Neonatal Health of Parents and Cognitive Development of Children

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2nd Workshop of the Centre for Social Data Analytics (CSDA)
February 24 - 2017

Research Agenda and Motivation

1 Neonatal health is correlated with cognitive development

- Behrman & Rosenzweig (RESTAT, 2004), Black et al (QJE, 2007), Figlio et al (AER, 2014), Bharadwaj et al (JOLE, forthcoming)

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Q: What is the relationship between intergenerational correlation in neonatal health and child cognitive development?

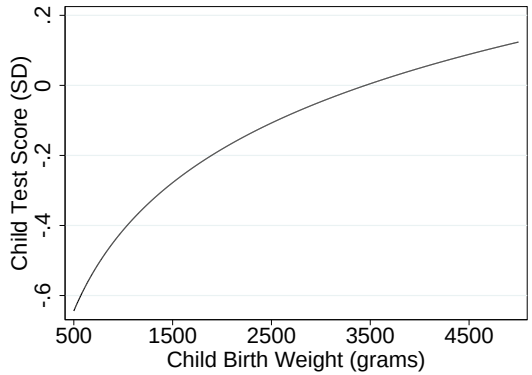
- Does parental neonatal health predict child cognitive development?
- Is the source of variation in neonatal health important?

Research Agenda and Motivation

A. Neonatal health and cogn. development

$testscore = \beta_0 + \beta_1 log(BW_g) + u$

- DK: $\widehat{\beta_1} \approx 0.30$
- US: $\widehat{\beta_1} \approx 0.29$ (Figlio et al; AER, 2014)



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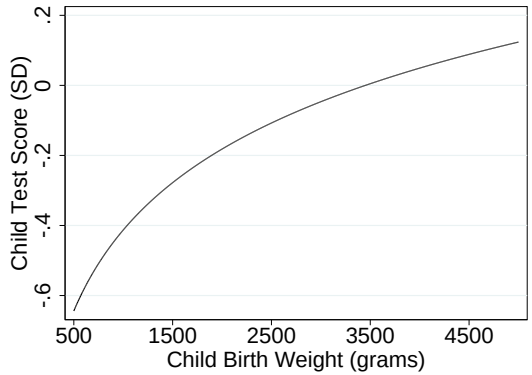

B. Intergen correlations in neonatal health

$log(BW_g) = \alpha_0 + \alpha_1 log(BW_{g-1}) + e$

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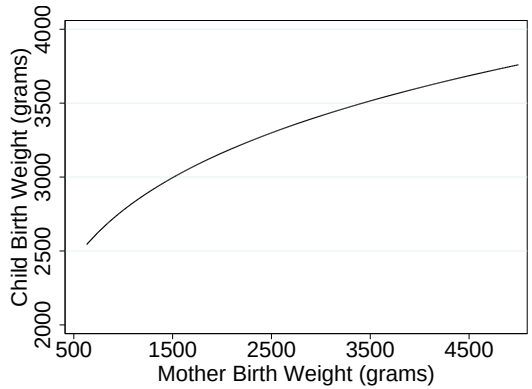

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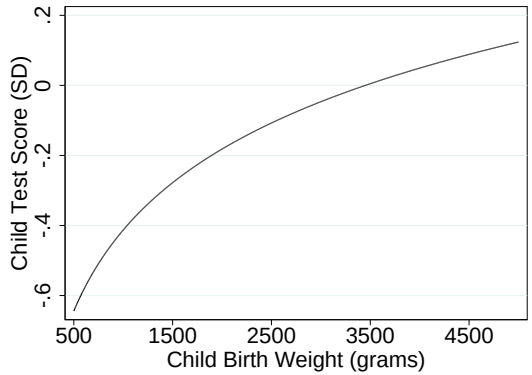

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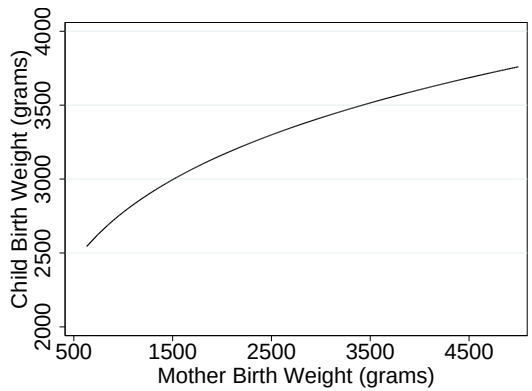


C. Neonatal health of parents and cogn. development of their children?

- Conjecture: $0.18 \times 0.30 \approx 0.05$

Agenda

A Does mother neonatal health predict child cognitive development?

