hander indicator on our control variables to investigate which characteristics predict reported left-handedness. We include cohort fixed effects in all regressions. Column one of table 2 demonstrates that females, East Germans and migrants are significantly less likely to be left-handed. Splitting up first generation migrants (direct migrants) by their country of origin in column two, we find that those from Middle Eastern, East or South European countries are driving the coefficient in column one. Interestingly, those with an indirect migration background are not significantly less likely to report left-handedness, although about 50% report to have at least one parent born in an Eastern European or Middle Eastern country.

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 to stronger social pressure on females to align with norms [Porac et al., 1986, Papadatou-Pastou et al., 2008]. Thus, it is unclear whether lower left-hander rates are observed due to natural or social causes. Investigating this finding further, figure 2 repeats figure 1, but splits the sample up by gender. The upper graph in figure 2 exhibits the level difference between males and females and it appears that the share of females lefties 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 the left-handed indicator among individuals born after 1930 are not significant at any conventional level. The interaction with gender is significant (p-value=0.054) and negative. If social pressure to report right-handedness decrease across cohorts, this result shows that the decrease is slower for females.

- Figure 2 about here -

The differences between West and East Germans and by country of origin have multiple reasons. Anecdotal evidence suggests that in East Germany, like 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].[20] We illustrate cohort trends between West and East Germany in figure 3, restricting the sample to those born before or in 1990, because information on place of birth is less reliable after this cohort. We find that the level difference between East and West is driven by cohorts born after 1960. The Berlin Wall was erected in 1961 and brought a new wave of oppression. As dissidents could not simply leave the country anymore, the regime aimed to stigmatize non-conformists to the socialist ideology, starting early in school. Thus, the liberal movement of 1968 as seen in West-Germany was much less developed in the East [Ohse, 2010]. As was the case with female-male differences, there is no significant cohort trend among West Germans, but the interaction with the East German dummy is negative.

- Figure 3 about here -

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 Greek Orthodox and considered to be more religious than Northern European states [Hank and Schaan, 2008]. At the same time, the left hand or left side is also negatively associated in Christianity. Obviously, these cross-country differences are subject to an 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]. We 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

[20] For further anecdotal sources on anti-left bias in Russia see Englund [1998] and Sindelar [2013].

three, which excludes migrants. Here too, no significant difference of reported left-handedness exist between catholic, protestant or denomination-free individuals. In columns one to three of table 2, parental education is never a significant predictor of left-handedness, as is urbanization at age 15. Excluding East Germans in column four does not change any of the previous findings.

If stigmatization against left-handers changes 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 exists discrimination in society as a whole. To investigate this, we 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 the Second World War and its aftermath. 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. The overall share of left-handers between all four groups does not differ significantly, however. 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 enforcement of the right hand writing norm diminishes, the association of parental education and reported left-handedness remains very low, even in the first cohort group. The two categorical variables 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 little compositional changes of left-handers with respect to these covariates over time.

To summarize, we find that left-handedness is only poorly predicted by our covariates, as indicated by adjusted R^2's of less than 1%. 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, and education. This near-randomness of left-handedness goes to the extent that some studies have exploited it as an instrumental variable for cognitive skills among children [Frijters et al., 2009, 2013].

[Goodman, 2014] found that perinatal health and maternal handedness are important predictors of left-handedness, while maternal education is not. While we can confirm the latter, our data contain no measure for infant health, such as birth weight. However, we 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. We 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 fathers handedness is statistically unrelated to own handedness (9.08% vs 8.75%, p-value=0.888). These result are robust to controlling for parental year of birth and education. Either a left-handed gene is inherited only via the mother, or children are more keen to use the left hand if they observe their mother doing so, as suggested by [Goodman, 2014].

5.2 sec:Switching

We now turn our focus to switching and perform a similar analysis as in the previous section, using only the sample of left-handers. Table 3 shows the respective regression results. East Germans were found to be less likely to report left-handedness and if they do so, they are 7.5% more likely to be forced to switch their writing hand. Looking at the lower graph in figure 3 we find that this difference is again found among the post-1960 cohorts. Abandonment of switching was considerably slower in East than in the West Germany, likely due to the oppression of non-conformist behavior as mentioned before. The regression in column one indicates that females are 5.5% less likely to be switched than males, which contrasts the idea that females are more oppressed in their true handedness than males and makes biological reasons the more likely explanation for male-female differences in left-hander rates. Males may be more likely to be switched, because use of the right-hand is more important in manual intensive work. As an alternative explanation, the "missing" female left-handers may be switched early in life, and there actually exist no differences between males and females. However, if the switching practice, early and at school, disappears over time, we would expect female left-hander rates to align with male rates among younger cohorts. The upper graph in figure 2 shows that this is not the case. Furthermore, switching rates by gender and across cohorts are nearly parallel, as shown in the lower graph of figure 2.

- Table 3 about here -

Higher paternal education negatively predicts switching, with considerably large, although non-significant, coefficients. Higher maternal education is significantly positively associated with switching, but the coefficients for middle and high levels are statistically not distinct from each other. Coarsening maternal education into two levels of none/basic and middle/high yields a coefficient of 7.31%, significant at the

10% level. Both coefficients of migration background are negative, but not significantly so. Due to a low number of cases, we do not distinguish migrants by country of origin here. Column two excludes migrants from the sample, but uses religious affiliation as additional covariate. Germans belonging to the protestant evangelical denomination are 8% less likely to be switched, as compared to Catholics. The dummy for 'other' affiliations exhibits a large and positive coefficient which is not significant due to a low number of cases. Excluding East Germans from the sample in column three, we find that maternal education becomes insignificant, but leaves coefficients otherwise unchanged. Given the evident dynamics of switching across cohorts, it is interesting to see if selection into the switching group changed over time. A priori, we expect that higher parental education negatively predicts switching among the younger cohorts and positively among the old. Splitting up the sample into four cohorts groups as in table 2 leads to low power, but the results remain basically unchanged when grouping individuals only into two groups, those born before 1961 and those after. Columns four to seven in 3 show that higher maternal education positively predicts switching only among the youngest cohort. This finding is inconsistent with the idea that low educated parents will force their child to switch the writing hand, even though its harms are known. On the other hand, the significant positive coefficient for growing up on the countryside, where social norms are more conservative, is. As was the case for left-handedness, differences between West and East Germans in switching rates only upon up in the third and fourth group. Females are less likely to be switched in any cohort, but only significantly so in the youngest.

Concluding, the regression analysis shows that even though the share of switched left-handers decreases strongly across cohorts, observable family background characteristics can only poorly predict its prevalence. Where they can, we find the opposite of our prior expectations.

6 Results

In this section we answer the question whether left- and right-handers perform differently in our outcome variables and whether consideration of the switching status matters at all. We first show differences in the full sample, before investigating them across cohorts. Table 4 shows the results from regression of the outcome variables on the left-handed indicator in the upper panel, and indicators for being a switched or non-switched left-hander in the lower panel. Thus, our regression model takes the form

$$y_{it} = \alpha_L \, lefty_{it} + \beta_0 \, X_i + \mu_t + \epsilon_{it} \tag{6.1}$$

in the upper panel and

$$y_{it} = \alpha_N \, non\text{-}switched \; lefty_{it} + \alpha_S \, switched \; lefty_i + \beta_0 \, X_i + \nu_t + \delta_{it} \tag{6.2}$$

in the lower panel. In both cases, right-handers are the reference group, and we include cohort fixed effects μ_t and all control variables X_i from column one of table 2. Age fixed effects are included in regressions on wages and cognitive skills.

- Table 4 about here -

In the first panel of table 4, the left-handed coefficient is negative for all outcomes, but only significantly different from zero for wages at the 10% level. Our results thus diverge from the existing literature, which finds clear deficits of left-handers as compared to right-handers [Johnston et al., 2009, Goodman, 2014].[21] We offer two explanations for this divergence. First, switching is very unlikely to be present in the cohorts studied by Johnston et al. [2009] and Goodman [2014]. Johnston et al. [2009, 2013] use data from the LSAC and the NLSY-C which sampled children in 2004 and 1986 respectively. Both studies stress that their cohorts are little to not affected by forced right-hand writing. To investigate differences in wages, Goodman [2014] uses participants in the British 1958 NCDS, a cohort were about 60% of the left-handers in our sample were switched. In the NCDS, we find that at age 16, about 11% of the respondents use the left-hand for writing, compared to only 4% in our sample of the same cohort. This is consistent with our impression that the UK was more progressive in terms of switching, with early advocates to stop the practice [Kushner, 2012]. Second, Johnston et al. [2009] and Goodman [2014] use samples of children and young adults for their analysis of cognitive skill. Our estimates come from a sample that comprises a much wider and older age range. , and Where possible, we investigate how left-handers from cohorts comparable to those of the previous literature perform in our sample below. Unfortunately, our cognitive skill sample does not include individuals below age 18. However, we can replicate the findings for human capital accumulation and wages.

