# Time Dimension of the Link between Income Inequality and Health:

## The Immediate, Cumulative, and Comparative Effects

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# THEORETICAL MOTIVATIONS: The Income Inequality-Health Link

- **Income inequality hypothesis (IIH)** (Wilkinson, 1992; 1996; 2005; Wilkinson & Pickett, 2008) -- Income inequality universally impairs individual health in a society by triggering psychosocial risks and chronic diseases.

- **Absolute income hypothesis (AIH)** (Gravelle 1998) -- Income inequality per se has no direct impact on individual health but one's absolute income confounds the assumed link from income inequality to individual health.

- **Neo-materialism pathway (NMP)** (Lynch et al., 2000) -- Income inequality correlates with individual health only because they are both outcomes of cultural norms, social regimes, and political ideologies.

# RESEARCH QUESTIONS

- Does income inequality within a society adversely affect individual health, regardless of individual socio-economic backgrounds, in alignment with the predictions of the Income Inequality Hypothesis (IIH)?

# OUR INNOVATIONS: TEMPORAL STRUCTURE OF IIH

- *Income distribution has changed significantly over time* (Piketty 2014) – Wild fluctuations of income inequality challenge the reliability of short-term, point-specific measures of income inequality (e.g., the **instant Gini index**).

- *Psychological mechanisms of physical health follow a "latency period"* (Lynch, 2005) *or time-lagging effects* (Blakely et al., 2000; Kondo et al., 2011) – We advocate exploring period-long income inequality and the **cumulative measure**.

- *Individuals perceive external stimuli in comparison with historical reference points* (Kahneman, 2011)--. We need to consider the possibility that the longitudinal change in income inequality could have a more substantial impact than the inequality itself, necessitating the **comparative measurement** of dynamic trends.