B Is the source of variation in BW important?

C Does mother BW simply capture economic and human capital?

D Does father neonatal health predict child outcomes?

Data: Sources

1 Danish Birth Registry

- Birth weight information on all births 1973-2014.

2 National Test Data

- Mandatory tests in public schools in grades 2-8.
- Reading, Math, English, Geography, Science, Biology.
- All tests 2010-2015.

3 Administrative registers

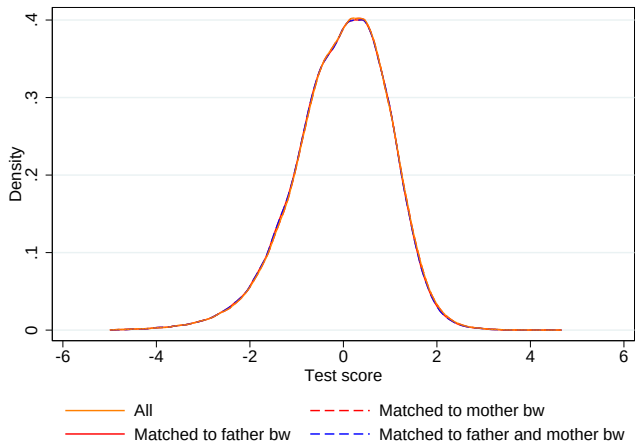
- Grandparents' income, wealth, and education.
- Parents' income, wealth, education, employment, origin, age and high school grades.

Data: Selection and measurement

Selection

- **All children born 1995-2006**.
- **By parental birth weight:** Birth weight on parents available for children with relatively young parents.
- **By test data:** Test data available for children in public schools.

Fig: Test distribution



Measurement

- **Standardized test score** (zero mean and unit sd).
- **Birth weight bins** and **Log birth weight**.

Data: Summary Statistics

Tab: Summary statistics for selected child variables

	Mean	SD
A. Child variables		
Birth weight, grams	3482.70	587.59
Birth weight $<$ 2,500gr	0.05	0.21
2,500 $\leq$ Birth weight $<$ 3,000gr	0.11	0.32
3,000 $\leq$ Birth weight $<$ 3,500gr	0.32	0.47
Birth weight $>$ 3,500gr	0.52	0.50
Singleton	0.93	0.26
Number of tests	3.60	2.28
B. Mother variables		
Birth weight, grams	3291.95	538.99
Birth weight $<$ 2,500gr	0.06	0.24
2,500 $\leq$ Birth weight $<$ 3,000gr	0.20	0.40
3,000 $\leq$ Birth weight $<$ 3,500gr	0.40	0.49
Birth weight $>$ 3,500gr	0.34	0.47
Age at child birth	26.27	3.84
Smoked during pregnancy	0.22	0.41

A Does parental neonatal health predict child cognitive development?

Tab: Mother neonatal health and child test score: partial estimates, conjecture and regression result

	Method	Relationship	Point estimate	SE	Conf. int.
1.	*regression:*	$y = \alpha + \beta log(bw_g) + u$	0.30^{***}	(0.012)	[0.27,0.32]

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3.	*conjecture:*	$y = \alpha + \beta log(bw_{g-1}) + u$	0.05^{***}	(0.002)	[0.05,0.06]