The second panel in table 4 splits up left-handers into switched and non-switched. We find that it are the latter who perform significantly worse on completed years

[21] Note that Ruebeck et al. [2007] actually find a wage premium for left-handed males and no difference for women. However, we are not aware of any study that replicated this finding.

of education, math grades, employment, and wages, as compared to right-handers. Switched left-handers have slightly more years of education and better math grades, but only insignificantly so. The differences in human capital accumulation are huge. Non-switched lefties report 0.4 less years of education, or 0.15 standard deviations.[22] A negative difference of the same size is found for math grades.[23] These deficits translate into a 4% lower employment probability and a wage penalty of 8.5% for non-switched left-handers. This is in the order of magnitude of about one year less of education. We further investigate these findings in appendix table 5. As hypothesized before, teachers might prohibit left-handers from pursuing higher schooling tracks when they fail to switch their writing hand to the right. The first column in table 5 regresses our switching indicators and control variables on a dummy which is equal to one when an individual graduated in a track which is higher than the basic (i.e. middle or high). We find a precisely estimated deficit of 11%, which compares to an overall mean of 61%. Non-switched left-handers are thus much less likely to advance to higher tracks, of which the highest allows college access. Turning to cognitive skills in rows 5 and 6 of table 4, there exist no differences between switched and non-switched left-handers and right-handers on average. This is surprising, as years of education are an important predictor of later life cognitive skills.

Robustness checks with respect to the choice of control variables are presented in table 7. We find that the inclusion of control variables other than year of birth does not change our conclusions qualitatively. Including only dummies for gender, East German and migration background, but not parental education and urbanization generates some differences to the estimates in table 4, in particular for years of education and wages. Conditional only on cohorts dummies, switched left-handers have 0.22 more years of education than right-handers (column one). However, due to the fact that switched left-handers are more likely to be East Germans and less likely to be female, this significant coefficient decreases to a non-significant 0.14 after controlling for these variables (column two). The deficit in math grades reduces from 0.20 standard deviations to 0.16 after controlling for demographics (column three and four). Results for employment change surprisingly little with the inclusion of any set of controls (columns five and six). There exists non differences in wages when controlling only for cohort fixed effects (column seven). However, non-switched left-handers experience a non-significant wage penalty of 7% after controlling for compositional

[22] Restricting the sample to individuals who are included in the SDT sample leads to a non-switched left-hander coefficient of -0.45 for years of education (significant at 5% level) and -0.10 for math grades (not significant).

[23] This difference is not driven by selection into different school tracks. Controlling for the latter leads to very similar results as without doing so.

differences in demographics in column eight. Only after including parental education as done in table 4 does a significant wage difference show up. For our cognitive skill outcomes, control variables other than year of birth matter little. Random effects panel models in columns 7, 10, 13 and 16 deliver very similar results to the pooled regression models, with a somewhat larger wage penalty of -11.3% for non-switched left-handers. A comparison of adjusted R-squares between tables 4 and 7 illustrates that parental education and urbanization at age 15 have additional explanatory power over the basic controls, in particular for years of education. Nevertheless, our coefficients of interest change little in response to their inclusion.

We now set out to study the dynamics of these differences over time. This is an interesting exercise as the share of switched left-handers changes considerably over time and therefore also possible selection mechanisms into switching. Instead of splitting the sample up as in tables 2 and 3, we use local linear regression to estimate cohort trends of outcome variables among right-handers, switched and non-switched left-handers. We then take differences of the estimated curves between right-handers and switched left-handers, and between right-handers and non-switched left-handers. These differences are then plotted in figures 4, 5 to 6. Table 6 accompanies these figures by testing the significance of these differences across time. More specifically, we test whether linear cohort trends are different between right- and left-handers (upper panel) and between right-handers and switched and non-switched left-handers (lower panel). We use a linear specification, but quadratic or cubic trends deliver qualitatively similar results for the interaction terms.

As illustrated in figure 4, years of education and math grades exhibit a very similar pattern. Over time, both switched and non-switched left-handers improve in these outcomes compared to right-handers. There exists a more or less constant level difference between the two curves, with switched left-handers performing better than the non-switched in any cohort. However, confidence intervals are very large, in particular among older cohorts where only very few left-handers were not forced to switch their writing hand. In cohorts born before 1960 non-switched left-handers experienced significantly fewer years of education than righties, while switched left-handers perform about as well as right-handers. From 1960 on, switched left-handers even outperform right-handers significantly. Non-switched left-handers improve little after 1970. Repeating the regression in column 1 of table 4 with individuals born after 1970, we find that non-switched left-handers again have 0.4 years less education than right-handers, while non-switched left-handers have 0.7 years more (both differences significant at 10% level). A similar difference is found for self-reported math-grades. The rise in the positive difference for switched lefties coincides closely with the fall of switching rates. Non-switched left-handers see a slow but steady improvement of their grades with respect to right-handers, but the increase for switched left-handers is significantly stronger from the 1970 cohort on. Table 6 shows that cohort trends for years of education and math grades among switched left-handers are significantly steeper than for right-handers. After 1980, confidence intervals become to large for meaningful inference.

Turning to employment and wages in figure 5, a much different picture appears. Employment levels decrease for switched left-handers, while non-switched left-handers are less likely to be employed among older cohorts, but not significantly so among the younger. When controlling for covariates, the trend for switched left-handers is significantly negative and positive for non-switched left-handers at the 5% level. Switched left-handers earn approximately the same as right-handers in any cohort. Non-switched left-handers experience a wage penalty that vanishes decreases from the 1970 cohort on.[24] Lower employment rates and wages for non-switched left-handers are not surprising given their lower education and math grades. What is surprising however, is that switched left-handers are actually not performing better given theirs. Note that the graphs for employment and log-wages start with cohorts born around 1945. For the same cohorts, years of education and math grades increased strongly among switched left-handers. We investigate if accounting for human capital differences leads to different regression results for labor market outcomes. In columns 2 to 7 of appendix table 5, we restrict the sample to individuals with non-missing years of education and math grades, which roughly halves the sample size.[25] Despite lower power, columns 2 and 5, which replicate columns 3 and 4 from table 4 in the smaller sample, deliver very similar coefficients as in the full sample. Adding years of education as explanatory variable for wages in column 6, we find that switched left-handers earn significantly less wages than right-handers, while the coefficient for non-switched left-handers becomes insignificant. Further adding math grades in column 7 corroborates this change. Although the coefficient for non-switched left-handers is still a considerable -5.6%, non-switched left-handers now earn 7.8% less wages, which is significant at the 5% level. Statistically, both coefficients are not significantly different from each other, however. Applying the same exercise to employment status in columns 3 and 4 does not lead to a similar magnitude in the change of coefficients. This comes from the fact that years of education and math grades have much less explanatory power for employment than for

[24] The curves in figure 5 seem to not reflect the significant wage penalty we found for non-switched left-handers in table 4. This is because we do not account for compositional differences here, which is done in robustness checks below.

[25] The reduction in sample size is driven by math grades, which are only available for half of the sample.

wages.

Figure 6 illustrates differences in cognitive skills across cohorts. For both the STD and the ANT, no significant differences exist between any group. Instead, all left-handers experiences an increase in the SDT and, to a lesser extent, also in the ANT over time. As was the case in the regression analysis, we do not find evidence that left-handers, switched or non-switched, perform worse or better than right-handers in cognitive skill tasks in any cohort. However, as mentioned before, our sample is less comparable to those in previous literature. Even our youngest participants are older than the children under study, e.g. in [Johnston et al., 2009, 2013]. One explanation for the observed pattern could be that as left-handers age, they become more adapted to a right-handed world and eventually are able to compensate or shake off the deficits in their youth. As was the case with wages, switched left-handers are again performing about the same as right-handers. In contrast to these labor market outcomes, non-switched left-handers have no significant cognitive skills than right-handers.

