Inequality in Health

Tutorial 4

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The Grossman model

Idea: Representation of health as a capital stock that depreciates by time but also can be increased . Length of life is an optimization issue under certain constraints.

- **Stock variable**: Health represents a quantity that is accumulated and depreciated over the years. The rate of depreciation accelerates as the person gets older.
- **Investment** in certain things (e.g medical care, diet) can increase health stock.

The Grossman model

Utility function:

$$U_t = U(H_t, C_t) \tag{1}$$

Production function:

$$H_t = I_{t-1} - (1 - \delta)H_{t-1} \tag{2}$$

Constraints:

$$T_t, B_t \tag{3}$$

Produce health until:

$$MC = MB \tag{4}$$

The Grossman model

$$H_t = I_{t-1} - (1 - \delta)H_{t-1} \tag{5}$$

Health at time t depends on investment of the previous time period I_{t-1} and the remaining health stock. δ is the depreciation rate. If the investment is too low or δ too large the health reduces. After a certain threshold death arises.

- **What are some implications of the model?**

Implications of the Grossman model

Health depreciation is proportional of H_{t-1}. δ is set at an increasing rate over the years in order for the model to account for death.

- **Implying:** As the years pass the health stock is affected less by the initial health endowment H_{t_0}. Thus, eventually effects of poor health during early life will fade over time.

What are the policy implications of this model?

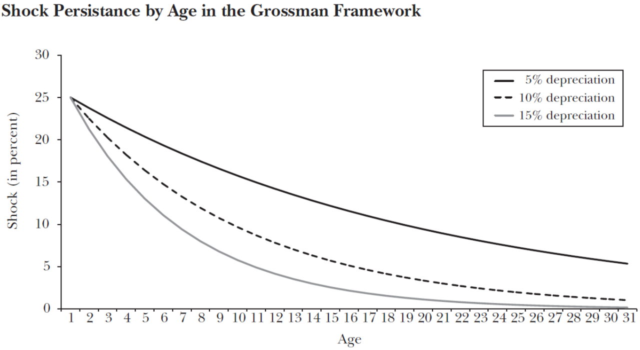


Figure: Source: Almond, D. and Currie, J., 2011. Killing me softly: The fetal origins hypothesis. Journal of economic perspectives

- High δ rate scenario: **A 25 % shock to the H_{t_0} it faded out until age 30.**

Health endowment H_{t_0}

Shocks on H_{t_0}: Are there evidence that they fade away?

- **No!** Research from different fields (economics, public health, medicine etc) is not supporting this hypothesis.
- Initial health is an important determinant of future health.
- **Barker Hypothesis:** Shock at intrauterine environments that affect fetal growth are leading to adverse health effects for lifetime.

Why do the origins of disease start so early in life?

Developmental plasticity: Organs have a certain period that they develop. Shocks can impede their growth or generate metabolic changes that will affect the reach of a healthy organ development. Fetal physiology and metabolism can be impacted by:

- **Malnutrition:** (e.g lack of micronutrients or junk food)
- **Maternal stress:** (e.g anxiety due to unemployment)
- **Environmental factors:** Environmental contaminants (e.g arsenic), cesarean section (due to gut microbiota composition changes), domestic violence, lack of clean water etc

Fetal origins hypothesis literature:

- **Persistence** of health and socio-economic effects in lifetime.
- Effects can appear decades **after** the shock.
- **Environmental factors** can mediate the process.
- **Inter-generational effects:** The programming can be inherited to the offspring.

Policy implication: Policies that improve health targeted at early-life are important.

Health Deficits and Fetal origins hypothesis

Dalgaard & Strulik's (2014) represent ageing as a process of health deficits accumulation. Simple form:

$$D_t - D_{t_1} = \mu(D_{t_1} - E) \tag{6}$$

- D represent health deficits, μ is the natural rate of aging, E the enviromental factors.
- Death occurs whenever $D(t) > \bar{D}$

This model better accommodates the Fetal origins hypothesis. Initially unhealthy persons accumulate faster health deficits. There is no convergence after years like in the Grossman model. Initial conditions widen disparities in later life among individuals.

Air pollution:

- Air pollution is a major public health concern globally.
- Associated with respiratory or cardiovascular diseases.
- Pollution can impact organs and change genetic expressions.
- Unequally distributed between communities. Demographic factors, poverty status determines who resides in a polluted environment.
- Reduces labor productivity, property values etc

Air Pollution

- Many areas experienced **improvements** regarding pollution.
- Many of those improvements were a result of various **reforms** that banned actions or factors that were generating pollution. Examples: Regulations on industrial polluters, banning of diesel cars etc.
- Those events create **variation** in pollution level that could be used as a 'natural experiment'.
- Quasi-experimental techniques can use those events to estimate effects that are causal. Example: Anything that exogenously moves around a pollution level can be used as an instrument.