# OUR INNOVATIONS: TEMPORAL STRUCTURE OF IIH

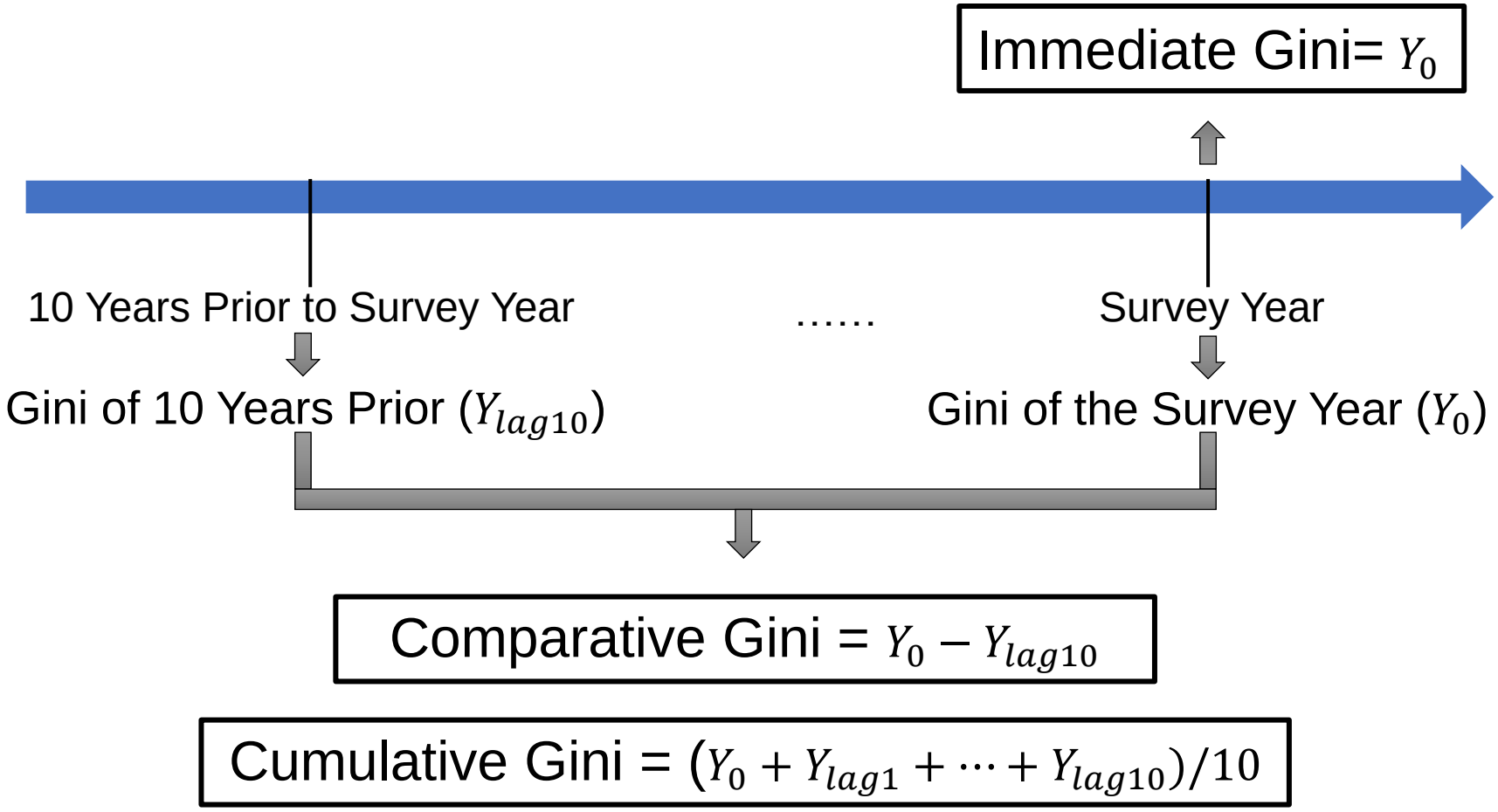



Figure 1. Conceptual Distinction of Three Measures on the Time Dimension

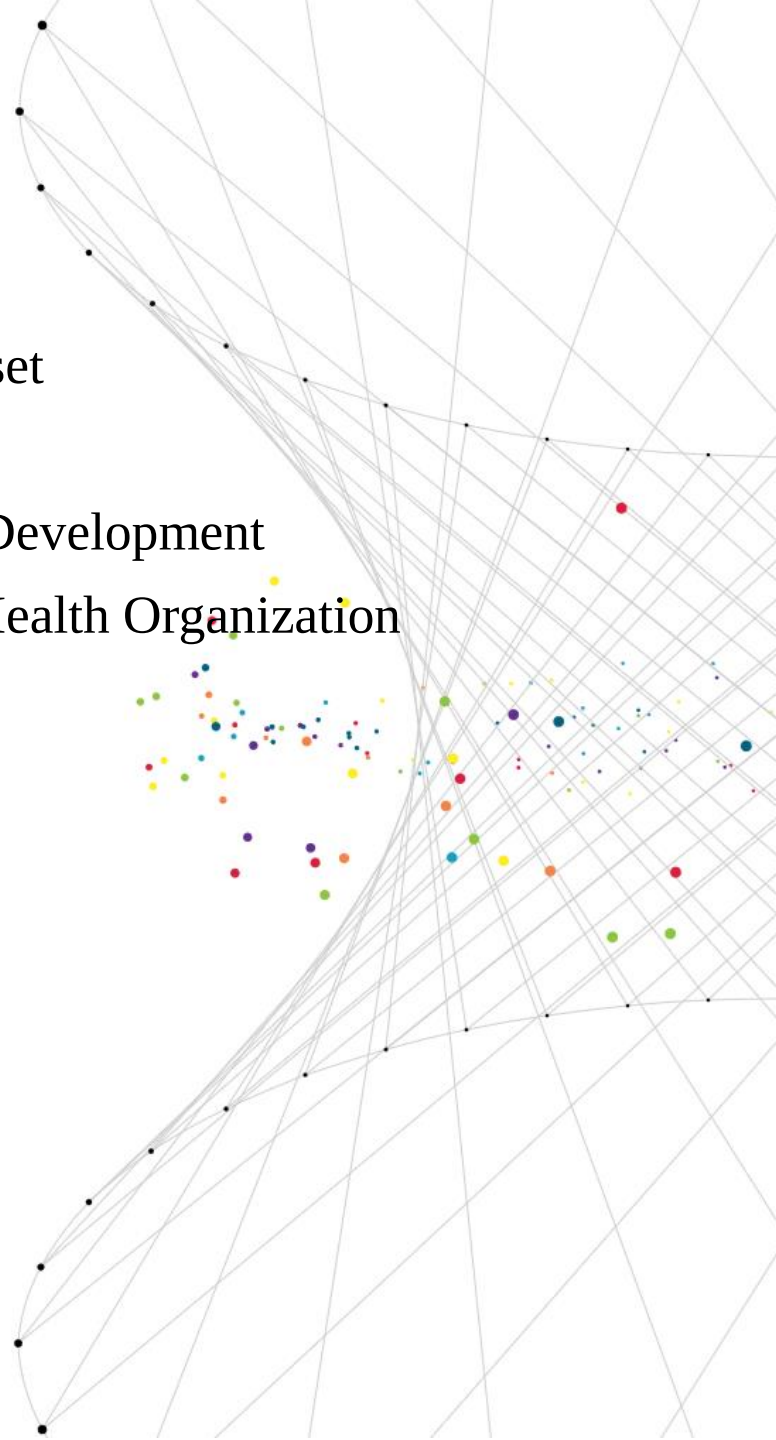
# RESEARCH DESIGNS

## DATA

- World Values Survey (WVS) 1981-2016 repeated cross-sectional dataset
- Standardized World Income Inequality Database (SWIID) (Solt, 2020)
- World Income Inequality Database (WIID) by the World Institute for Development
- Health Indicator Dataset by the Global Health Observatory of World Health Organization