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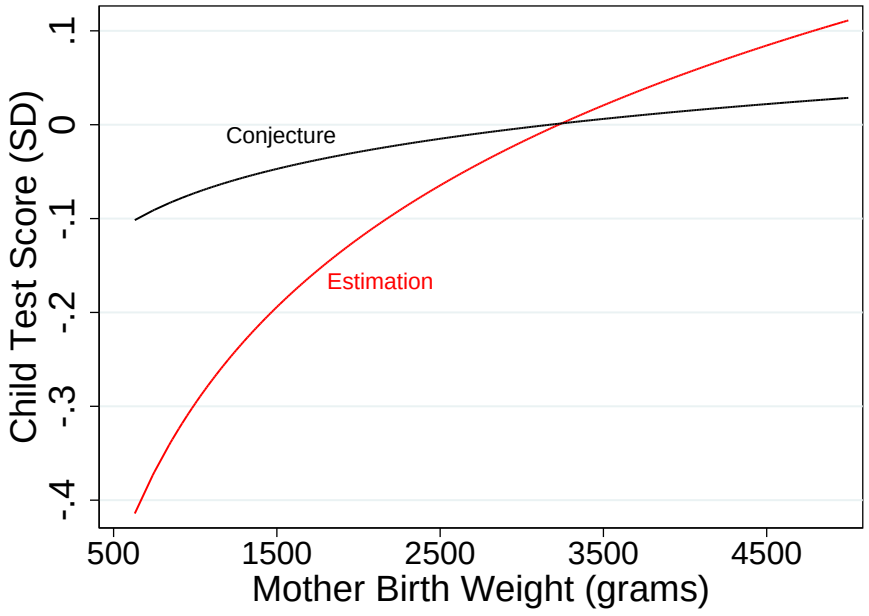
3.	*conjecture:*	$y = \alpha + \beta log(bw_{g-1}) + u$	0.05^{***}	(0.002)	[0.05,0.06]
4.	*regression:*	$y = \alpha + \beta log(bw_{g-1}) + u$	0.25^{***}	(0.014)	[0.22,0.28]

A Does parental neonatal health predict child cognitive development?

Fig: Lin-log relationship - Mother's neonatal health and the child cognitive development



- Estimate $testscore = \gamma_0 + \gamma_1 log(BW_{g-1}) + \epsilon \Rightarrow \widehat{\gamma_1} \approx 0.25$

A Does mother neonatal health predict child cognitive development?

- **Yes**, coefficient $\approx$ five times larger than partial estimates suggest.

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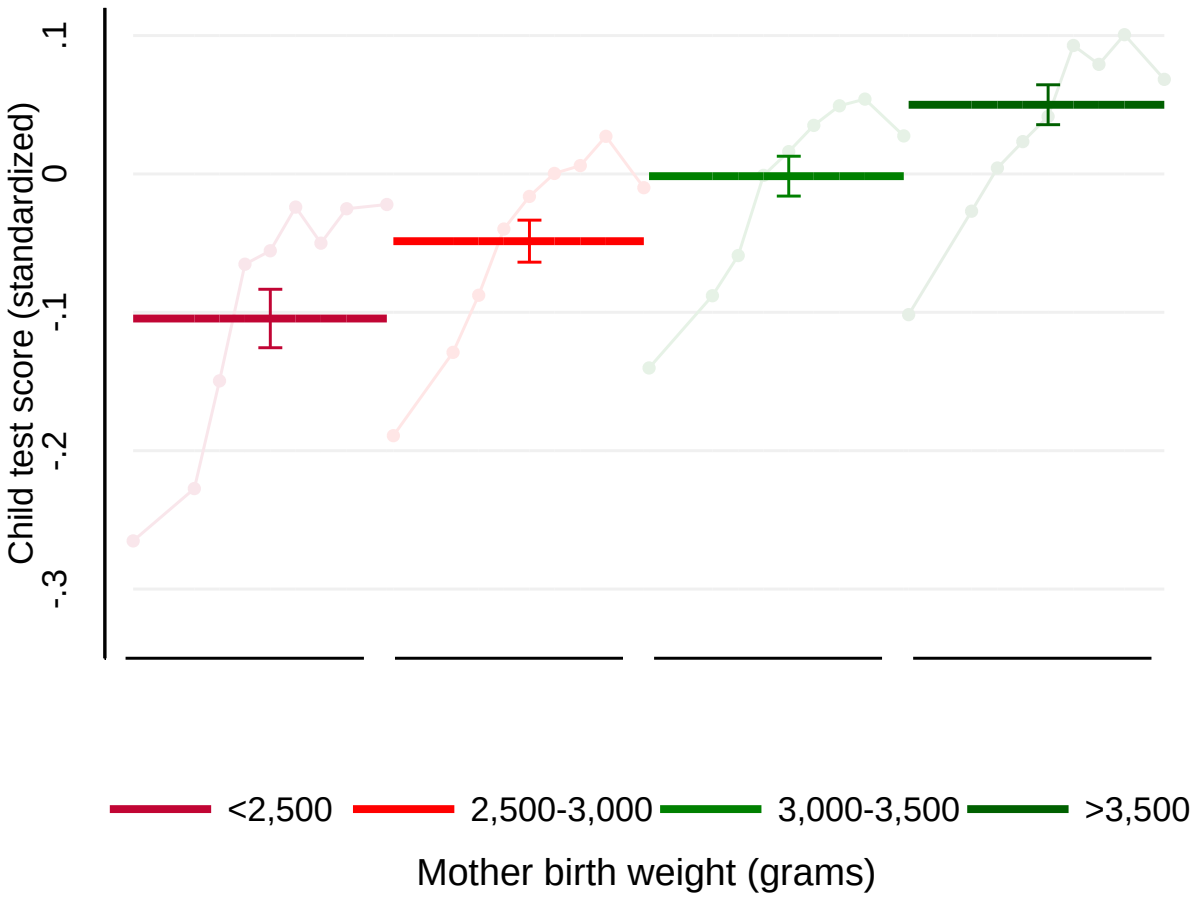
Fig: Mother's neonatal health and child's cognitive development



