The Causal Effect of Grandparental Overlap on Grandchildren's Cognitive Outcomes

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Social inequality in ability emerges early in children's lives. The consequences of inequality persist across the life course and across several generations (Mare 2014; Pfeffer and Killewald 2017; Song 2016; Song and Campbell 2017; Song and Mare 2017; Hallsten and Preffer 2017). However, findings within the social science literature on the importance of grandparents for grandchildren's life outcomes are mixed, and few if any studies have produced convincing causal evidence (see Breen 2018 for recent review). As such, it is unknown whether grandparents affect social inequality among grandchildren or do not.

Numerous authors have argued that grandparent effects should increase with the duration of generational overlap between grandparents and grandchildren, since any direct interaction between grandparents and grandchildren is confined to this period of overlap. Mare and Song (2016) argue that the duration of overlap between the grandchild and grandparent may represent the main mechanism by which grandparents influence their grandchildren (see also Mare 2011, Mare 2014, Pfeffer 2014, Song et al. 2015). Rising life expectancy causes an increase in the multigenerational overlap and in the importance of the extended family (Bengtson 2001). An increase in overlap may exacerbate multigenerational inequality by differentially amplifying the disadvantages and advantages of different families (Mare and Song 2016). Yet, so far, the literature has not empirically defined or identified overlap effects.

In this paper, we define a new class of multigenerational effects, which we term grandparent-overlap effects. The effects capture how exposure to grandparents affects children's cognitive development. To recover grandparent-overlap effects, we develop a novel identification strategy and two new heterogeneous fixed effects estimators. We then provide the first-ever empirical estimates of grandparent-overlap effects, using population-level Danish administrative data with test scores at the outcome of interest. Our study makes three main contributions. First, we define four new causal effects of grandparent overlap—the population average overlap effect (PAOE), the subpopulation average overlap effect (SAOE), the conditional average treatment effect of grandparent characteristics given overlap (CATEGC) and the causal interaction effect of overlap and grandparent characteristics (CIEO). Our key innovation is to define overlap effects as inherently cumulative effects: an increase in overlap by one year increments the effect of observed and unobserved grandparent characteristics by one year. Therefore, the effect of overlap is interactive—it varies with observed and unobserved grandparent characteristics. Second, we posit a formal non-additive fixed-effects model that relates grandparent overlap effects to grandchild cognitive outcomes. This model explicitly captures the cumulative and interactive nature of grandparent overlap effects. Third, we develop two new estimators to recover the key model parameters empirically. Our concept of grandparent overlap effects captures the totality of grandparent effects initiated during the shared lifetime of grandparents and grandchildren. The approach thus goes significantly beyond past research on grandparent overlap effects, which has focused on the effects of one or two observed grandparent characteristics in isolation. By contrast, our approach captures the effects of all observed and unobserved grandparent behaviors and characteristics on grandchild outcomes.

Background

Recent years have witnessed a surge of interest in the effects of multigenerational transmission of resources on children's socioeconomic outcomes (Mare 2011, Mare 2014, Jaeger 2012, Song

and Mare 2017, Pfeffer 2014, Solon 2015, Chan Boliver 2013, Song 2016, Hallsten and Pfeffer 2017). The key question is whether intergenerational mobility estimates underestimate the persistence of social inequality across multiple generations. New empirical evidence challenges the traditional tenet that grandparents affect grandchildren only indirectly via parents [Markovian transmission] (Becker and Tomes 1979, Warren and Hauser 1997, Cherlin 1992). Existing studies focus on the correlations between specific grandparent characteristics and the grandchild's socioeconomic or developmental outcomes, including grandparent's education (Lindahl et al. 2015, Ziefle 2016, Zeng and Xie 2012), income (Lindahl et al. 2015, Jaeger 2012), wealth (Hallsten and Pfeffer 2017), household structure (Zeng and Xie 2012), and occupation (Chan and Boliver 2013, Knigge 2016, Hertel and Groh-Samberg 2014, Najman et al. 2004). With few exceptions (Song 2016), no studies have explored whether these associations are causal, and none have defined the grandparent effect in a comprehensive way to capture the evolution of multigenerational social advantage or disadvantage.