Air Pollution Literature: Example

1. **Clean Air Act regulations**

   Isen et al. (2017): Those regulations improved labor force participation and earnings.

2. **Diesel emission scandal**
   - Alexander and Schwandt (2019): VW defeat devices increased low-birth weight and acute asthma attacks. The effects were across all SES.

3. **Inversion episodes**
   - Jans et al. (2018): Inversion episodes increased particulate matter levels. Leading to children respiratory diseases by 5.5 per cent. Poor children are more vulnerable.

4. **Emission Zones in Germany**
   - Klauber et al. (2021): Exposure to clean air around birth is associated with lower medication usage in childhood.

Lead exposure

- Lead is a heavy metal that is **toxic** for humans.
- Exposure to lead impedes **growth and development**.
- Lead in the blood of infants can affect long-term cognitive abilities.
- In utero or within **24 months** of life exposure matters.
- It was commonly used in the past (e.g paints, gasoline)

Paper I: Grönqvist et al. (2020)

What are the long-term effects of lead exposure?

- Challenge 1: Sorting into neighborhoods. Children that live in lead-contaminated areas are poorer.
- Challenge 2: Difficult to capture lead exposure.
- Challenge 3: Dataset should have a large follow-up time to capture the long-term effects,

Source: Understanding How Low Levels of Early Lead Exposure Affect Children's Life Trajectories. Journal of Political Economy.

Grönqvist et al. (2020) Paper

- Sweden was historically a **low-lead contamination** setting due to various regulations in place since the 1920s.
- Still lead was a component on gasoline in order to enhance engine performance.
- Policy-makers initially were not concerned due to **low traffic density** in many parts of the country. Eventually they decided that it could be an important issue in the future
- Introduction of a policy in 1980/1981 that **phased out the lead in gasoline in Sweden**.

Grönqvist et al. (2020) Paper

Dataset:

- Administrative data covering the periods 1972-1974, 1977-1979, 1982-1984. Grade point average.
- Information on criminal convictions and crimes.
- Cognitive measures (conscription data).
- Measures of heavy metal air pollution. Lead exposure MPb level.

Grönqvist et al. (2020) Paper

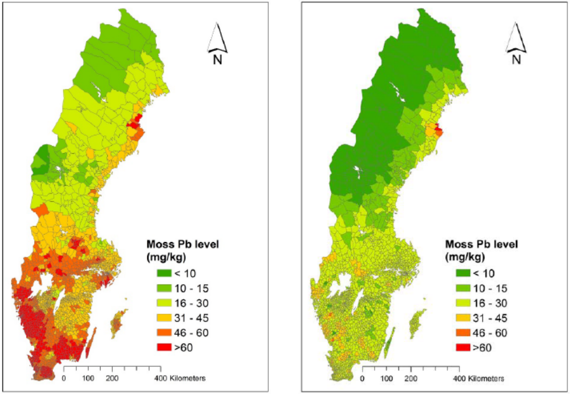


Figure 3. Neighborhood of birth lead exposure levels in 1975 (left) 1985 (right), (in color)

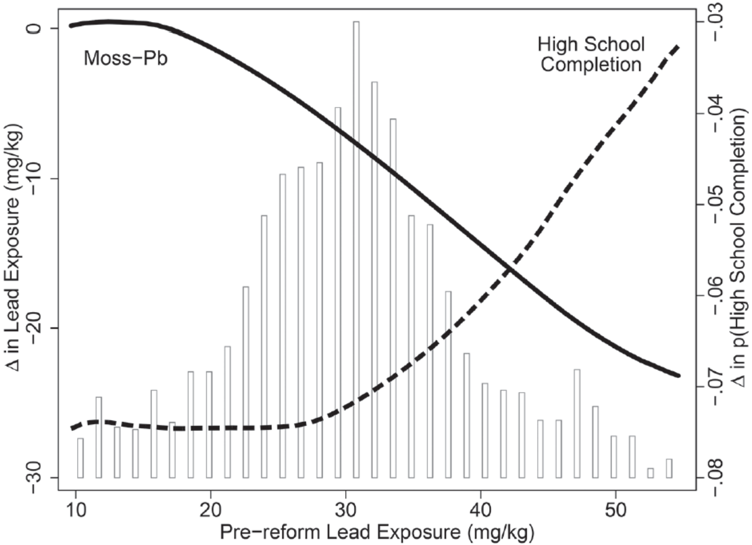
Figure: Source: Understanding How Low Levels of Early Lead Exposure Affect Children's Life Trajectories. Journal of Political Economy.