As robustness checks, figures **??** to **??** use residuals from regressions that include all covariates that we also used in the regressions from table 4 instead of the raw data. The procedure is as follows. In the full sample, we regress outcome variables on the same covariates as in table 4 and take residuals. Point-wise 90% confidence intervals are derived by bootstrapping the procedure 999 times. Our conclusions change little, except for log-wages, where the curve for non-switched left-handers is downward shifted.

These results allow for several interpretations. Assume that there exists no causal effect of switching, but that only the more able and motivated children are able to switch their writing hand. In this case, we would only observe a selection effect. If, as previous studies suggest, there exist general differences between left- and right-handers, than the positive selection of switched left-handers may offset these general differences, while the negative selection of non-switched left-handers is reinforced by these. In this case it seems strange then that the traits that let switched left-handers to over-perform in school do not also lead to a higher labor market performance and cognitive skills measures in adulthood. Rather, it could be the case that teachers discriminate against non-compliance to the right-hand writing norm by discouraging left-hand writing children from higher schooling tracks.

7 Disscusion

Apart from its short term consequences described before, switching may have effects on later life outcomes. This makes it a policy relevant treatment, in particular for education policy makers in developing countries, who can discourage the practice. In this section we outline an identification strategy to estimate the causal effect of switching.

The analysis so far was limited to comparing conditional means between endogenous groups, prohibiting causal claims. Since the switching decision has to be made conscientiously by parents and teachers, it is unlikely that the individual's characteristics found to correlate with the intervention are its sole predictors. In particular, we are worried about reverse causality with respect to innate cognitive skills. A priori, we expect that children of high cognitive skills are more successfully in achieving a task as hard as learning to write with the non-dominant hand. This concern is confirmed by Sattler [1996] who notes that it are usually the brighter and more motivated children on which switching attempts are successful. Furthermore, and as derived by our theoretical model, parents with higher altruism and involvement with their child's development may contribute to a positive selection bias. An argument in favor of a negative selection bias is that very progressive parents may not switch their child in times when nearly all left-handers are switched and that very conservative parents who value conformism and tradition more than the child's well being may still do so even when the practice is out of fashion. However, the analysis in the previous section favors the arguments for a positive selection bias. We found that non-switched left-handers performed worse compared to right-handers in the oldest cohort group, where only few left-handers were not switched. The middle group, switched lefties outperformed righties, with non-switched being worse off, though not necessarily significantly. In the younger cohort, where less than one quarter of lefties were switched, this pattern was, somewhat surprisingly, repeated, indicating no reversal of the positive selection mechanism. Although to a lesser degree, comparing right to all left-handedness isn't free of confounding factors either, in particular those related to reporting behavior.

As described in the introduction, the observed decline of switching rates across cohorts originates in a change of the Zeitgeist on parenting, education and the importance of religion, and not in possible long-term consequences of switching, which were not known at this point of time in Germany [Sattler, 1996]. The short term effects of switching were known, however. Although three studies were published in the 1970's that discouraged switching, these were largely ignored by parents and policymakers alike and are unlikely to have had an impact on the practice [Sattler, 1996].

This shift in norms allows us to identify the causal effect of switching. Since right-handers were never switched, their cohort trend serves as a counterfactual for left-handers. The identifying assumption in this approach is that time trends for left- and right-handers would have developed parallel in the absence of switching. We can then employ two-stage least-squares (2SLS) estimation, with a difference-in-differences specification in the first stage. We formalize this idea in the following two equations model

$$Y_i = \alpha\, S_i + \beta_1\, X_i + \gamma_1 L_i + \theta_1\, \phi(t_i) + \epsilon_i \tag{7.1}$$

$$S_i = \delta\, \phi(t_i) \times L_i + \beta_0\, X_i + \gamma_0 L_i + \theta_0\, \phi(t_i) + \tau_i, \tag{7.2}$$

where α is the treatment effect of interest, X_i are control variables and $\phi(t_i)$ is a function of the cohort trend. S_i and L_i denote an individuals reported switching and left-handedness status and ϵ_i and τ_i are two possibly correlated error terms. The set of control variables X_i consists of all variables described in section 4.2 and our robustness checks include different sets of control variables. The form of $\phi(t_i)$ is important, because it has to fulfill two roles at the same time. First, it has to fit the time trend of the outcome variable for right-handers in (7.1), the counter-factual. Second, it must correctly trace the development of switching among left-handers across cohorts ($\phi(t_i) \times L_i$) in (7.2). Initially we use a quadratic trend, but test the robustness of our results with different specifications.

Important for the causal interpretation of the 2SLS coefficient is that, in the absence of switching, the level difference between left- and right-handers would have been constant across cohorts. We are not aware of any other institutional change in schooling practices which applied only to left-handers and which occurred simultaneously to the decline in switching.[26] Nevertheless, there might be causes outside the school context that run parallel to its time trend and could explain the pattern observed in the data. For example, stigmatization and prejudices against switched and non-switched left-handers in society may decline in general, leading left-handers to catch up over time. Violation of the exclusion restriction would hence lead to a downward bias of the 2SLS coefficient. This is a critical concern in particular for years of education, grades and wages, in short all outcomes where left-handers might be recognized as such and treated differently than righties. However, this is less of a concern for hard-wired cognitive skills. Another concern are changes of the composition of left-handers over time. While we already include some predictors of left-handedness in our preferred specification, we check how our results react to

[26] The first time policymakers paid specific attention to left-handers was in 1987, when an institute for school quality published a left-hander guideline for teachers, which instructed them to help left-handed children learn to write with their preferred hand [Sattler, 1996]. How quickly these guidelines diffused or to what extent they actually changed the behavior of teachers is unknown.

the exclusion of certain demographic groups which are likely to cause compositional changes in the left-hander group.

This finding is consistent with brains scans that found less gray matter in the putamen of switched individuals, compared to non-switched [Klöppel et al., 2010].

8 Conclusion

The use of the right hand for writing, eating and human interaction was a social norm in many of today's developed countries. Left-handers involuntary diverge from to this norm and were seen as inferior with respect to physical, mental and social abilities by scientists and large parts of society alike. To save their children from this fate, parents decided to switch their child's writing hand from the left to the right and teachers encouraged their students to only write with the right hand. Unknowingly or deliberately taken in account, this switching of the writing hand can damage the child's brain and psychological well-being. The practice of forced right-hand writing is still common in developing countries today, where stigmatization of left-handers origins in traditions, social conventions and religion.

In this paper we estimate the causal effect of this early childhood intervention on human capital in the mid and long run. Our sample is a subset from the German SOEP that participated in grip strength measurements from 2006 to 2014 and report on both their innate and writing hand. These data are a rare opportunity to observe switching of the writing hand, while also providing educational and cognitive skill measures as outcome variables. We first consider a simple investment decision model in which it is optimal for altruistic parents to adopt an exogenously given social norm for their children in order to avoid stigmatization. While this norm influences the treatment decision, it has no direct effect on the child's future human capital. This motivates our identification strategy. We find in our data that the share of switched individuals was nearly 90% among those born before 1950. From this year on, and most rapidly in the 1960's and 70's, switching rates decreased to less then 10% in the 1990's cohorts. This change in attitudes towards the importance of the writing hand came along with a dramatic change in other social norms during these years. We use the fact that right-handers were never affected by this treatment in a difference-in-differences approach in the first stage of a two-stage least-squares regression. Assuming that in the absence of switching cohort trends of our outcome variables would have evolved parallel between left- and right-handers, we can identify the causal effect of switching.

