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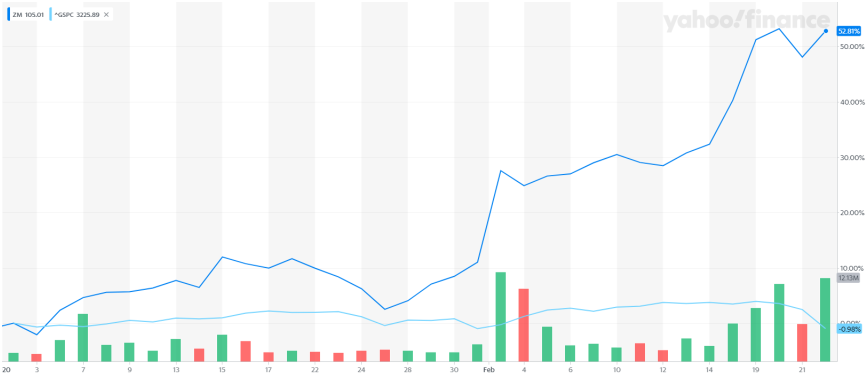

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How would covid-19 (coronavirus) affect U.S. economy?

Beyond GDP

Harvard Economics 1011B
Professor Gabriel Chodorow-Reich
Spring 2020

Overview of growth and income differences

- Kaldor facts.
- Solow model.
  - Growth from capital accumulation and exogenous technology.
- Neoclassical growth model.
  - Growth from equilibrium capital accumulation and exogenous technology.
  - Efficiency result.
- Confronting neoclassical growth theory with evidence.
- Other and deeper theories of cross-country growth differences.
- Growth over time.
- **Cross-country welfare differences beyond GDP.**

Outline

OUTLINE

Background

- So far we have focused on GDP per capita as measure of development.
- Long history of criticizing GDP as not the same as welfare.
- What might replace it? Measurement?
- Economic theory offers some structure...

Human development index

- Life expectancy index:

$$LI = \frac{\text{Life expectancy} - 2}{85 - 20}.$$

- Education index:

$$EI = \frac{1}{2}\left(\frac{\text{Avg. school yrs. 25 y.o.}}{15} + \frac{\text{Exp. school yrs. 5 y.o.}}{18}\right).$$

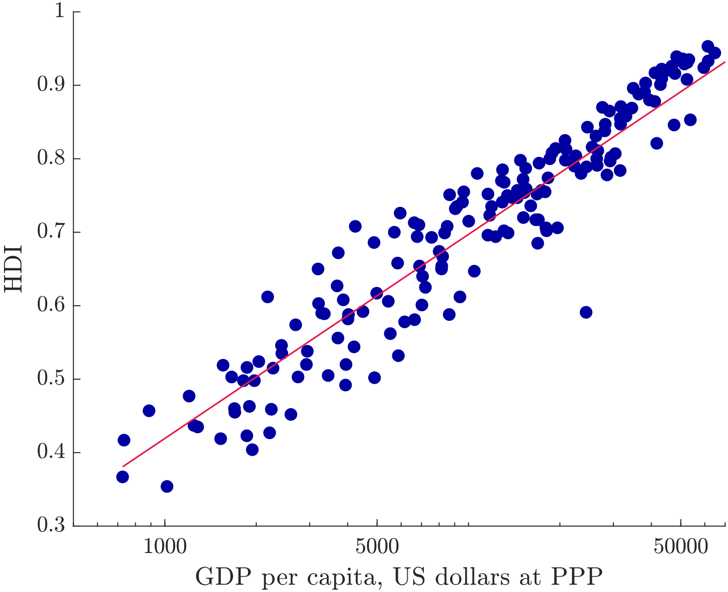
- Income index:

$$II = \frac{\ln(GNP/capita) - \ln(100)}{\ln(75{,}000) - \ln(100)}.$$

- Human development index:

$$HDI = (LI \times EI \times II)^{\frac{1}{3}}.$$

HDI



1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
HDI
1000
5000
50000
GDP per capita, US dollars at PPP

Outline

Thought experiment

An individual ("Rawls") can spend spend his/her life as a random resident in one of two countries:

1. A country whose living standards we would like to measure.
2. A country exactly like the U.S. except everyone's consumption is multiplied by λ.