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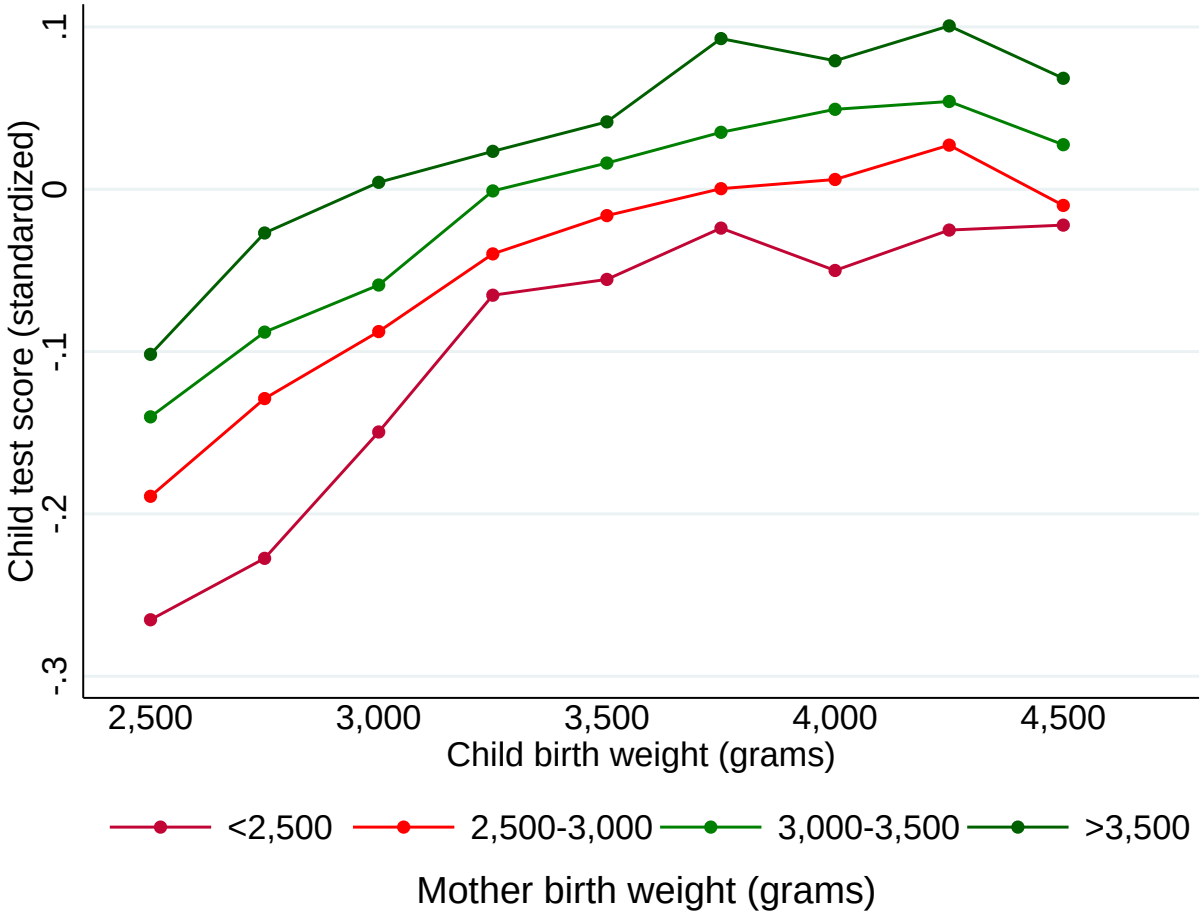


A Does mother neonatal health predict child cognitive development?