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Tables and Figures

	All		Left-handers			
	Right	Left	Non-switched	Switched	Total	N
Share in sample:	91.05%	8.95%	42.24%	57.76%		11,083
Outcome variables:						
Years of education	12.388	12.448	12.354	12.493	12.393	8,928
(if age$\geq$ 25)	(2.727)	(2.891)	(2.918)	(2.879)	(2.742)	
Math grade	0.005	-0.045	-0.240	0.077	0.000	6,592
(standardized)	(1.002)	(0.982)	(1.069)	(0.902)	(1.000)	
Employed	0.835	0.826	0.799	0.843	0.834	38,203
(if 60 $\geq$age$\geq$ 25)	(0.371)	(0.379)	(0.401)	(0.364)	(0.372)	
Log(hourly wage)	2.596	2.607	2.524	2.656	2.597	31,765
(if 60 $\geq$age$\geq$ 25)	(0.639)	(0.658)	(0.686)	(0.637)	(0.641)	
Symbol-Digit Test (SDT)	-0.005	0.043	0.501	-0.214	0.000	5,410
(standarized)	(0.992)	(1.072)	(1.016)	(1.016)	(1.000)	
Animal Naming Test (ANT)	-0.001	0.003	0.123	-0.052	0.000	2,638
(standarized)	(0.995)	(1.044)	(1.049)	(1.040)	(1.000)	
Covariates:						
Year of Birth	1961.7	1962.3	1975.2	1952.8	1961.8	11,083
	(19.07)	(18.52)	(14.83)	(14.90)	(19.03)	
Female	0.533	0.475	0.492	0.462	0.527	11,083
East German	0.218	0.194	0.124	0.244	0.216	11,083
Migration background						
none	0.801	0.841	0.811	0.862	0.805	11,083
direct	0.113	0.076	0.084	0.070	0.110	11,083
indirect	0.086	0.084	0.105	0.068	0.085	11,083
Father's education						
None/Basic	0.667	0.672	0.566	0.750	0.667	11,083
Middle	0.185	0.175	0.217	0.145	0.184	11,083
High	0.148	0.152	0.217	0.105	0.149	11,083
Mother's education						
None/Basic	0.679	0.682	0.556	0.775	0.680	11,083
Middle	0.225	0.213	0.277	0.166	0.224	11,083
High	0.095	0.105	0.167	0.059	0.096	11,083
Urbanization at age 15						
Metropolitan	0.202	0.210	0.205	0.213	0.203	11,083
Mid-size city	0.171	0.205	0.229	0.187	0.174	11,083
Small town	0.233	0.226	0.272	0.192	0.232	11,083
Countryside	0.394	0.360	0.294	0.408	0.391	11,083
Religious affiliation						
Catholic	0.311	0.313	0.297	0.322	0.311	8,944
Protestant	0.359	0.372	0.416	0.347	0.360	8,944
None	0.279	0.270	0.230	0.293	0.279	8,944
Other	0.051	0.045	0.057	0.039	0.050	8,944
Country of origin						
Germany	0.888	0.925	0.919	0.930	0.892	11,063
Middle East	0.035	0.021	0.026	0.017	0.034	11,063
Eastern Europe	0.049	0.032	0.029	0.035	0.048	11,063
Northern Europe	0.008	0.011	0.012	0.010	0.008	11,063
Southern Europe	0.012	0.004	0.007	0.002	0.011	11,063
Other	0.008	0.006	0.007	0.005	0.008	11,063

Table displays means of variables by handedness and switching status group. Standard deviations of non-binary variables are displayed in parenthesis below respective means. 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 don 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. Years of education included only for individuals of age greater or equal to 25 at last observations. 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 within 90 seconds. SDT, ANT and math grades are standardized in full sample. Log(wage) applies for individuals observed at age 25 and 60 between years 2004 to 2013. Country of origin applies for individuals with direct migration status only. Middle eastern countries include Central Asian countries. Eastern Europe includes Russia. Northern Europe countries includes West Europe countries, see text.

Table 1: Descriptive statistics

	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	-0.043**	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	-0.037***			-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	11,083	11,063	7,349	8,688	2,586	2,620	2,792	3,085
Adjusted R^2	0.002	0.002	0.002	0.002	-0.001	0.003	-0.000	0.006

Left-handed: Respondent answers at least once being born as left-hander and any survey year. 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. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 2: Regressions on left-handed indicator

	Linear regression for switching						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Sample restrictions:		Non-migrants only	Exclude East Germans	By cohort 1920-1949	1950-1960	1961-1970	1971-1997
Share of switched:	57.76%	65.13%	54.12%	90.87%	82.85%	50.56%	15.61%
Female	-0.055**	-0.047	-0.051*	-0.058	-0.045	-0.044	-0.088**
	(0.025)	(0.031)	(0.029)	(0.039)	(0.050)	(0.064)	(0.043)
East German	0.073**	0.066		-0.048	-0.006	0.188**	0.187**
	(0.032)	(0.040)		(0.047)	(0.054)	(0.086)	(0.079)
Mothers education							
Basic/none	(ref.)						
Middle/other	0.070*	0.045	0.050	0.067	-0.202	0.067	0.124**
	(0.042)	(0.054)	(0.046)	(0.088)	(0.134)	(0.097)	(0.057)
High	0.099*	0.082	0.072	0.086	0.089	-0.028	0.177**
	(0.057)	(0.079)	(0.061)	(0.107)	(0.157)	(0.152)	(0.076)
Fathers education							
Basic/none	(ref.)						
Middle/other	0.020	0.016	0.029	-0.021	0.102	-0.083	0.001
	(0.040)	(0.051)	(0.043)	(0.088)	(0.079)	(0.097)	(0.061)
High	-0.072	-0.084	-0.052	-0.035	-0.113	-0.031	-0.086
	(0.052)	(0.065)	(0.057)	(0.115)	(0.144)	(0.123)	(0.074)
Urbanization at age 15							
Large city	(ref.)						
Mid-size city	0.014	0.006	-0.024	0.043	0.022	-0.091	0.090
	(0.040)	(0.052)	(0.046)	(0.060)	(0.089)	(0.094)	(0.061)
Small town	-0.032	0.035	-0.034	-0.065	0.039	-0.163*	0.057
	(0.039)	(0.048)	(0.043)	(0.068)	(0.076)	(0.095)	(0.058)
Countryside	0.015	0.021	0.025	-0.040	0.027	-0.095	0.158**
	(0.037)	(0.045)	(0.043)	(0.056)	(0.072)	(0.087)	(0.071)
Migration background							
none	(ref.)						
direct	-0.048		-0.053	-0.169	-0.092	-0.093	0.135
	(0.057)		(0.058)	(0.116)	(0.090)	(0.119)	(0.110)
indirect	-0.029		-0.048	-0.011	-0.045	0.143	-0.036
	(0.041)		(0.048)	(0.082)	(0.134)	(0.108)	(0.053)
Religious affiliation							
Catholic		(ref.)					
Protestant		-0.082**					
		(0.035)					
Denomination free		-0.032					
		(0.048)					
Other		0.212					
		(0.131)					
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes
N	992	697	800	219	239	265	269
Adjusted R^2	0.401	0.372	0.412	0.082	0.085	0.050	0.122

Switch-handed: Respondent reports at least once being born as left-hander and to write with the right in the same year. Full 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.

Table 3: Regressions on switching indicator in left-hander sample

	Education	Math grade	Employed	Log(Wage)	SDT	ANT
Pool left-handers:						
Left-handed	-0.038	-0.023	-0.016	-0.042*	-0.015	-0.032
	(0.093)	(0.042)	(0.014)	(0.025)	(0.043)	(0.075)
Differentiate between switched and non-switched left-handers:						
Switched lefty	0.135	0.058	-0.001	-0.016	-0.033	-0.014
	(0.110)	(0.049)	(0.017)	(0.031)	(0.054)	(0.093)
Non-switched lefty	-0.401**	-0.150**	-0.040*	-0.085**	0.017	-0.072
	(0.164)	(0.073)	(0.023)	(0.041)	(0.067)	(0.121)
Controls	yes	yes	yes	yes	yes	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes
Age fixed effects			yes	yes	yes	yes
N	8,928	6,592	38,203	31,731	5,399	2,632
N(cluster)			6,440	5,756	4,406	2,010
Adjusted R^2	0.245	0.043	0.054	0.164	0.325	0.137

The upper panel regresses control variables and an indicator for all left-handers on outcomes. 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 regression control for cohort fixed effects, being East German, female, migration background (none, direct and indirect), mothers' and fathers' education (low/none, middle and high) and urbanization at age 15 (large city, mid-size city, small town and countryside). 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. 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 within 90 seconds. SDT, ANT and math grades are standardized. Employment status and log(wage) applies for individuals observed at age 25 and 60 between years 2004 to 2013. Adjusted R^2 applies to first panel. Robust or clustered standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: Linear regression of left-hand indicator and controls on outcome variables