## ANALYTICAL SAMPLES

316,251 individuals from 91 countries/regions and 27 years



# RESEARCH DESIGNS

## DEPENDENT VARIABLE

Subjective Health: Self-Reported, from 1 (very poor) to 5 (very good)

## INDEPENDENT VARIABLES

Immediate, Cumulative, and Comparative Values of the Gini Index

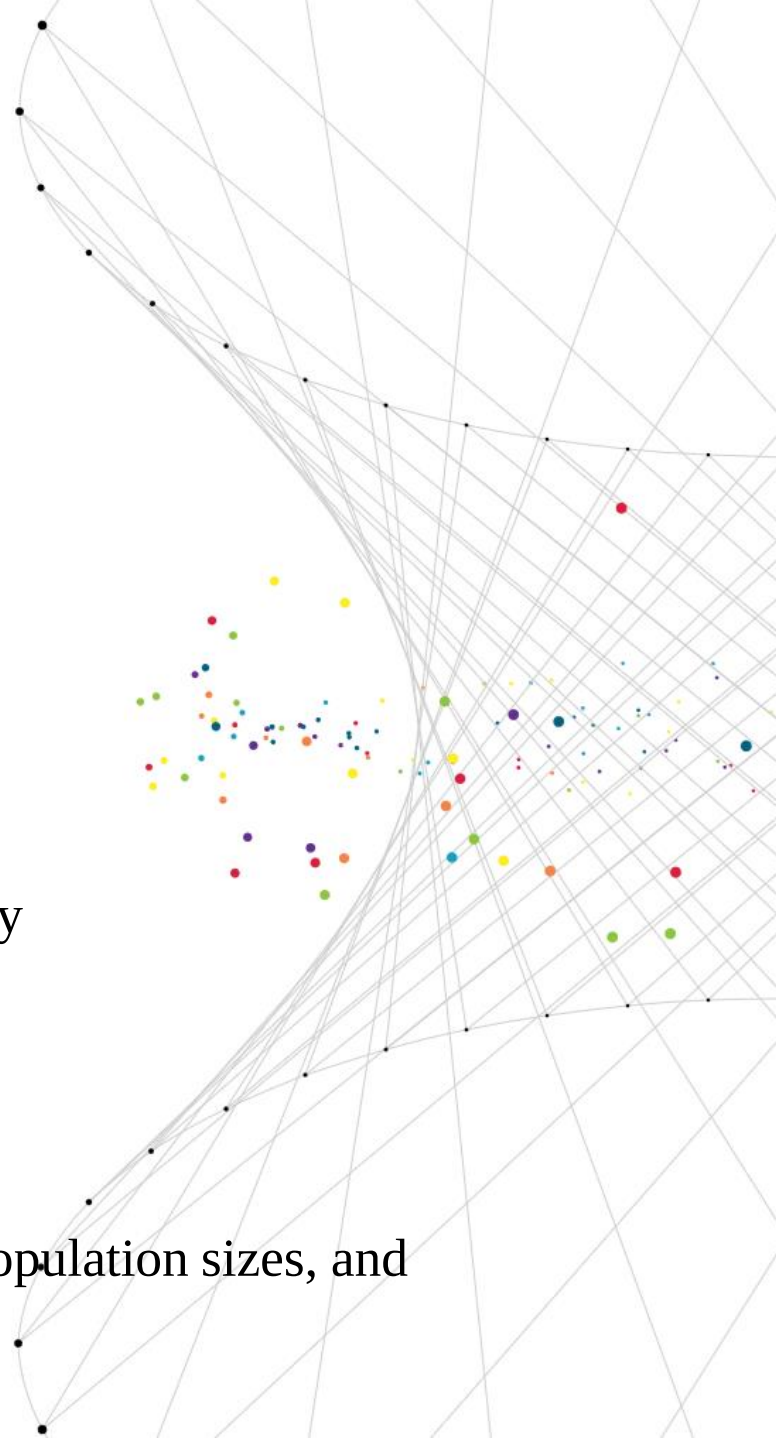
## METHODS: Multilevel Panel Data Models

- Two-Level Random-Effect Model: Individual - Country*Time
- Three-Level Fixed-Effect Model: Individual - Country*Time - Country