- **Yes**, coefficient $\approx$ five times larger than partial estimates suggest.

Potential explanations

- Source of variation in child BW is important.

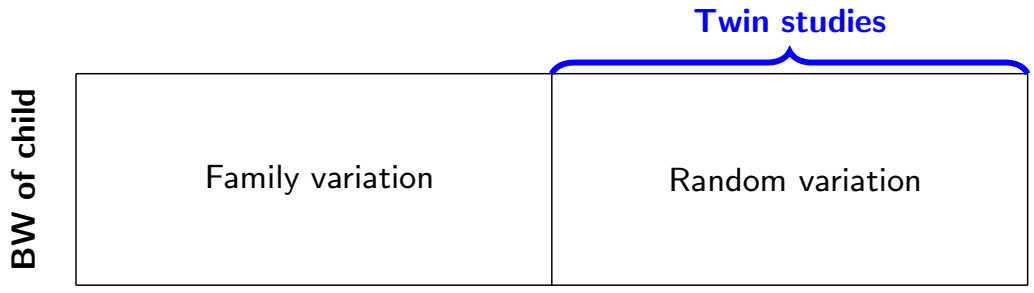
Next step

- What is the relative importance of family variation in birth weight for child cognitive development?

B Relative importance of family variation in birth weight

Decomposition exercise

1. **Twin studies** measure the correlation between test score and the variation in birth weight unrelated to parental background.



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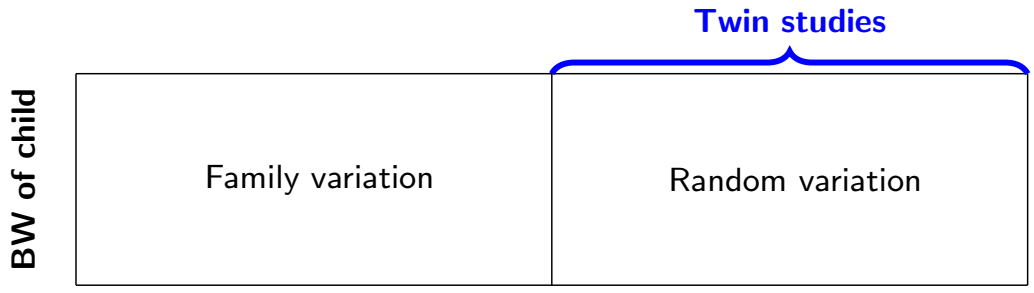

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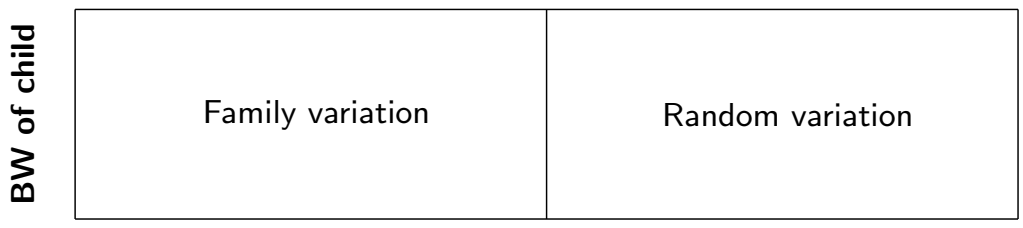

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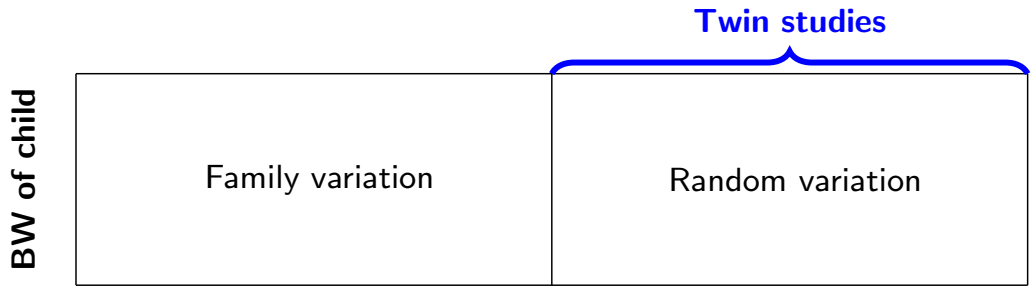