Note: Using Rawlsian "veil of ignorance". The philosopher John Rawls argued this problem requires maximizing the minimum. Instead, we will take an expected utility view.

Definition: consumption equivalence

- Utility function: $U_i = E\sum_{a=1}^{100} S_a^i \beta^a u(c_a^i, \ell_a^i)$.
  - $E[.]$: expectations operator.
  - S_a^i: probability of survival to age a.
  - β: subjective discount factor.
  - $u(c_a^i, \ell_a^i)$: period utility over consumption c and leisure ℓ at age a.

- Definition: $U_i(\lambda) = E\sum_{a=1}^{100} S_a \beta^a u(\lambda c_a^i, \ell_a^i)$.
- Consumption equivalent: $U_{us}(\lambda_i) = U_i(1)$ for country i.
- Literal interpretation: adjustment to consumption each period to equalize expected lifetime utility in U.S to country i.
- Rawlsian interpretation: equalize welfare behind Rawlsian "veil of ignorance."

Going to data: consumption

- Compute expectation using current cross-sectional distribution of consumption and leisure. In practice, household survey of $j = 1, 2, \ldots, N_a^i$ individuals with sampling weights $\bar{\omega}_{j,a}^i$, $\sum_{j=1}^{N_a^i} \bar{\omega}_{j,a}^i = 1$.
- Assume consumption growth rate of g (constant inequality).
- Age 0 individual expects consumption at age a of $\sum_{j=1}^{N_a^i} \bar{\omega}_{j,a}^i e^{ga} c_{j,a}^i$.
- Therefore: $U_i = \sum_{a=1}^{100} S_a^i \sum_{j=1}^{N_a^i} \bar{\omega}_{j,a}^i u(e^{ga} c_{j,a}^i, \ell_{j,a}^i)$.
- Specify:
  $u(c_a, \ell_a) = \bar{u} + \ln c_a + v(\ell_a) \Rightarrow u(e^{ga} c_{j,a}^i, \ell_{j,a}^i) = \bar{u} + ga + \ln c_{j,a}^i + v(\ell_{j,a}^i)$.
- Define: $u_a^i = E[u(e^{ga} c_{j,a}^i, \ell_{j,a}^i)] = \bar{u} + ga + \sum_{j=1}^{N_a^i} \bar{\omega}_{j,a}^i \left[\ln c_{j,a}^i + v(\ell_{j,a}^i) \right]$.
- Then: $U_i = \sum_{a=1}^{100} S_a^i \beta^a u_a^i$, $U_{us}(\lambda_i) = \sum_{a=1}^{100} S_a^{us} \beta^a [u_a^{us} + \ln \lambda_i]$.

Solve

$$\text{Country } i: \quad U_i = \sum_{a=1}^{100} S_a^i \beta^a u_a^i,$$

$$\text{U.S. equiv.:} \quad U_{us}(\lambda_i) = \sum_{a=1}^{100} S_a^{us} \beta^a \left[u_a^{us} + \ln \lambda_i\right],$$

$$\text{Solve:} \quad \ln \lambda_i = \frac{1}{\sum_{a=1}^{100} S_a^{us} \beta^a} \sum_{a=1}^{100} \beta^a \left[\left(S_a^i - S_a^{us}\right) u_a^i + S_a^{us} \left(u_a^i - u_a^{us}\right)\right],$$

$$\text{where:} \quad u_a^i = \bar{u} + ga + \sum_{j=1}^{N_a^i} \bar{\omega}_{j,a}^i \left[\ln c_{j,a}^i + v(\ell_{j,a}^i)\right].$$

Going to data: leisure

- Assume: $v(\ell^i_{j,a}) = -\frac{\theta\varepsilon}{1+\varepsilon}\left(1-\ell^i_{j,a}\right)^{1+\frac{1}{\varepsilon}}$. Where does this come from?
- Consider choice to increase leisure by $d\ell$ at (after-tax) wage w:

$$\begin{aligned}
\text{Lost income:} &\quad -wd\ell, \\
\text{Lost utility from consumption:} &\quad du(c) = -u'(c)wd\ell, \\
\text{Additional utility from leisure:} &\quad dv(\ell) = \theta\left(1-\ell^i_{j,a}\right)^{\frac{1}{\varepsilon}} d\ell.
\end{aligned}$$