	More than basic school	Employed			Log(Wage)		
Switched lefty	-0.016	0.018	0.011	0.009	-0.033	-0.072*	-0.078**
	(0.020)	(0.021)	(0.020)	(0.020)	(0.042)	(0.038)	(0.038)
Non-switched lefty	-0.109***	-0.044	-0.037	-0.034	-0.104*	-0.065	-0.056
	(0.028)	(0.030)	(0.030)	(0.030)	(0.054)	(0.050)	(0.050)
Years of education			0.017***	0.016***		0.084***	0.080***
			(0.002)	(0.002)		(0.004)	(0.004)
Math grade				0.015***			0.054***
				(0.005)			(0.009)
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
N	8,136	21,291	21,291	21,291	17,793	17,793	17,793
Adjusted R^2	0.267	0.054	0.068	0.069	0.164	0.264	0.270

Right-handers are the reference group for switched and non-switched left-handers. Table uses linear regression for all outcomes. All regression control for cohort fixed effects, being East German, female, migration background (none, direct and indirect), mothers' and fathers' education (low/none, middle and high) and urbanization at age 15 (large city, mid-size city, small town and countryside). Sample restricted to cohorts born between 1920 and 1997. More than high school equals one if individual attended a higher track than the basic track, which is the lowest. Includes only individuals of age greater or equal to 25 at time of observation in survey. Employment status and log(wage) apply for individuals observed at age 25 and 60 between years 2004 to 2013. Robust or clustered standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: Linear regression of left-hand indicator and controls on outcome variables

	Education	Math grade	Employed	Log(Wage)	SDT	ANT
Pool left-handers:						
Cohort trend	0.030***	-0.005***	0.001**	-0.011***	0.031***	0.015***
	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Left-handed	0.005	0.001	-0.001	0.001	0.004*	0.001
× cohort trend	(0.007)	(0.002)	(0.001)	(0.002)	(0.002)	(0.004)
Differentiate between switched and non-switched left-handers:						
Cohort trend	0.030***	-0.005***	0.001**	-0.011***	0.031***	0.015***
	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Switched lefty	0.022**	0.008**	-0.001	0.003	0.005	0.002
× cohort trend	(0.009)	(0.003)	(0.002)	(0.004)	(0.004)	(0.005)
Non-switched lefty	0.011	0.007	0.003	-0.001	0.004	0.005
× cohort trend	(0.012)	(0.005)	(0.003)	(0.004)	(0.004)	(0.007)
Controls	no	no	no	no	no	no
Cohort fixed effects	no	no	no	no	no	no
Age fixed effects			no	no	no	no
N	8,928	6,592	38,203	31,731	5,399	2,632
N(cluster)			6,440	5,756	4,406	2,010
Adjusted R^2	0.034	0.006	0.001	0.029	0.299	0.062

The upper panel regresses an indicator being a left-hander, a linear cohort trend, and their interaction on outcomes. The lower panel differentiates between switched and non-switched left-handers. In both cases, right-handers are the reference group. Dummies for being a left-hander or switched or non-switched left-hander are not shown. Table uses linear regression for all outcomes. 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. 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 within 90 seconds. SDT, ANT and math grades are standardized. Employment status and log(wage) applies for individuals observed at age 25 and 60 between years 2004 to 2013. Adjusted R^2 applies to first panel. Robust or clustered standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Linear cohort trends by handedness group

	Education		Math grade		Employed			Log(Wage)			SDT			ANT		
Estimation:	OLS	OLS	OLS	OLS	Pooled OLS	Pooled OLS	Random Effects	Pooled OLS	Pooled OLS	Random Effects	Pooled OLS	Pooled OLS	Random Effects	Pooled OLS	Pooled OLS	Random Effects
Pool left-handers:																
Left-handed	0.027	-0.039	-0.044	-0.026	-0.009	-0.017	-0.016	0.003	-0.037	-0.052**	0.007	-0.007	-0.012	-0.007	-0.013	-0.050
	(0.105)	(0.104)	(0.043)	(0.042)	(0.014)	(0.014)	(0.014)	(0.028)	(0.026)	(0.025)	(0.043)	(0.042)	(0.043)	(0.079)	(0.076)	(0.073)
Differentiate between switched and non-switched left-handers:																
Switched lefty	0.219*	0.142	0.052	0.056	0.009	-0.003	-0.000	0.012	-0.017	-0.009	-0.021	-0.029	-0.023	0.003	-0.009	-0.042
	(0.125)	(0.124)	(0.050)	(0.049)	(0.018)	(0.017)	(0.017)	(0.035)	(0.032)	(0.030)	(0.054)	(0.053)	(0.054)	(0.095)	(0.094)	(0.090)
Non-switched lefty	-0.374**	-0.416**	-0.196***	-0.156**	-0.038	-0.040*	-0.037*	-0.012	-0.070	-0.113***	0.057	0.033	0.007	-0.030	-0.023	-0.069
	(0.183)	(0.182)	(0.074)	(0.074)	(0.024)	(0.023)	(0.022)	(0.045)	(0.043)	(0.041)	(0.067)	(0.066)	(0.067)	(0.136)	(0.128)	(0.120)
Controls	no	basic	no	basic	no	basic	yes	no	basic	yes	no	basic	yes	no	basic	yes
Cohort fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Age fixed effects					no	no	yes	no	no	yes	no	no	yes	no	no	yes
N	8,928	8,928	6,592	6,592	38,203	38,203	38,203	31,765	31,765	31,765	5,410	5,410	5,410	2,638	2,638	2,638
N(cluster)					6,440	6,440	6,440	5,756	5,756	5,762	4,415	4,415	4,415	2,014	2,014	2,014
Adj./overall R^2	0.040	0.063	0.007	0.025	0.026	0.047	0.055	0.040	0.128	0.163	0.302	0.310	0.343	0.085	0.113	0.179

The upper panel regresses control variables and an indicator for all left-handers on outcomes. The lower panel differentiates between switched and non-switched left-handers. In both cases, right-handers are the reference group. All regression control for cohort fixed effects. Basic controls are gender, being East German and migration background (three categories: none, indirect, direct). 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. 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 within 90 seconds. SDT, ANT and math grades are standardized. Log(wage) applies for individuals observed at age 25 and 60 between years 2004 to 2013. Adjusted R^2 applies for upper panel. Robust or clustered standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 7: Robustness checks for linear regression of left-hand indicator on outcome variables