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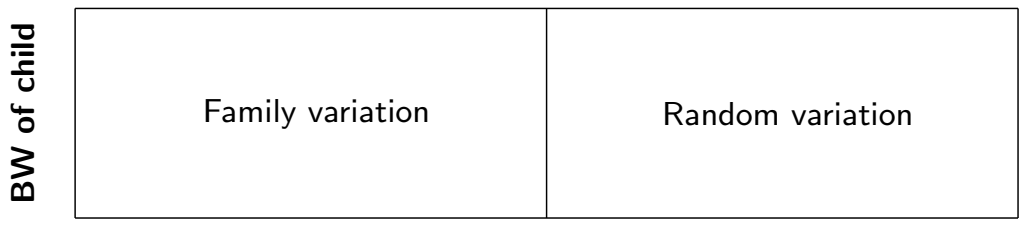

Pro: Not restricted to special sample of twins.

Con: Only part of family variation.

B Relative importance of family variation in birth weight

Birth weight of child w_g related to birth weight of parents w_{g-1}:

$$w_g = \gamma_w w_{g-1} + \gamma_\varepsilon \varepsilon \tag{1}$$

Test score a of child:

$$a = \alpha_w w_{g-1} + \alpha_\varepsilon \varepsilon + \sigma \tag{2}$$

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$$\left.\frac{\partial a}{\partial w_g}\right|_{\partial w_{g-1}} = \frac{\partial a / \partial w_{g-1}}{\partial w_g / \partial w_{g-1}} = \frac{\boldsymbol{\alpha_w}}{\boldsymbol{\gamma_w}} \qquad \left.\frac{\partial a}{\partial w_g}\right|_{\partial \varepsilon} = \frac{\partial a / \partial \varepsilon}{\partial w_g / \partial \varepsilon} = \frac{\boldsymbol{\alpha_\varepsilon}}{\boldsymbol{\gamma_\varepsilon}}$$

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- $\frac{\boldsymbol{\alpha_w}}{\boldsymbol{\gamma_w}}$ equals $\frac{\boldsymbol{\alpha_\varepsilon}}{\boldsymbol{\gamma_\varepsilon}} \Rightarrow$ doesn't matter where variation in birth weight comes from.
- $\frac{\boldsymbol{\alpha_w}}{\boldsymbol{\gamma_w}}$ greater (less) than $\frac{\boldsymbol{\alpha_\varepsilon}}{\boldsymbol{\gamma_\varepsilon}} \Rightarrow$ variation in birth weight is more (less) important if related to parental birth weight.

B Relative importance of family variation in birth weight

The OLS regression of test score on birth weight

$$\hat{\beta}_{OLS} = \frac{cov(a, w_g)}{var(w_g)} = \Omega \frac{\alpha_w}{\gamma_w} + (1 - \Omega) \frac{\alpha_\varepsilon}{\gamma_\varepsilon} \tag{3}$$

where $\Omega = \frac{\gamma_w^2 var(w_{g-1})}{\gamma_w^2 var(w_{g-1}) + \gamma_\varepsilon^2 var(\varepsilon)}$.

The IV-regression

$$\hat{\beta}_{IV} = \frac{cov(a, w_{g-1})}{cov(w_g, w_{g-1})} = \frac{\alpha_w}{\gamma_w} \tag{4}$$

The joint regression

$$a = \overbrace{\frac{\boldsymbol{\alpha_\varepsilon}}{\boldsymbol{\gamma_\varepsilon}}}^{\beta_1} w_g + \overbrace{\gamma_w \left(\frac{\boldsymbol{\alpha_w}}{\boldsymbol{\gamma_w}} - \frac{\boldsymbol{\alpha_\varepsilon}}{\boldsymbol{\gamma_\varepsilon}} \right)}^{\beta_2} w_{g-1} + \sigma \tag{5}$$

B Relative importance of family variation in birth weight

Tab: Child test score and child birth weight: Decomposed into the source of variation in child birth weight.