Grandparent overlap may perpetuate multigenerational transmission of resources and lead to diverging trajectories for children. The potential of prolonged love, care and support from the elderly suggests gains for grandchildren, while the deterioration of health and income as grandparents age lead to losses. Thus, whether an additional year of life-course overlap with grandparents benefits or harms grandchildren is empirically unknown. Most studies assume that a longer life-course overlap with the elderly is by nature salubrious due to the support generated by the extended-family network. Yet, prolonged grandparent-grandchildren overlap might benefit grandchildren heterogeneously. Younger, healthy, and financially independent grandparents can participate in active child care, aiding the immediate family. In contrast, elderly and ailing grandparent may themselves need support from their adult children, which makes them compete with their grandchildren for resources. In that case, the rising grandparent overlap may suggest a widening social economic gap in family resources available to invest in children.

Overlap effects are inherently cumulative. They capture the social process of how between-individual influences cumulates across time. The grandchild's cognitive outcome may be cumulatively affected by persistent social institutions, by the observed flow of grandparent income and health, and by the unobservable grandparental ability, attitude and personality. Some social institutions may have a remaining effect even after the death of the grandparents. As an example, the elite college preference system affects the grandparent income directly and the grandchild's motivation and test scores via legacy admissions, which may play a role even after the death of the grandparents. Such effects would function independently of length of overlap. However, the context we study empirically – Denmark – does not have such institutional legacy mechanisms. However, other environmental confounder such as multigenerational correlation in neighborhood choice remains. Experiencing an impoverished and segregated neighborhood may affect the grandparent's lifespan, health and income as well as the grandchild's cognitive development (Sharkey Elwert 2011, Sampson et al. 2002, Yen et al. 2009). Increased overlap will accumulate time-varying and time-constant grandparent characteristics. Grandparent overlap effects' cumulative nature further poses unique challenges to causal identification because of interaction effects between overlap and both observed and unobserved characteristics.

Challenges to causal identification

The identification of grandparent overlap effects is difficult for two reasons. First, overlap is a measure of elapsed time. Thus, overlap extends the full sequence of grandparents' observed and unobserved characteristics and amplifies their effects. Second, the relevant confounders of the

parent and grandparent generations often reach back decades and are not typically measured. Grandparents' unobserved characteristics, as well as social institutions, may confound grandparents' income and health and children and grandchildren's cognitive outcome (Baker et al. 1997, Heckman et al. 2006). Unobserved characteristics may also affect the duration of overlap. Grandparents' lifespan and the parents' fertility timing functionally determine overlap; i.e., overlap remains confounded as along as confounders of longevity and fertility exist (Song et al. 2015, Piraino et al. 2014). Further, grandparent overlap may interact with the unobserved confounders to affect the grandchild's cognitive development., causing bias in the estimates of grandparent overlap effects. Standard regression, random effects models, and marginal structural models unrealistically assume away these unobserved confounders. IV approaches are infeasible due to the abundance of endogenous characteristics and the absence of convincing instruments.

Instead, we suggest an extension of fixed effect models. Fixed effect models appeal to social scientists because the models eliminate all time-invariant unobservables by exploiting within-group variations absent interactions between the fixed effect term and the overlap. However, conventional fixed effect models would unrealistically assume that the overlap effect is homogenous across social groups with different fixed characteristics. We argue that the assumption is unfeasible. Therefore, we extend the framework of fixed effect strategies to allow for a data generating model in which the fixed unobservables interact with grandparental overlap.

