Selection Effects in the E4Kids Longitudinal Study

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Today...

- Selection effects. NICHD and Duncan (2003), Duncan and Gibson-Davis (2006)
- Issues for the E4Kids Study Team
- Not a statistician. Multidisciplinary discussion.
- What is selection bias (selection effects) and why does it matter?
- What are the potential remedies and which ones might work for E4Kids?
The E4Kids Study

- 5 year study of children from ages 3-4 to Year 3 of school
- 2500 children in Victoria and Queensland currently in many different types of arrangement and at home with parent
- Collect detailed information on child baseline abilities, on family background and parenting, on quality and other program characteristics of ECEC experiences, and on numerous child outcome measures each year
Research Questions

- Does ECEC affect Australian children’s development? Which aspects of development? How much? In what way?

- Which aspects of ECEC have which effects? Quality? Full-time vs. part-time? Accumulated length of exposure? Program details? Well-educated teachers? Warm and supportive teachers?

- What family and child characteristics affect the impact of ECEC? Low-income, disadvantaged? Gender? Parent time and attitudes? Ethnic/language background?
Our underlying model of child development

- Many measures of child development – cognitive, language, health, social, emotional.

- When our children enter the sample, they are already very different from one another – genetically, gender, birth weight and birth order, health, parental and non-parental care situations, and the stimulating or stressful effects of life experiences to that point.

- The level of development of the child at any later point is the result both of the underlying abilities and characteristics of the child when he/she enters the sample and the accumulation of different experiences (in the home and outside the home) that the child has received since then.

- Initial characteristics and subsequent investments.
Child development equation

Let Y be a measure of child development (Woodcock-Johnson, NAPLAN). Let CHILD refer to the child’s unchanging or initial characteristics and FAM refer to the initial characteristics of the family/parents. Let HOME refer to household investments in the child and CARE refer to the characteristics of the early childhood education and care (and later the school) investments in the child. “i” refers to the child and “t” refers to the time period.

\[ Y_{it} = \alpha + \beta_1 \text{CARE}_{it} + \beta_2 \text{HOME}_{it} + \beta_3 \text{CHILD}_i + \beta_4 \text{FAM}_i + \epsilon_{it} \]
For example...

- \( Y_{it} = \alpha + \beta_1 \text{CARE}_{it} + \beta_2 \text{HOME}_{it} + \beta_3 \text{CHILD}_i + \beta_4 \text{FAM}_i + \varepsilon_{it} \)
- CARE = e.g., quality, hours and type of child care at each child age
- HOME = e.g., parental activities with the child at each age, changes in the family structure, employment and income at each age
- CHILD = e.g., child’s ability at entry to the sample, gender, birth weight, birth order, initial health and (dis)ability
- FAM = e.g., mother’s and father’s education at entry to the sample, religion, ethnic background, family structure
Causal Relationships

- There are many determinants of child development, and many factors correlated with child development.
- We are interested in uncovering (plausibly) causal relationships; causal relationships are relevant for policy.
- Projecting costs and benefits of policy reforms requires good estimates of causal relationships between ECEC programs and child development.
Threats to estimates

- Potential threats to getting good estimates: sample and sampling biases, accuracy of testing, accuracy of measures of quality, non-random attrition

- Once good data are collected, the primary threat to getting good causal estimates of the effects of ECEC on child development is “selection bias”

- What is selection bias, and how do we avoid it, or statistically control for it?
What does causality mean?

- Every child might receive the “treatment” or not. The treatment might be “attends kindergarten”, or the treatment might be “receives a high quality experience in long day care” or something else.

- For any individual child there are, then, two potential outcomes – the outcome if he/she receives the treatment, and the outcome if he/she does not receive the treatment. The causal effect of the treatment is a comparison between these two potential outcomes on the same child, in the same family, living in the same situation before treatment.

- However, we can only observe one of these potential outcomes. We have data on the outcomes for children who are treated. We do not have information on what the outcomes would have been for these children if they had not been treated (the counterfactual). We can think of this as a missing data problem.

- We need to find a plausible “counterfactual” group in order to estimate the causal effect.
Where is the counterfactual group of children?

- Obvious possibility: take the children in the data set who did not receive the treatment

- Problem: In both measured ways and unmeasured ways, this group of children is different from the treated group of children

- In particular, the parents have chosen the treatment for the child (and the other parents did not choose the treatment for their child). Does that mean these families are different in unmeasured ways?
The beauty of RCT

- Randomized control trials (RCTs) assign individuals randomly to receiving a treatment or no treatment. Because parents do not choose the treatment for their children, the parents’ characteristics and the child’s characteristics are not correlated with the choice of a particular quality, number of hours, or program characteristics of ECEC.

- In other words, the unobserved counterfactual is “missing at random”

- At the end of the experiment, we can plausibly claim that the measured differences between treatment and control groups are the result of the experimental treatment (causal effects of ECEC).
What is the selection bias problem?

- The selection bias problem is an omitted variable problem. Omitted variables cause bias problems if the omitted variable is correlated with both the variables of interest (features of ECEC - like quality, hours, type, program) and with the development of the child.

- Parental beliefs about child rearing and attitudes towards the virtues of nonparental care are likely to affect the choice of type, hours, program and quality of ECEC. However, these beliefs and attitudes may well also be correlated with parental investments in the child, and therefore directly with child development.

- If we can measure these parental beliefs and attitudes, or we can measure fully the consequent parental investments in the child, there need not be an omitted variable problem.