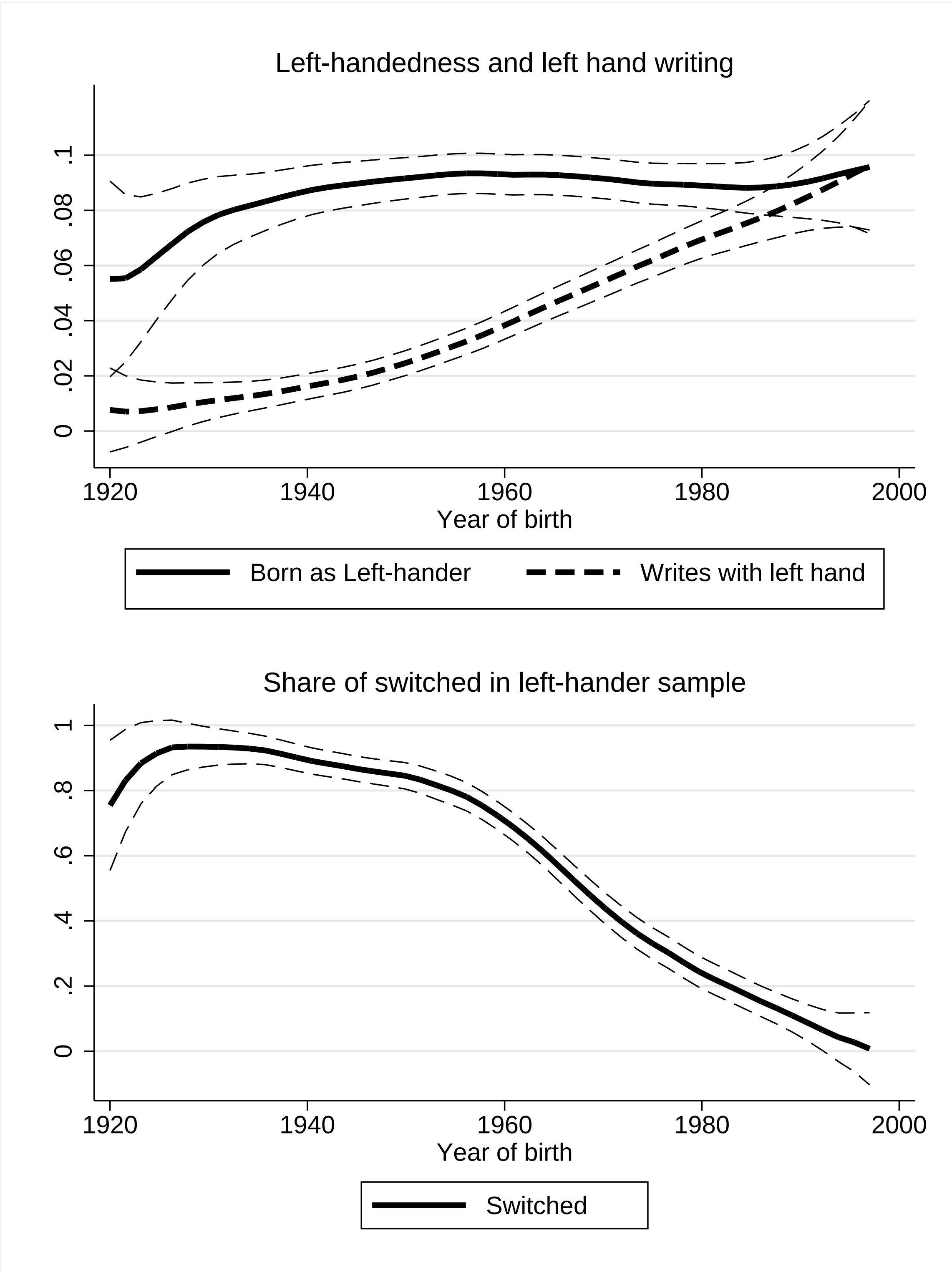

Figure 1: Share of respondents who report being born as left-handers, write with their left hand (first panel) and are switched (if left-handed, second panel) by year of birth. Includes 95% confidence intervals.

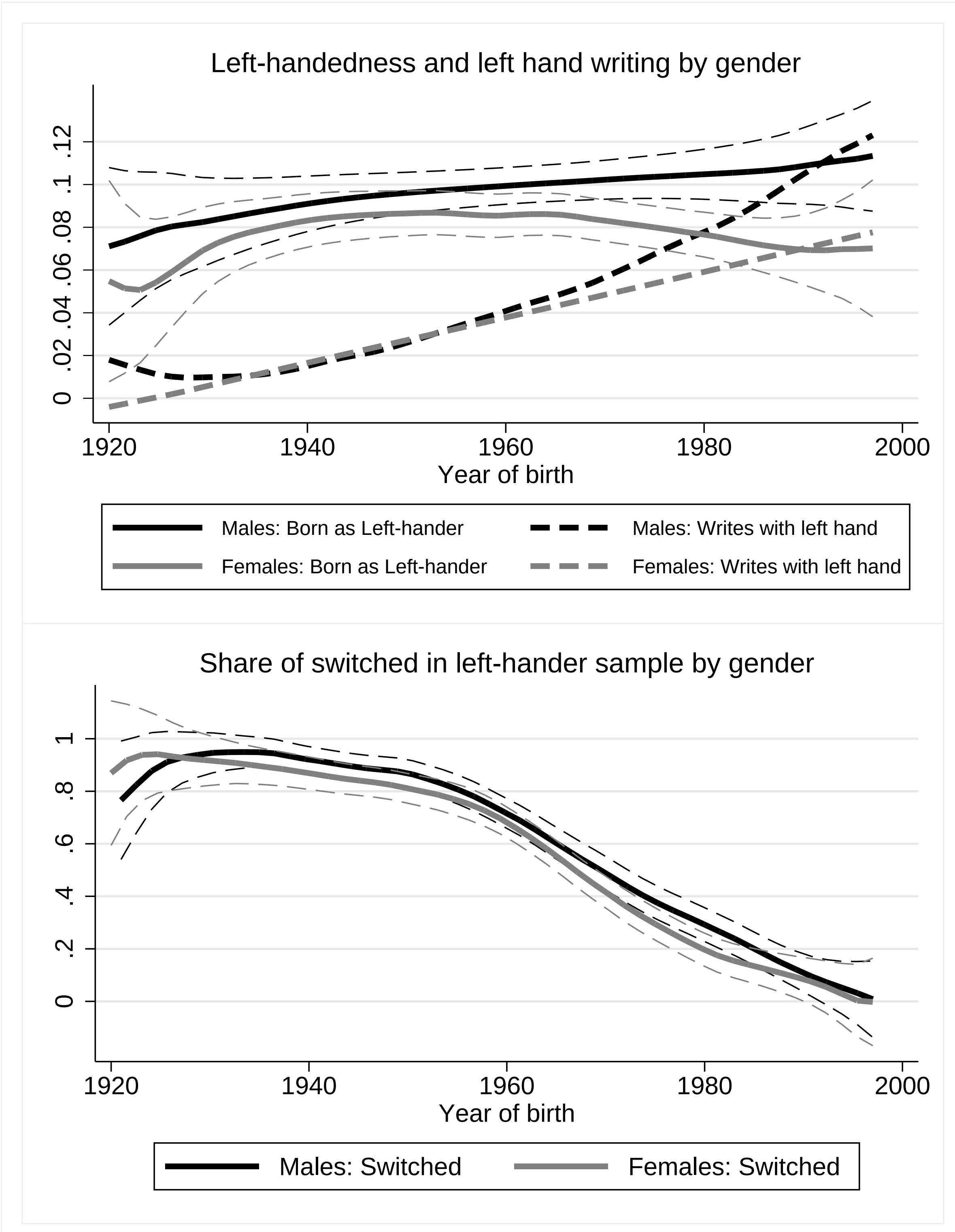

Figure 2: Share of respondents who report being born as left-handers, write with their left hand (first panel) and are switched (if left-handed, second panel) by year of birth and gender. Includes 95% confidence intervals except for writing hand.