## CONTROL VARIABLES

Individual Level: sex, age, age square, individual income, education

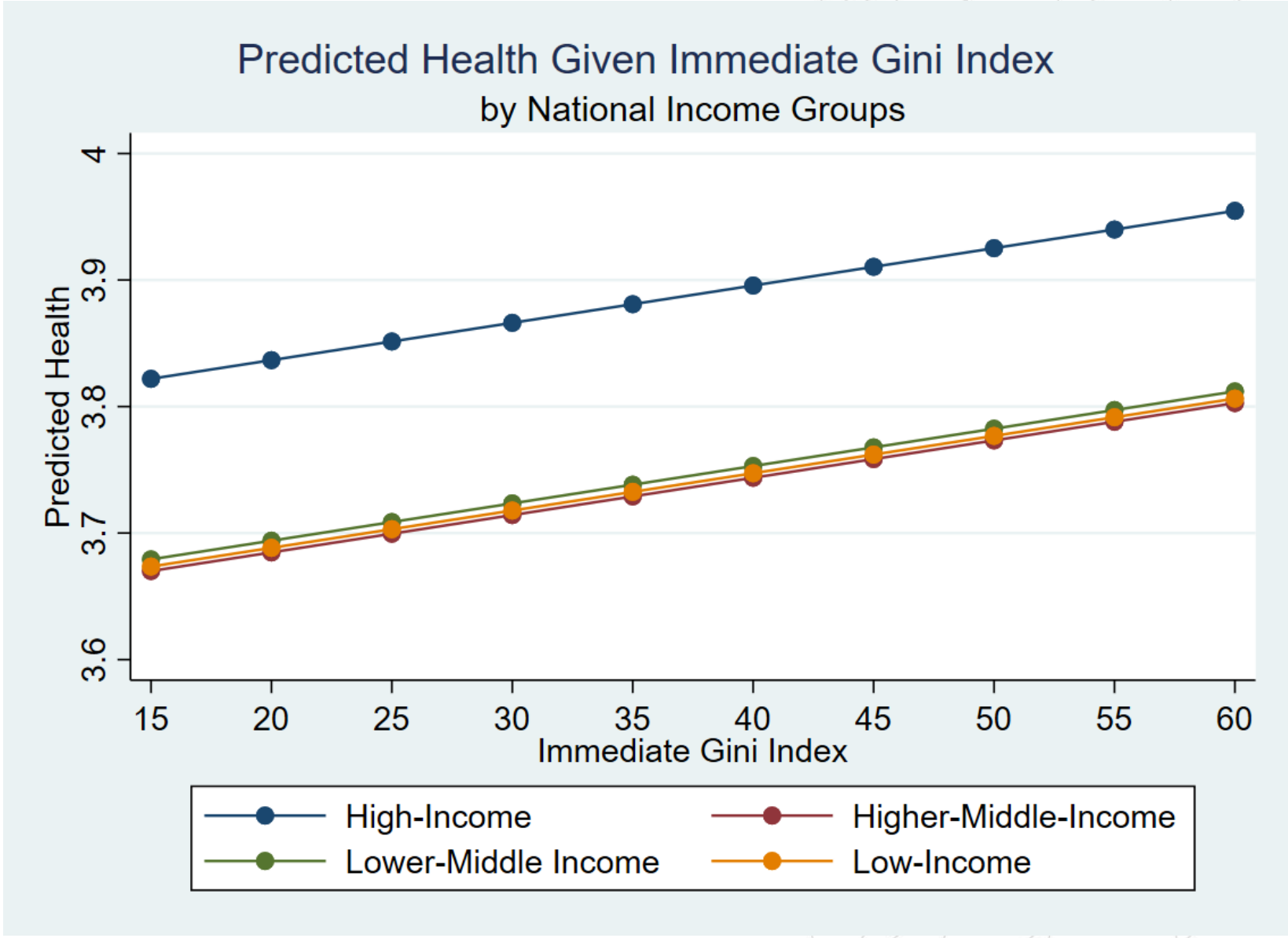
Nation*Time Level: logged GDP per capita, GDP growth rates, logged population sizes, and percentages of out-of-pocket medical expenditure (%)