- To the extent that we do not accurately measure these beliefs, attitudes or investments, our regressions will produce biased estimates of the effects of ECEC characteristics on child development.
Plausible stories of bias

- Parents who choose the best quality care for their children will probably also invest time and effort that we do not measure. Our estimates will incorrectly attribute all of the resulting child development to the quality of ECEC.

- Parents who have particular problems coping with the stresses of life may choose a poor quality child care arrangement, but may also, in unmeasured ways, be inattentive to the child and transfer these stresses to the child. Our estimates will incorrectly attribute the negative effects on child development to the low quality of ECEC.

- Children may have unmeasured (negative) characteristics – problems of inattention, insecurity, unsociability. The parents may, as a result, take special care to get their child in the best possible quality child care arrangement. To the extent that we do not have accurate baseline measures of child ability, our estimates will incorrectly attribute the relatively low level of child development to the quality of child care, concluding that quality has negative effects.

- Some parents may choose to invest considerable amounts of parental time and effort in children, and choose mediocre quality (cheaper) ECEC arrangements. Other parents may choose to substitute long hours of very good quality ECEC arrangements for scarce parental time. These two strategies may produce equal levels of child development. If we have inadequate measures of the amounts and quality of parental investment, our regressions will find that quality of care has no impact on child development, although the opposite is true.
Potential solutions to the selection bias problem

1. Collect and include normally unmeasured selection variables in regressions on child development.
2. Estimate the “change” in child development, rather than its level. (Or “residualized change” models)
3. Instrumental Variables – find an instrument for the “treatment” variable that is not correlated with parent and child selection effects.
4. Fixed-effects model (e.g., sibling fixed-effects) – compare only children for whom the selection factors are the same.
5. Propensity score matching – compare outcomes of children who are treated only to outcomes of children who had a high probability of being treated (but were not).
6. Natural experiment, difference-in-difference model – If a policy change affects two groups of children differently, compare the average change in the two groups of children.
7. Regression discontinuity design – If access to treatment depends on a forcing variable (e.g., child age), compare only those children who were just on the margin of being treated (and were treated), to those who were just on the margin of being treated (and were not).
(1) Adding variables

- When regressing level of child development against explanatory variables, (collect and) include a large number of selection-related variables
- Include only selection variables not affected by ECEC treatment!
- NICHD and Duncan (2003), Magnuson, Ruhm and Waldfogel (2007)
- e.g., child gender, ethnicity, mother’s education, parental vocabulary, child-rearing beliefs, home environment, maternal mental health, attitudes about maternal work, income-to-needs ratio, parental expectations of the child’s attainment
(2) Estimate change, not level, of child development

- \( Y_{it} = \alpha + \beta_1 \text{CARE}_{it} + \beta_2 \text{HOME}_{it} + \beta_3 \text{CHILD}_{i} + \beta_4 \text{FAM}_{i} + \varepsilon_{it} \). Change model may difference out the child and family selection effects.

- Assumes same selection effect on early and late outcomes

- Measurement error in levels leads to large measurement error in change. Therefore large standard errors.

- Residualized change = estimate effect on level, but early value of child outcome is a regressor.
(3) Instrumental Variables

- Problem is that child and family factors are correlated with CARE. Solution = replace CARE with a variable that is not correlated with child and family selection.

- Need an instrument that is correlated with CARE, but does not affect child outcome in any other way (than through CARE).

- Magnuson, Ruhm and Waldfogel (2007). Instruments are measures of access to state prekindergarten programs.

- Bernal and Keane (2009). Instruments are detailed changes in welfare rules affecting use of different types of child care.
(4) Fixed-effects model

- If family factors are the ones that are correlated with the selection of CARE, compare only outcomes for children within the same family (different child outcomes for different siblings)


- But – perhaps selection within a family is non-random. Did parents choose brightest sibling to go to Head Start? Or, the slowest learner to go to Head Start?

- Magnuson, Ruhm and Waldfogel use a teacher fixed-effects model. Compare only children that ended up in same school classroom (presuming this group will have similar selection effects)
(4) Propensity Score Matching

- Simple regressions compare outcomes for treated children to children who were not treated (the no-program controls). But these children/families are not very comparable.

- Propensity score matching chooses better “control” groups for various groups of “treated” children.

- Estimate probit or logit on probability of choosing treatment. Calculate probability that each family will choose treatment (a propensity score).

- Match each treated child with a group of untreated children who, nonetheless, had a similar probability of being treated. Regression is based on comparison across these groups. Selection on observables.


- Magnuson, Ruhm and Waldfogel (2007) found effects of prekindergarten on school readiness using ECLS-K.
Difference-in-difference model

- If a policy reform affects two groups of children differently, compare the change in those eligible for treatment to the change in those not eligible

- Baker, Gruber, Milligan (2008) on Quebec child care reforms. Comparing before-after difference in outcomes between those eligible for reform and those not eligible

- Havnes and Mogstad (2009) compared 30-year before-after difference for 3-6 year-olds in treated municipalities vs. not-treated municipalities in Norway

- Cascio (2009) on long-term effects of introducing kindergartens in public schools in the U.S.
Regression Discontinuity Design

- Requires “forcing” variable that is correlated with treatment and not readily manipulable. Regression to compare outcomes for children who are “close” to each other.
- We can test for validity of RDD. It does not have to be assumed.
Implications for E4Kids

- Plan to use several methods of control for selection bias
- Collect detailed information about selection mechanisms
- Collect data on selection-related variables from parents and children
- Collectively discuss and write about best methods of analysis and control for selection bias for E4Kids