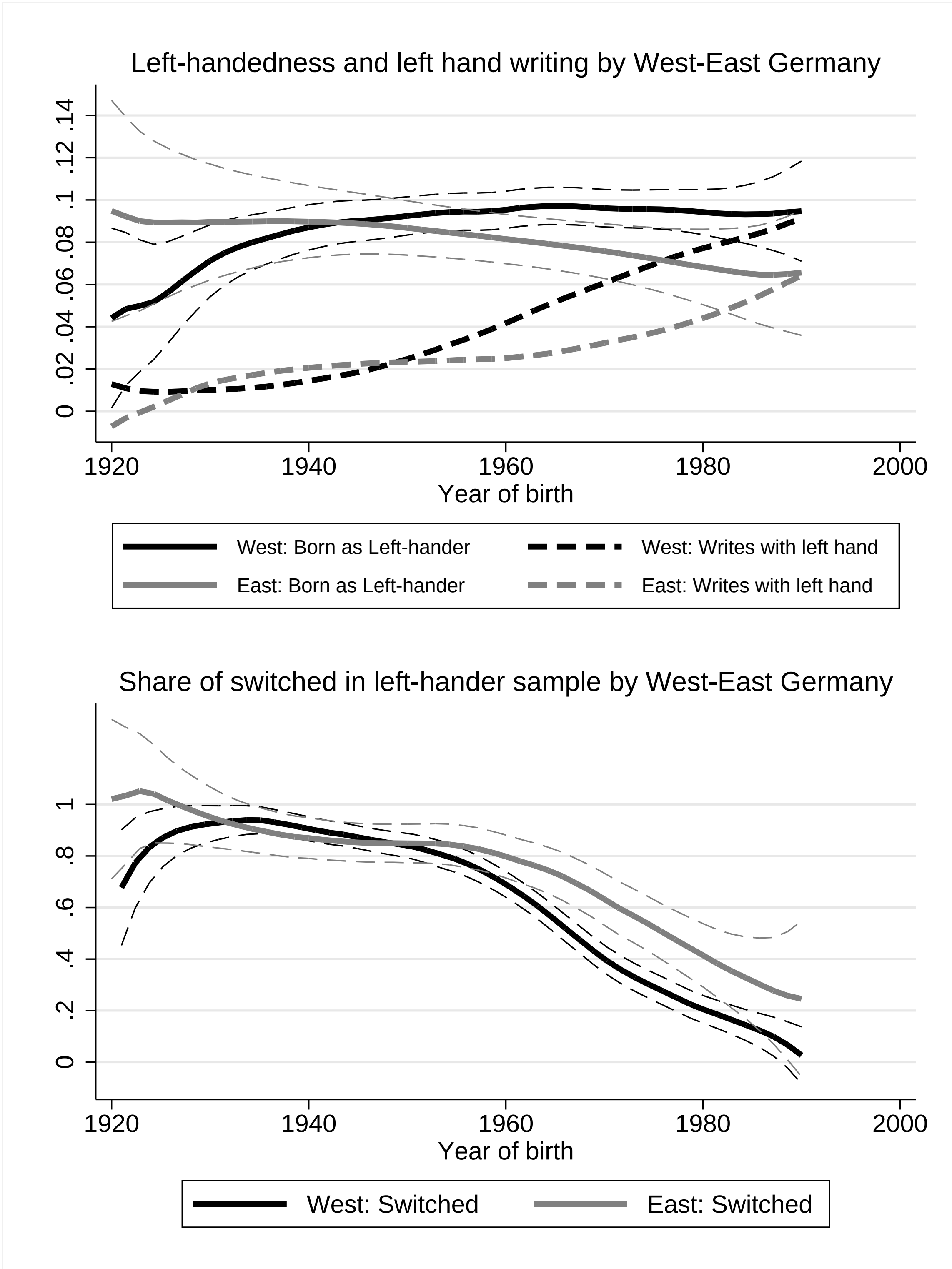

Figure 3: Share of respondents who report being born as left-handers, write with their left hand (first panel) and are switched (if left-handed, second panel) by year of birth and West or East Germany. Uses only cohorts up to 1990. Includes 95% confidence intervals except for writing hand.

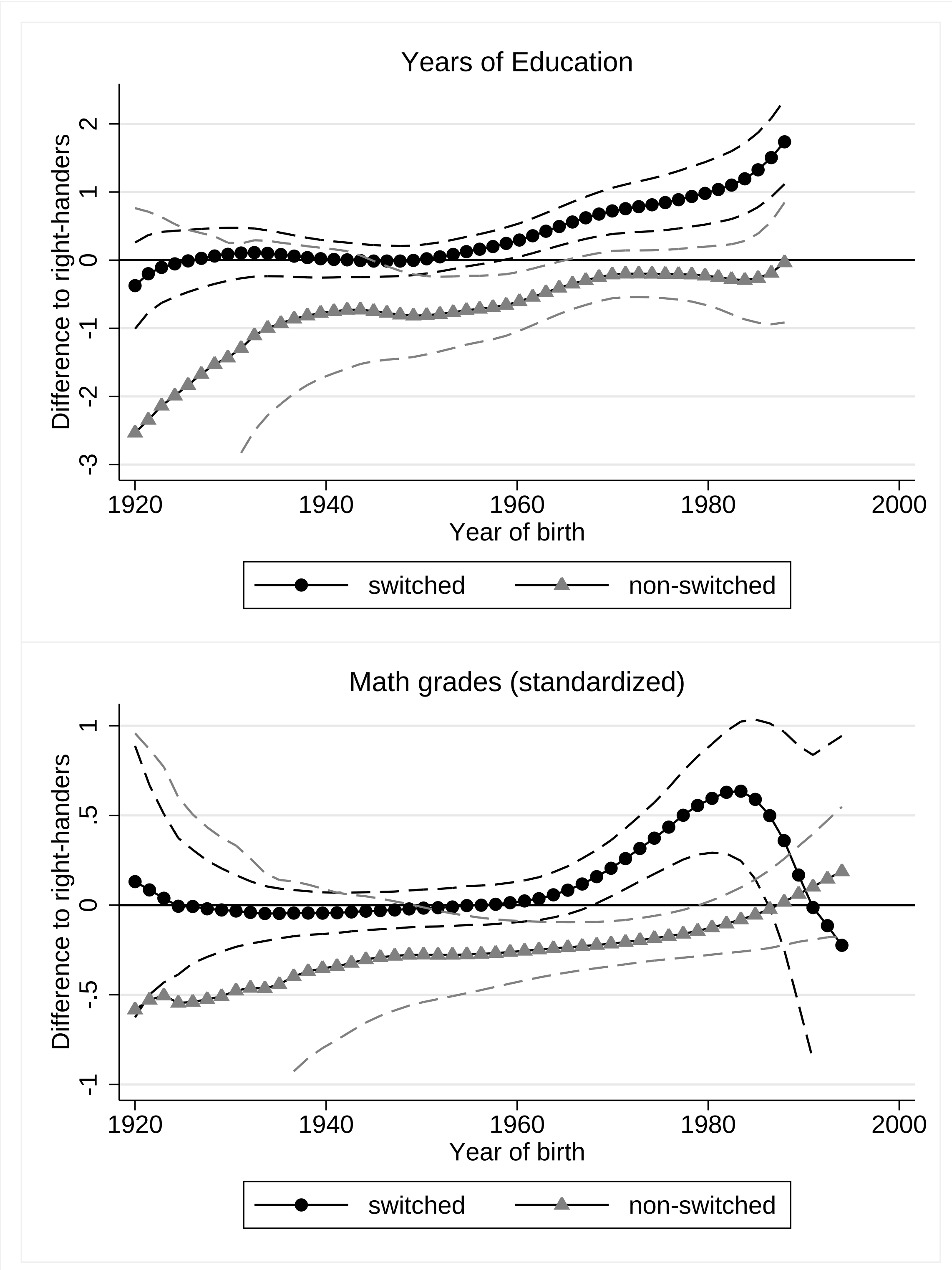

Figure 4: Difference of switched and non-switched left-handers to right-handers in years of education and math grades across cohorts. Includes 90% confidence intervals.