# MODEL
# **RESULTS**

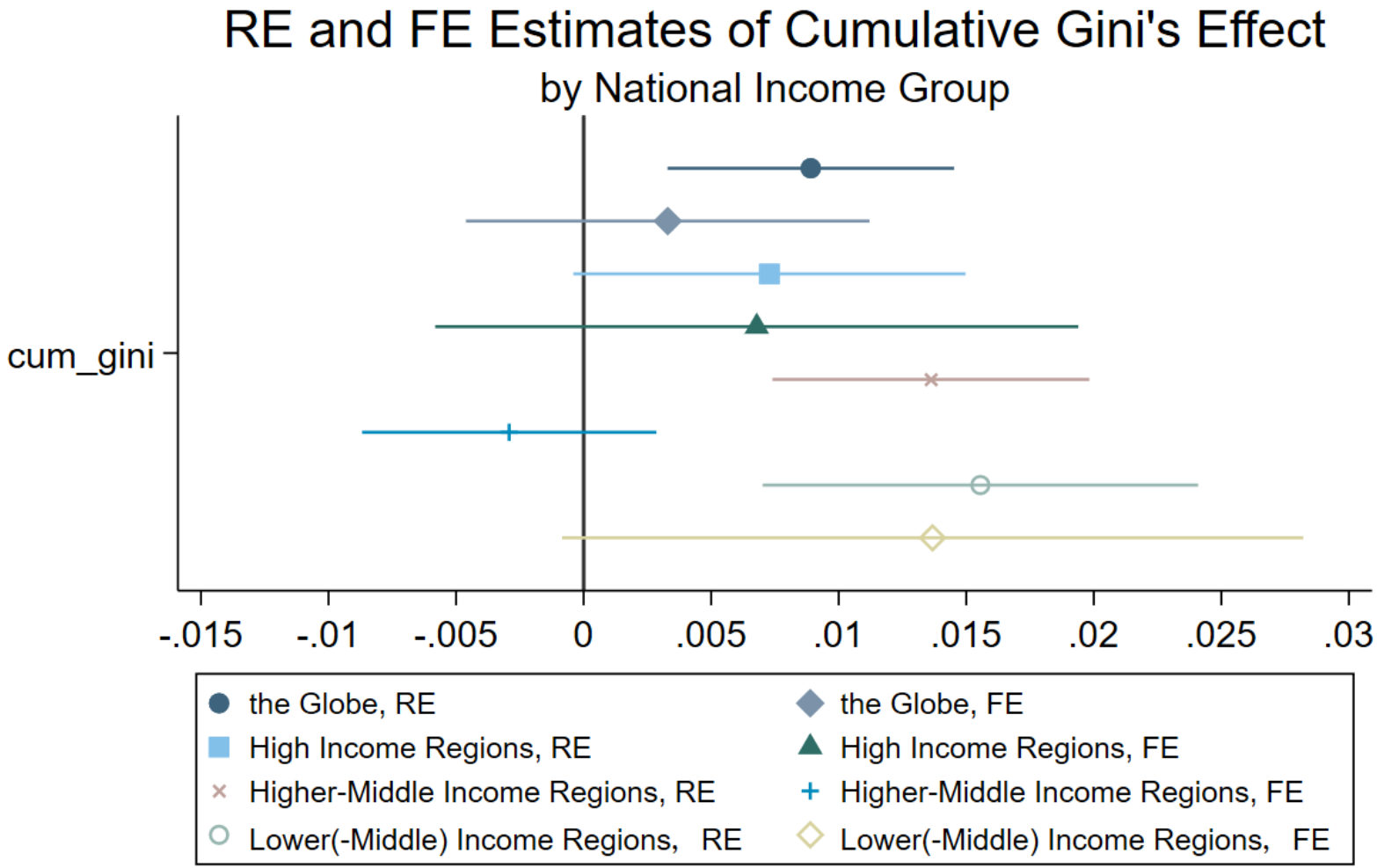
# Model-Based Prediction

**The positive link from immediate income inequality to individual health is evident for all regions across the world, contrary to IIH.**




Note: Predictions here come from RE models. Control variables include sex, age, age square, individual income, education, ang national logged GDP per capita.