	$\frac{\alpha_\varepsilon}{\gamma_\varepsilon}$	$\frac{\alpha_w}{\gamma_w}$	Ratio
A. Log specification			
	0.27^{***}	1.36^{***}	5.09^{***}
	(0.01)	(0.08)	(0.38)
B. Level specification			
	0.09^{***}	0.39^{***}	4.51^{***}
	(0.00)	(0.02)	(0.33)

B Is the source of variation in BW important?

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Next step

- Is the strong correlation between mother BW and child cognitive development simply capturing economic and human capital of parents?

C Controlling for different channels

Tab: Child test score and mother birth weight, controlling for channels. Dependent variable: child test score.

	(1)	(2)	(3)	(4)	(5)	(6)
Log(mother_bw)						
Mother smoked						
Controls	1	125	142	542	757	758
Basic controls		Yes	Yes	Yes	Yes	Yes
Human capital			Yes	Yes	Yes	Yes
Economic capital				Yes	Yes	Yes
Grandparent capital					Yes	Yes
Behavior						Yes

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Tab: Child test score and mother birth weight, controlling for channels. Dependent variable: child test score.

	(1)	(2)	(3)	(4)	(5)	(6)
Log(mother_bw)	0.246***					
	(0.014)					
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	(0.014)	(0.014)				
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	(0.014)	(0.014)	(0.013)			
Mother smoked						
Controls	1	125	142	542	757	758
Basic controls		Yes	Yes	Yes	Yes	Yes
Human capital			Yes	Yes	Yes	Yes
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Log(mother_bw)	0.246***	0.176***	0.106***	0.101***	0.085***	0.080***
	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)
Mother smoked						-0.086***
						(0.006)
Controls	1	125	142	542	757	758
Basic controls		Yes	Yes	Yes	Yes	Yes
Human capital			Yes	Yes	Yes	Yes
Economic capital				Yes	Yes	Yes
Grandparent capital					Yes	Yes
Behavior						Yes

C Does mother BW simply capture economic and human capital?

- **No**, $\approx 1/3$ of the coefficient is not explained by parent and grandparent economic and human capital.

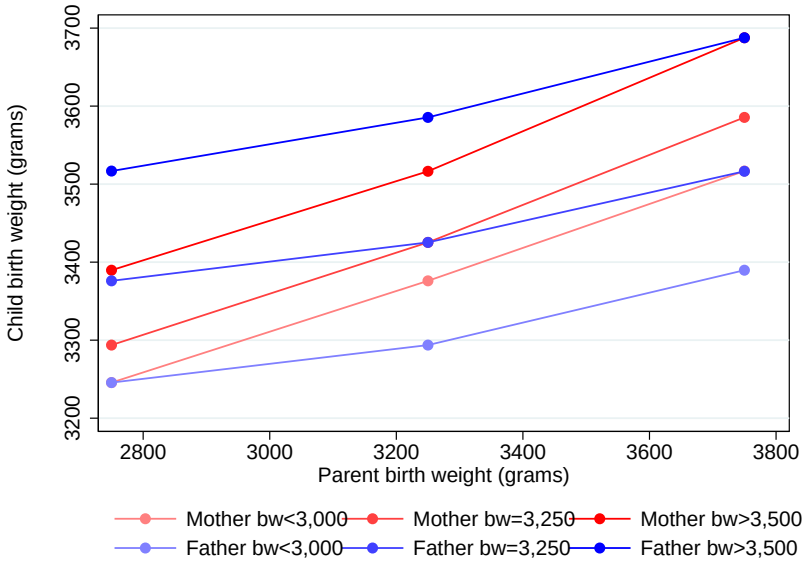
The missing father

- How important is father neonatal health?

D Mother vs. father neonatal health.