Identifying assumptions

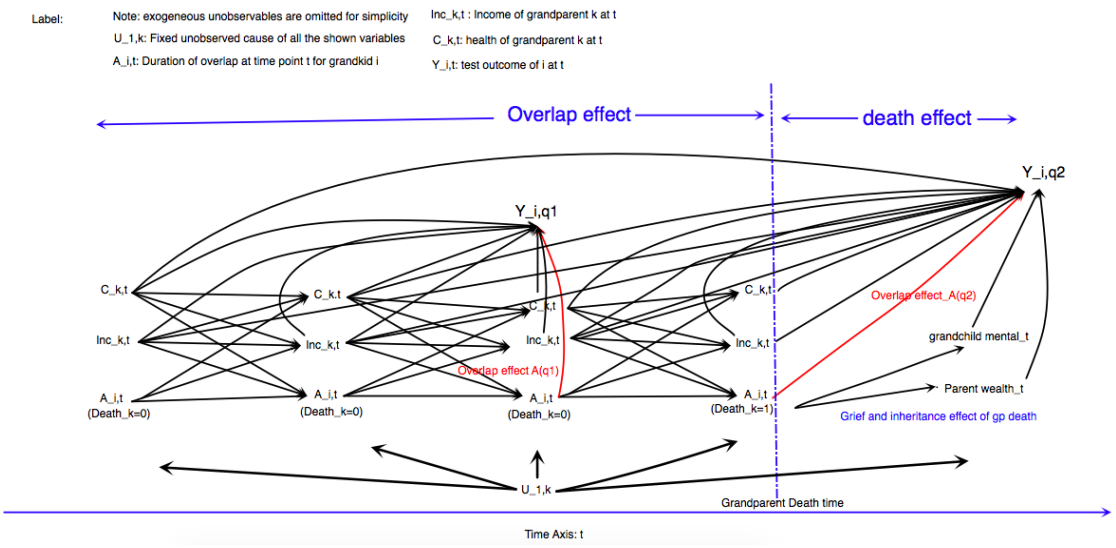
We conceptualize the grandparent-overlap effect as the cumulative impacts of a grandchild's exposures to grandparents' observed and unobserved characteristics and behaviors across the shared life course. The model implies that grandparent overlap effects vary with the value of grandparents' unobserved characteristics. This interaction rules out conventional additive fixed effects strategies and necessitates the development of both new identification results and novel estimators. We have developed two new heterogeneous fixed-effect strategies to identify an ensemble of interrelated grandparent-overlap effects. Identification in both strategies is achieved under the conventional assumption of strict exogeneity. Specifically, we assume that (a) grandparent survival and grandchild test scores are jointly determined by a set of unobserved characteristics fixed at grandchild's birth, in addition to observed time-varying factors, such as grandparents' age, somatic and mental health, earnings history, labor force attachment, and residential distance between grandparents and parents; (b) grandchild educational achievement does not affect grandparents' age, health, earnings, and survival.

Estimation proceeds in two differencing steps. The first step removes the main effects of the unobservables. The second step removes the interactions between the unobservables on one hand and the covariates and grandparent overlap on the other. Our first—within-grandchild—estimator leverages three consecutive test-score observations for each grandchild. To obtain within-grandchild variation in grandparental overlap, some grandparents must survive the grandchild's first test and die before the third test. Our second estimator uses both within-grandchild and between-sibling variation in grandparent overlap to further control for confounding.

Our identification strategies are robust to a set of reasonable concerns. First, grandparent overlap is not collinear with grandparent age; rather, grandparent-overlap effects accumulate the effects of grandparents' age *and* other characteristics. Second, grandparent overlap is not collinear with grandchild age, as long as some grandparents die during follow up. Third, we can distinguish

between grandparent-overlap effects and (presumably positive) inheritance effects upon grandparents' death by observing the devolution of property to grandchildren's parents captured through changes in parents' wealth. Fourth, we can distinguish between grandparent-overlap effects and (presumably negative) grief effects by modeling the dissipation of grief over time. Figure 1 illustrates the qualitative causal structure of our data-generating model. Our empirical strategy exploits plausible parametric restrictions of the qualitative model to achieve identification.

Figure 1: DAG representing the causal relationships between grandparental overlap and children's cognitive outcomes



Empirical extension

We use data drawn from the Danish administrative school and population registries to empirically identify the grandparent-overlap effects. Our preferred estimator is "data-hungry" and requires at least three observations per individual. Since 2010, the Danish Ministry of Education have tested Danish school children in grades 2 through 8 annually to biennially using standardized tests (Beuchert and Nandrup 2014). For our analysis, we sample all Danish children who have participated in at least three rounds of the test. Through the Danish fertility database and population registries, we can link all children to their parents and grandparents. From death records, we obtain precise date of death for all grandparents. Through hospital, income, and educational records, we obtain time-varying grandparental characteristics. The large sample size and high data quality allow us to robustly estimate the overlap effect under the assumptions stated above.

Conclusion

Our study defines, identifies, and estimates a new category of comprehensive multigenerational effects, which we label grandparent overlap effects. Previous studies of multigenerational transmission have focus on the transmission of specific types of capital, and likely suffer from issues of confounding (see Breen 2018). In contrast, our overlap effects are comprehensive and plausible identified under milder assumptions. Thereby, we provide the first causal test of the effect of grandparental overlap on children's cognitive development.