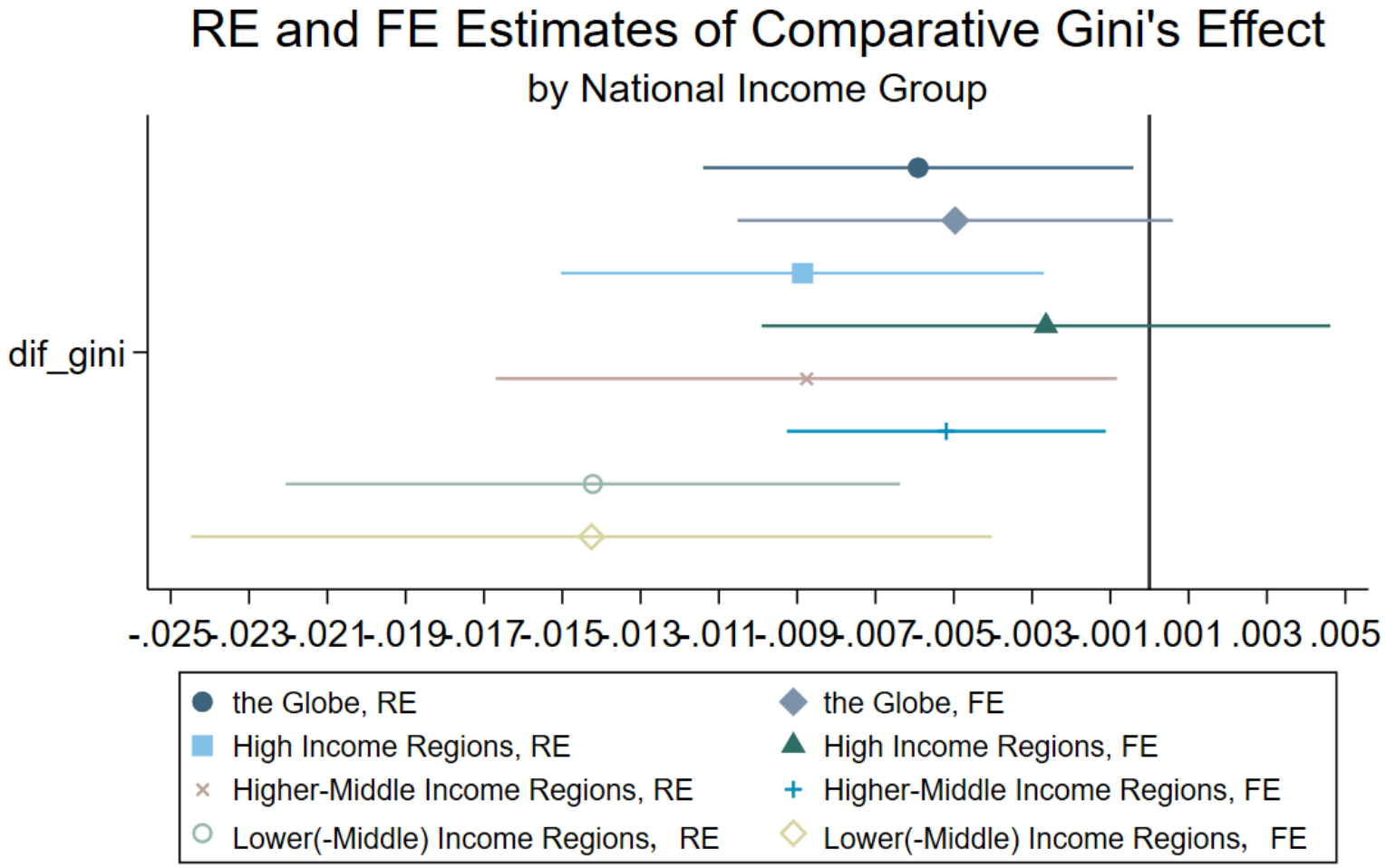
Figure 3 Random- and Fixed-Effect Model Estimates for Parameters of the Cumulative Gini Index: From 1981 to 2016, by National Income Groups




Data source: micro data from World Values Survey, 1981-2016; macro data from Standardize World Income Inequality Database (Solt, 2020), World Income Inequality Database, United Nations Development Programme, and Global Health Indicator Dataset.

Note: Markers represent the point estimates for parameter while horizontal bars are the 95% confidence intervals. Full models are shown in the appendix tables. In both fixed- and random-effect models, control variables include sex, age, age square, individual income, education, ang national logged GDP per capita. For the full-sample models, we introduce more national time-variate control variables, such as GDP growth rates, logged population sizes, and percentages of out-of-pocket medical expenditure (%).

Figure 4 Random- and Fixed-Effect Model Estimates for Parameters of the Comparative Gini Index: From 1981 to 2016, by National Income Groups

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# CONCLUDING REMARKS

- *The comparative/dynamic effect of income inequality varies significantly from the static or cumulative effect.* Thus, we emphasize the importance of the temporal structure of the inequality-health link.

- *Our findings assert that income inequality negatively impacts individual health universally, aligning with the Income Inequality Hypothesis (IIH), at least in its comparative version.* This reinforces the consensus that health is not solely biologically determined but intricately shaped by societal constructs.

- *The perplexing positive correlation between income inequality and health demands careful interpretation in future research.* There is a pressing need for more detailed, in-depth, and comprehensive investigations, utilizing high-quality data and robust methodologies across diverse regions and time periods to advance our understanding of this complex relationship.

# THANK YOU FOR LISTENING

All questions and comments are warmly welcomed!