Grönqvist et al. (2020) Paper

Identification: Exploits variation in lead exposure across groups born around the policy.

- Assumption: No other concurrent changes correlated with the reform that also affect cognitive abilities.
- Common trends.

Grönqvist et al. (2020) Results



Grönqvist et al. (2020) Empirical Method

Reduce Form:

$$Y_{inc} = \sum_{1976}^{1984}(BirthCohort * PrereformLead_n) * \gamma_c + Covariates_{in} + FE_c + \epsilon \quad (7)$$

First-Stage:

$$Lead_{nc} = \pi(FullReform_c * PrereformLead_n) + Covariates_{in} + FE_c + \epsilon \quad (8)$$

Second-Stage:

$$Y_{inc} = \delta * \hat{Lead}_{nc} + Covariates_{in} + FE_c + \epsilon \quad (9)$$

- Prereformlead: Lead-levels before the reform.
- FullReform: 1982-84 cohort.
- Covariates: Individual-level and municipality-level controls.
- Subscripts: n:neighborhood, c:cohort, m:municipality

Grönqvist et al. (2020) Results

TABLE 6
OLS and 2SLS Estimates of the Effect of the 1980–81 Reforms on Males

	Dependent variable							
	GPA		*P*(high school graduation)		Noncognitive Skills		Cognitive Skills	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
	A. Above Threshold							
Lead exposure (mg/kg)	−.164***	−.256***	−.0022***	−.0044***	−.0056**	−.0124***	.0003	−.0015
	(.030)	(.0769)	(.0006)	(.0008)	(.0020)	(.0030)	(.0009)	(.0024)
Commuting zones (CZs)	46	46	46	46	46	46	46	46
Neighborhoods	1,313	1,313	1,313	1,313	1,313	1,313	1,313	1,313
No. of children	172,786	172,786	172,786	172,786	172,786	172,786	172,786	172,786
First-stage *F*-statistic	NA	49.1	NA	49.1	NA	49.1	NA	49.1
	B. Below Threshold							
Lead exposure (mg/kg)	−.0109	−.0534	.0009	−.0014	.00251	.01095	.0007	−.0031
	(.0571)	(.1633)	(.0008)	(.0033)	(.0024)	(.0085)	(.0016)	(.0037)
CZs	71	71	71	71	71	71	71	71
Neighborhoods	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,138
No. of children	123,780	123,780	123,780	123,780	123,780	123,780	123,780	123,780
First-stage *F*-statistic	NA	19.4	NA	19.4	NA	19.4	NA	19.4

Grönqvist et al. (2020)

Differential trends can arise in this setting and bias the estimates.

- For example Population density both influences emissions and child outcomes.
- Authors check this possibility and they do not find any correlation of population density or employment changes with lead level changes .

Could sorting in neighborhoods explain the results?

- Balancing test to investigate the relationship of family characteristics and lead exposure. Authors argue that is not a concern.

Clean Air Act

- Flagship program in the USA to improve the air quality.
- Introduced regulations that restrict the pollutants that can be produced.
- Reduced particulate matter, carbon monoxide, lead levels
- This policy led to quasi-random variation between counties in the change of pollutant levels.

Clean Air Act

Research demonstrates that this program improved health:

- Deschenes et al. (2017): Policy improved air quality and reduced premature mortality
- Bishop et al. (2019): Pollution is connected with dementia.
- Isen et al (2017): Pollution improved human capital.

But do the effects extend beyond the people directly affected?

Colmer and Voorheis (2020): The grandkids aren't alright: the intergenerational effects of prenatal pollution exposure

Research demonstrates that this program improved health:

- In utero-exposure in pollution affects not only the long-term outcomes of the affected persons but also their offspring.
- The future generation is less likely to attend college half a century later.
- Inter-generational transmission due to economic forces (e.g family investments)

Colmer and Voorheis (2020): The grandkids aren't alright: the intergenerational effects of prenatal pollution exposure

- **Administrative Data** with children-parent pairs.
- **Approach**: Use the Clean Air Act policy as an instrument
- **Assumption**: Policy does not affect outcomes in any other way than through reductions in pollution.
- **Findings**: A 10 mg/m3 reduction in parental prenatal pollution increases college attainment by 8 per cent.

Tutorial

Thank you!