Fig: Mother and father neonatal health

A: Child BW



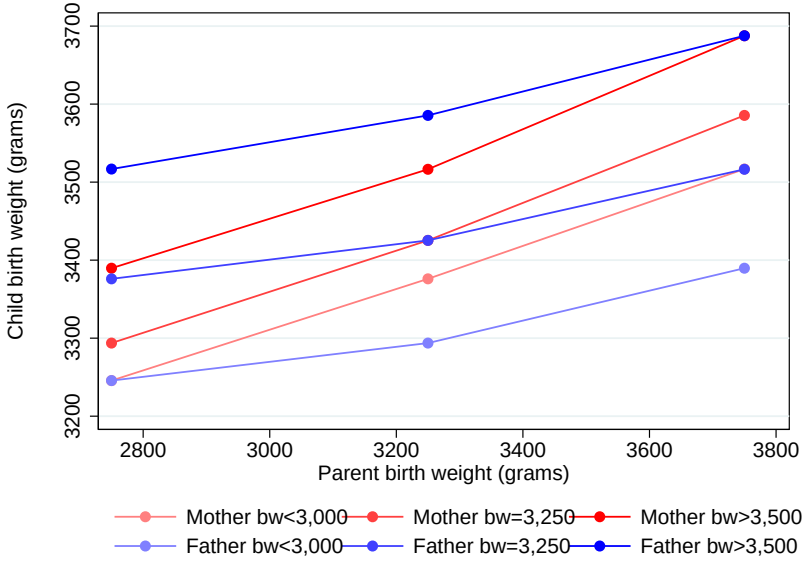
D Does father neonatal health predict child outcomes?

- **Yes**, father BW predicts child BW, but father BW is less powerful than mother BW.

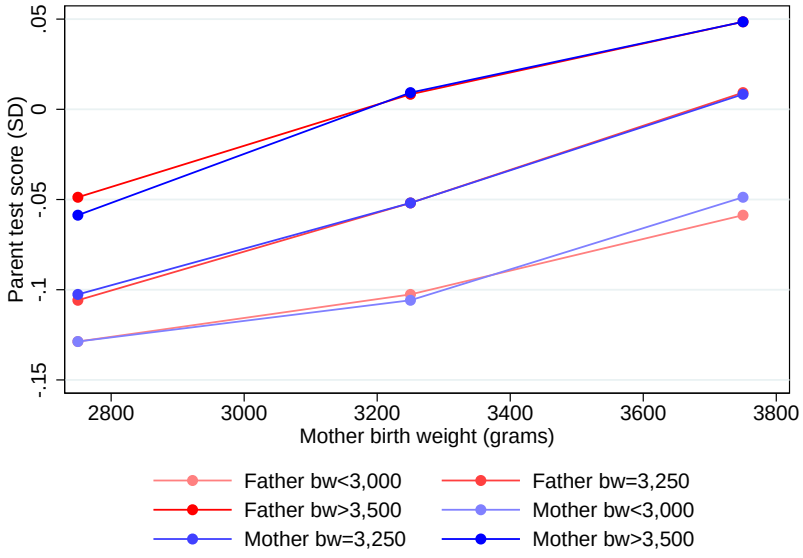
D Mother vs. father neonatal health.

Fig: Mother and father neonatal health

A: Child BW



B: Child test score



D Does father neonatal health predict child outcomes?

- **Yes**, father BW predicts child BW, but father BW is less powerful than mother BW.

  Father and mother BW equally important in predicting child cognitive development.

Conclusion

A Does mother neonatal health predict child cognitive development?

- **Yes**, coefficient $\approx$ five times larger than partial estimates suggest.

B Is the source of variation in BW important?

- **Yes**, variation in BW related to parental BW $\approx$ five times more important than variation in BW unrelated to parental BW.

C Does mother BW simply capture economic and human capital?

- **No**, $\approx 1/3$ of the coefficient is not explained by parent and grandparent economic and human capital.

D Does father neonatal health predict child outcomes?

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  Father and mother BW equally important in predicting child cognitive development.

Implications

Intergenerational transmission of neonatal health is related to development of cognitive skills and probably also economic outcomes.

- A 10% higher mother (or father) BW is associated with a 2.5% SD higher test score
  ($\approx$ to a change of 5 income percentiles).

- Understanding how parental neonatal health is related to child development is important for understanding intergenerational correlations in economic outcomes.

extra slides

Mother Twin FE results

Tab: Regression results Mother twin FE

Dependent variable	(1) log(child bw)	(2) log(child bw)	(3) test score	(4) test score
Log (mother bw)	0.025	0.098	0.390	1.321**
	(0.068)	(0.119)	(0.371)	(0.621)
Observations	100	100	100	100
Grandmother FE		Yes		Yes

Controls included: mother age at child birth (indicators). * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

Finding: Within twin variation in birth weight related to BW and GPA of next generation.