# Complementarities in investments and long-run returns: Evidence from historical records and administrative data

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## Extended Abstract

A growing body of evidence suggests that early-life circumstances have long-run impacts on people's health, educational, and labor market outcomes in adulthood, and even on the outcomes of their offsping (Barker, 1990; Almond and Currie, 2011; Almond et al., 2012). While much of the empirical literature has focused on isolating the consequences of *single* shocks arising from rare natural disasters, diseases, famines, or from early developmental interventions affecting expectant and new mothers,[1] recent economic models of human capital formation suggest that complementarities between *multiple* investments at different stages of childhood may be important determinants of human capital formation (e.g., Cunha and Heckman, 2007). However, causal empirical evidence on these complementarities is limited.

Using large-scale Danish administrative data together with several policy experiments, this project aims to address this gap in the literature and shed light on possible complementarities in the long-run effects of different investments. We use three natural experiments to identify distinct shocks to individuals' health, non-cognitive, and cognitive investments at different stages of childhood. The health investment arises from the differential impact of the 1952 polio epidemic (and the 1955 polio vaccine introduction) across municipalities and cohorts. The non-cognitive investment arises from the staggered expansion of pre-school daycare centers in Danish municipalities between 1930 and 1960. The cognitive investment comes from a 1958 schooling reform that increased access to education for cohorts of students born in 1946 and later who lived in rural areas. The reform mandated that all rural areas (and not only towns) offered an academic-track high school with 9 (instead of 7) years of schooling.

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[1]See, for example: Almond, 2006; Almond et al., 2009; Carneiro et al., 2011; Chetty et al., 2011; Isen et al., 2013; Hjort et al., 2014; Hoynes et al., 2012; Gertler et al., 2013, among many others.

To estimate complementarities in investments, we examine interactions in exposure to these quasi-exogenous shocks. For example, we can answer the following questions: 1) Do children protected from polio benefit more from the daycare expansion than children who were exposed to polio? 2) Do children from municipalities with more per-capita pre-school daycare slots experience larger gains from access to an academic-track high school than children from municipalities with less pre-school availability?

We compile a unique data set that combines individual-level data on cohorts born in 1930-1960 with municipality-level historical records on their childhood access to pre-school daycare and schooling beyond grade 7. We use the quasi-experimental variation in the three shocks described above in a difference-in-differences (DiD) design to study how these investments interact in their long-run effects on individuals' human capital attainment, career choices, earnings, work force participation, and health measured in 1980-2011.

In addition to providing some of the first causally-identified empirical estimates of dynamic complementarities in childhood investments, this project has two other main contributions. Unlike existing studies of some of the investments we consider, we can study effects on a wider range of outcomes and on outcomes measured throughout the lifecycle. Most existing studies of pre-school and educational interventions focus on them in isolation, study a limited set of outcomes measured at young ages, and offer mixed evidence.[2] By considering interventions affecting cohorts born in 1930-1960 and studying outcomes in 1980-2011, we can estimate long-term effects on numerous dimensions of human welfare through age 80. We will particularly focus on occupational choice, a previously under-studied outcome that may serve as one important channel through which early-life investments affect individuals' health and permanent income.

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[2]Havnes and Mogstad (2011) find sizeable effects of the late 1970s Norwegian daycare expansion on educational and labor market outcomes, while Bingley and Westargaard-Nielsen (2011) do not find significant correlations between daycare density and educational attainment in Denmark in the same period. Clark and Royer (2010) find no effects of a schooling reform in Britain on adult health, while Arendt (2005) and Arendt (2008) provide inconclusive evidence on the relationship between the Danish schooling reform and (survey) health outcomes and some evidence for at positive relationship between schooling and hospitalizations for women. In the U.S., recent work using administrative data from an experiment in Tennessee shows lasting effects of kindergarten classroom quality on earnings at age 27, but cannot speak to the effects on outcomes throughout the life course (Chetty et al., 2011).

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