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# DATA REPRESENTATION

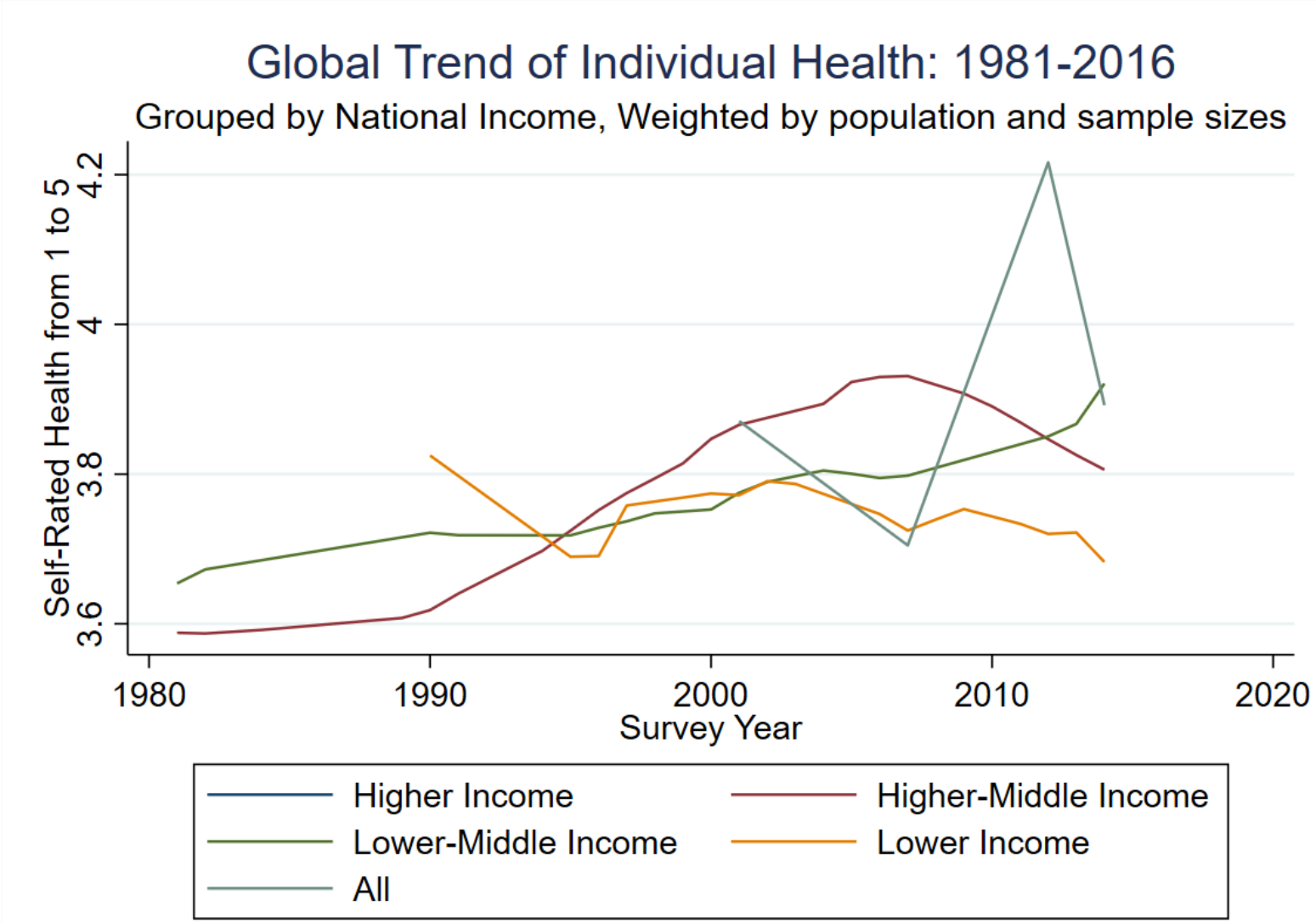
Appendix

| NATIONAL INCOME GROUP | COUNTRIES/REGIONS SAMPLED |
|---|---|
| High-Income Group | Andorra, Argentina, Australia, Canada, Chile, Croatia, Cyprus, Czech Rep., Estonia, Finland, France, Germany, Hong Kong, Hungary, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Puerto Rico, Qatar, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Taiwan |
| Higher-Middle-Income Group | Albania, Algeria, Armenia, Azerbaijan, Belarus, Bosnia Herzegovina, Brazil, Bulgaria, China, Colombia, Dominican, Ecuador, Guatemala, Iran, Iraq, Jordan, Kazakhstan, Macedonia, Malaysia, Mexico, Peru, Romania, Russia, Serbia, South Africa, Thailand |
| Lower-Middle-Income Group | Bangladesh, Egypt, El Salvador, Georgia, Ghana, India, Indonesia, Moldova, Morocco, Nigeria, Pakistan, Palestine, Philippines, Tunisia |
| Low-Income Group | Burkina Faso, Ethiopia, Mali, Rwanda, Tanzania |

# DATA COVERAGE: 1981-2016



| World Values Survey waves | |
|---|---|
| Wave | Survey years |
| 1 | 1981-1984 |
| 2 | 1990-1994 |
| 3 | 1995-1998 |
| 4 | 1999-2004 |
| 5 | 2005-2009 |
| 6 | 2010-2014 |
| 7 | 2017-2020 |




Note: The WVS dataset does not provide weights. For the purpose of Figure 1 only, we calculate the mean of health with the following formular: individual weight = population / sample size of the national income group which the individual belongs to in the given year.