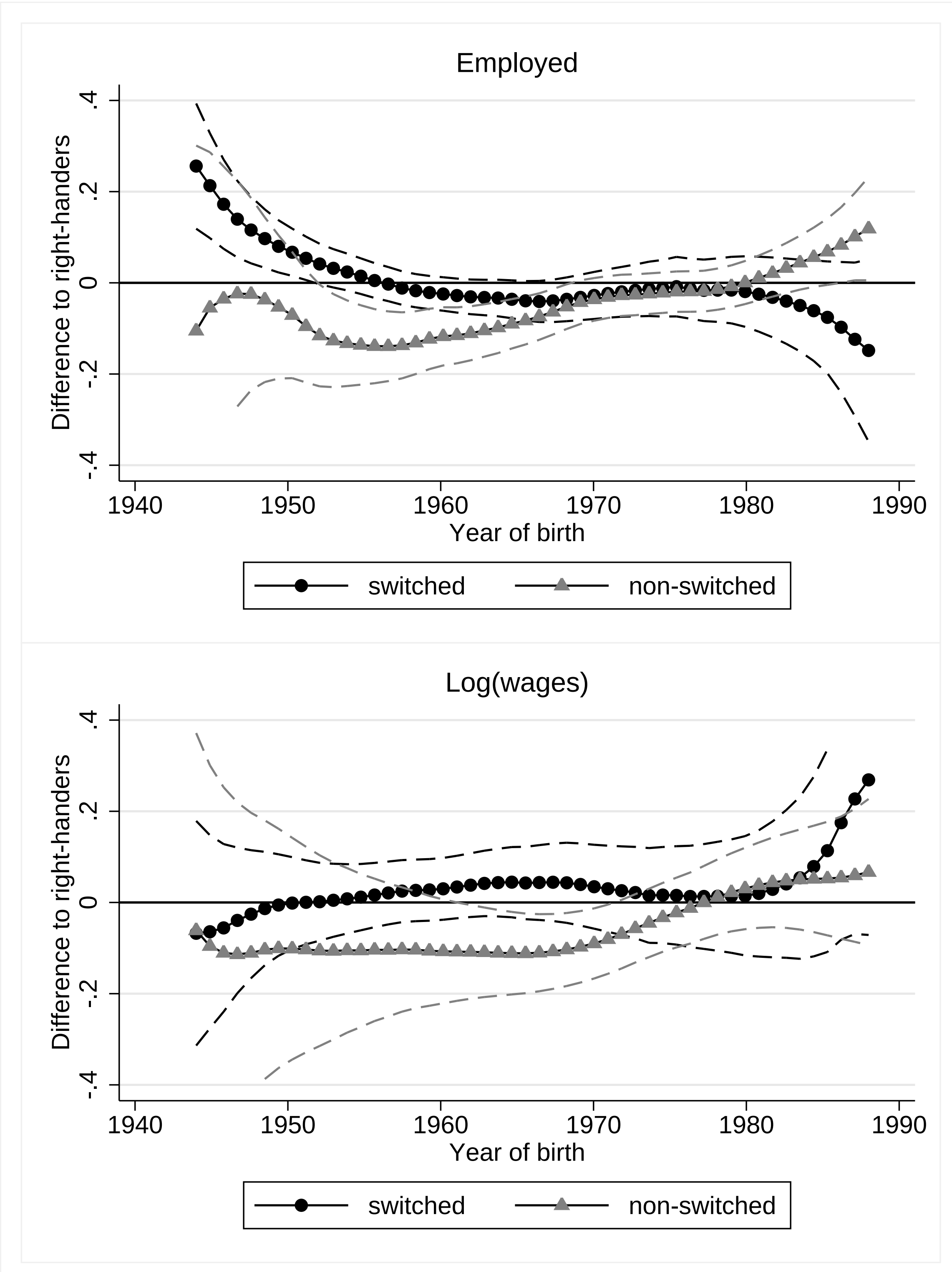

Figure 5: Difference of switched and non-switched left-handers to right-handers in employment status and log(wages) across cohorts. Includes 90% confidence intervals.

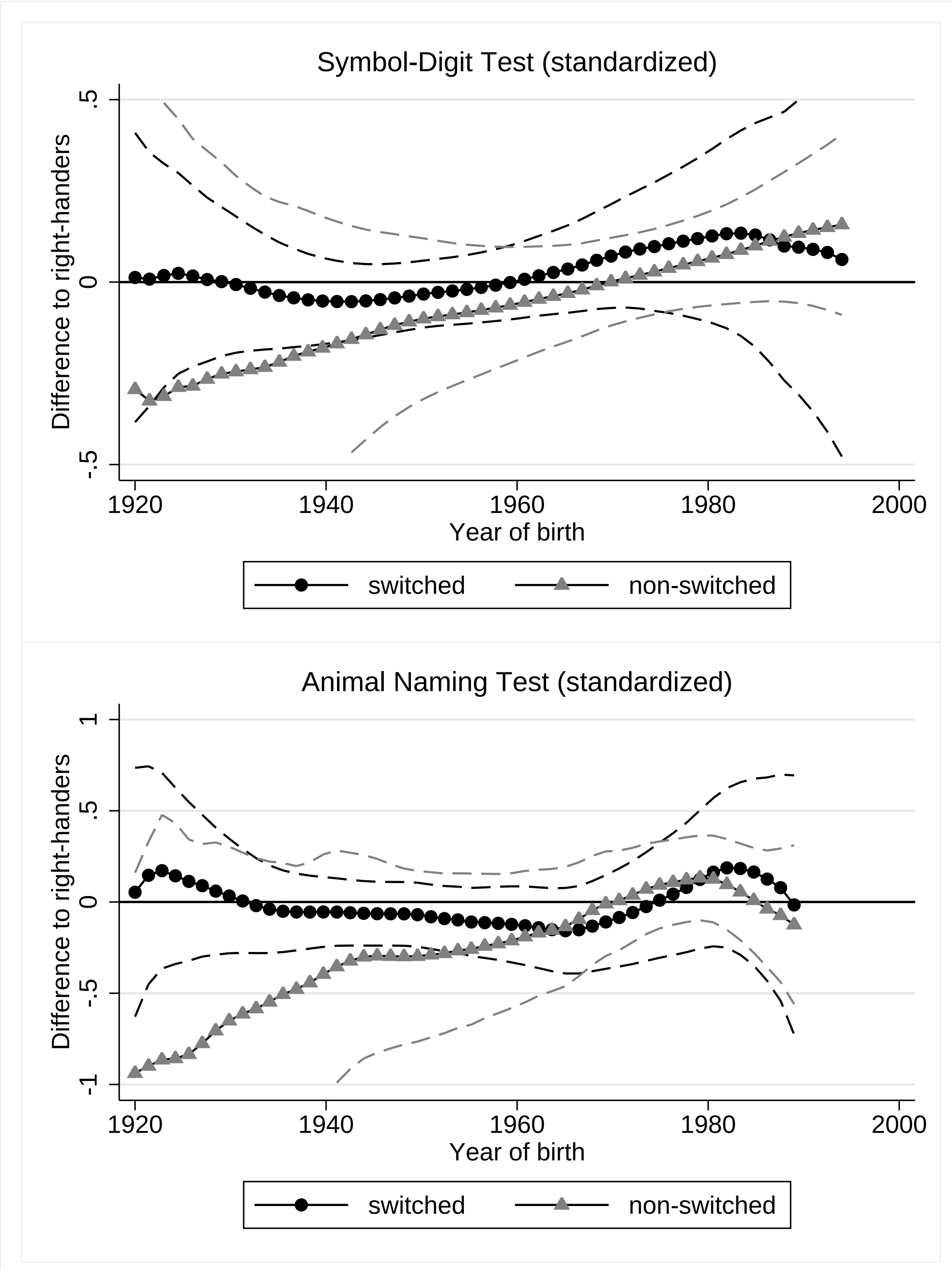

Figure 6: Difference of switched and non-switched left-handers to right-handers in the symbol-digit and animal naming tests across cohorts. Includes 90% confidence intervals.

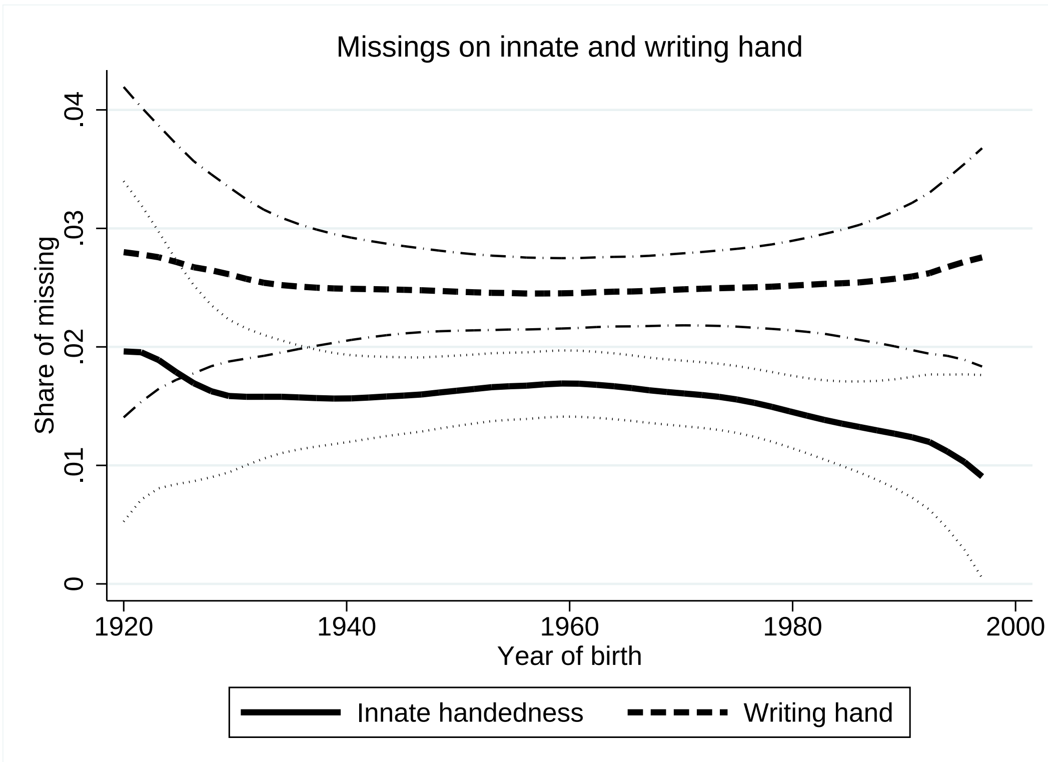

Figure 7: Share of missing observations on handedness and writing hand across cohorts. Includes 95% confidence intervals.