# CONTROL FOR CONFOUNDERS: AIH & NMP

Appendix

| Variables | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| Gini | .007*** | .003 | .004** | .008*** | .007*** | .003 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.004) |
| Control for sex, age, age square, education level | | | | | | |
| Income ← Variable for Absolute Income Hypothesis | | | .051*** | .051*** | .051*** | .051*** |
| | | | (.002) | (.002) | (.003) | (.003) |
| Logged GDP | | | | .107*** | .11*** | .151*** |
| | | | | (.025) | (.029) | (.051) |
| GDP Growth Rate | | | | | .006** | .005** |
| | | | | | (.003) | (.002) |
| Logged Population Size ← Variables for Neo-Materialism Pathway | | | | | .001 | -.155* |
| | | | | | (.018) | (.082) |
| Out-of-Pocket Medical Expenditure (%) | | | | | 0 | .004 |
| | | | | | (.002) | (.003) |
| Consider national fixed effects? | No | No | No | No | No | Yes |

Standard errors are in parentheses; *** p<.01, ** p<.05, * p<.1.

# VARIABLE OVERVIEW: 5-LEVEL SUBJECTIVE HEALTH



| Level | Frequency |
|---|---|
| 1 | 2,008 |
| 2 | 22,594 |
| 3 | 90,450 |
| 4 | 140,274 |
| 5 | 76,412 |

# MODEL CHOICE: RE OR FE?



- Is RE assumption (i.e. E [ui|Xit] = 0), which is required by the random effects model, likely to hold?
- Within-subject variations (FE)  VS. between-subject variations (RE)
- Exchangeable units or subjects drawn randomly from a population (RE) VS. non-exchangeable units or subjects drawn non-randomly from a population (FE)
- Unbiasedness (FE) VS. efficiency (RE)
- Extrapolation of conclusion to units not sampled (RE)
- Number of clusters/subjects/units
- Sample size within clusters/subjects/units
- Whether covariates are time-(in)variant
- Whether main variation is within or between clusters

# MODEL CHOICE: RE OR FE?



**Our two-level random-effect model**

Level 1 (individual) Model:

$$Health_{ij} = \pi_{0j} + \beta_{1j} Age + \beta_{2j} Age\ Square + \beta_{3j} Sex + \beta_{4j} Educ + \beta_{5j} Income + e_{ij}$$

Level 2 (country* year) Random-Effect Model for Intercept:

$$\pi_{0j} = \eta_{00} + \tau_{01} Inequality + \tau_{02} \log GDP + \tau_{03} GDPGrowth + \tau_{04} logPopu + \tau_{05} MedExpen + \upsilon_{0j}$$

**Our three-level fixed-effect model**

Level 1 (individual) Model:

$$Health_{itc} = \pi_{tc} + \beta_1 Age + \beta_2 Age\ Square + \beta_3 Sex + \beta_4 Educ + \beta_{5j} Income + e_{itc}$$

Level 2 (country* year) Model:

$$\pi_{tc} = \eta_c + \tau \log GDP_{tc} + \sigma INEQ_{tc} + \upsilon_{tc}$$

Level 3 (country) Fixed-effect Model:

$$\eta_c = \eta + a_c, \text{ where } a_c \text{ denotes the } cth \text{ country's fixed effect}$$

# MODEL CHOICE: RE OR FE?

Appendix

```
. *Fit a three-level null model to determine the variance components
. mixed health ||country: || countryyear:

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -413129.18
Iteration 1:   log likelihood = -413129.18

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =    331,738
```

Grouping information

| Group variable | No. of groups | Observations per group Minimum | Average | Maximum |
|---|---|---|---|---|
| **country** | **94** | **414** | **3,529.1** | **16,741** |
| **countryyear** | **232** | **240** | **1,429.9** | **4,068** |

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# MODEL CHOICE: RE OR FE?

Appendix

Log likelihood = **-413129.18**

Wald chi2(**0**) = .
Prob > chi2 = .

| health | Coefficient | Std. err. | z | P>\|z\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| _cons | **3.806904** | **.0275676** | **138.09** | **0.000** | **3.752873** | **3.860936** |

| Random-effects parameters | Estimate | Std. err. | [95% conf. | interval] |
|---|---|---|---|---|
| **country**: Identity var(_cons) | **.0587291** | **.0102431** | **.0417247** | **.0826635** |
| **countryyear**: Identity var(_cons) | **.0235198** | **.0028562** | **.0185381** | **.0298403** |
| var(Residual) | **.704425** | **.0017302** | **.7010419** | **.7078243** |

LR test vs. linear model: chi2(**2**) = **37484.81** Prob > chi2 = **0.0000**