- At optimum, total utility must be unchanged:

$$0 = du(c) + dv(\ell) = -u'(c)wd\ell + \theta\left(1-\ell^i_{j,a}\right)^{\frac{1}{\varepsilon}} d\ell$$

$$\Rightarrow 1-\ell^i_{j,a} = \left[\frac{u'(c)}{\theta}w\right]^{\varepsilon} = \left[\frac{1}{\theta}\frac{w}{c}\right]^{\varepsilon}$$

$$\Rightarrow \frac{\partial \ln\left(1-\ell^i_{j,a}\right)}{\partial \ln(w)} = \varepsilon.$$

- ε is the Frisch elasticity of labor supply, i.e. the compensated elasticity holding the marginal utility of consumption fixed.

Going to data: $\bar{u}$

- What is $\bar{u}$?
- Value of a statistical life (VSL): "the additional cost that individuals would be willing to bear for improvements in safety that, in the aggregate, reduce the expected number of fatalitites by one."
- Crucial component of U.S. regulatory cost-benefit analyses that determine environmental regulations, product safety requirements, etc.
- Also used in countries with single-payer health systems to decide what treatments to cover.
- Typical measurement: compare wages in two otherwise similar jobs, one of which has a higher risk of fatality.

Revised Departmental Guidance 2016:

Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses

On the basis of the best available evidence, this guidance identifies **$9.6 million as the value of a statistical life to be used for Department of Transportation analyses assessing the benefits of preventing fatalities and using a base year of 2015**. It also establishes policies for assigning comparable values to prevention of injuries.

Background

Prevention of injury, illness, and loss of life is a significant factor in many private economic decisions, including job choices and consumer product purchases. When government makes direct investments or controls external market impacts by regulation, it also pursues these benefits, often while also imposing costs on society. The Office of the Secretary of Transportation and other DOT administrations are required by Executive Order 13563, Executive Order 12866, Executive Order 12893, OMB Circular A-4, and DOT Order 2100.5 to evaluate in monetary terms the costs and benefits of their regulations, investments, and administrative actions, in order to demonstrate the faithful execution of their responsibilities to the public. Since 1993, the Office of the Secretary of Transportation has periodically reviewed the published research on the value of safety and updated guidance for all administrations. Our previous guidance revision, issued on February 28, 2013, stated that we planned to update our guidance annually to adjust for changes in prices and real incomes. This guidance updates our values based on 2015 prices and real incomes.

The benefit of preventing a fatality is measured by what is conventionally called the Value of a Statistical Life (VSL), defined as the additional cost that individuals would be willing to bear for improvements in safety (that is, reductions in risks) that, in the aggregate, reduce the expected number of fatalities by one. This conventional terminology has often provoked misunderstanding on the part of both the public and decision-makers. What is involved is not the valuation of life as such, but the valuation of reductions in risks. While new terms have been proposed to avoid misunderstanding, we will maintain the common usage of the research literature and OMB Circular A-4 in referring to VSL.

Most regulatory actions involve the reduction of risks of low probability (as in, for example, a one-in-10,000 annual chance of dying in an automobile crash). For these low-probability risks, we shall assume that the willingness to pay to avoid the risk of a fatal injury increases proportionately with growing risk. That is, when an individual is willing to pay $1,000 to reduce the annual risk of death by one in 10,000, she is said to have a VSL of $10 million. The assumption of a linear relationship between risk and willingness to pay therefore implies that she would be willing to pay $2,000 to reduce risk by two in 10,000 or $5,000 to reduce risk by five in 10,000. The assumption of a linear relationship between risk and willingness to pay (WTP) breaks down when the annual WTP becomes a substantial portion of annual income, so the assumption of a constant VSL is not appropriate for substantially larger risks.

Calibration

- Calibration means picking numbers for parameters.
- Parameters: $g, \beta, \varepsilon, \theta, \bar{u}$.
- $g = 2\%$ per year: frontier growth rate, no convergence.
- $\beta = 0.99$: interest rate of 4% given growth rate of g and mortality.
- $\varepsilon = 1$: estimated from hours/wage elasticity.
- $\theta = 14.2$: match hours worked in U.S. using equation from previous slide.
- $\bar{u} = 5$: value of life of U.S. 40 year old of \$6 million.

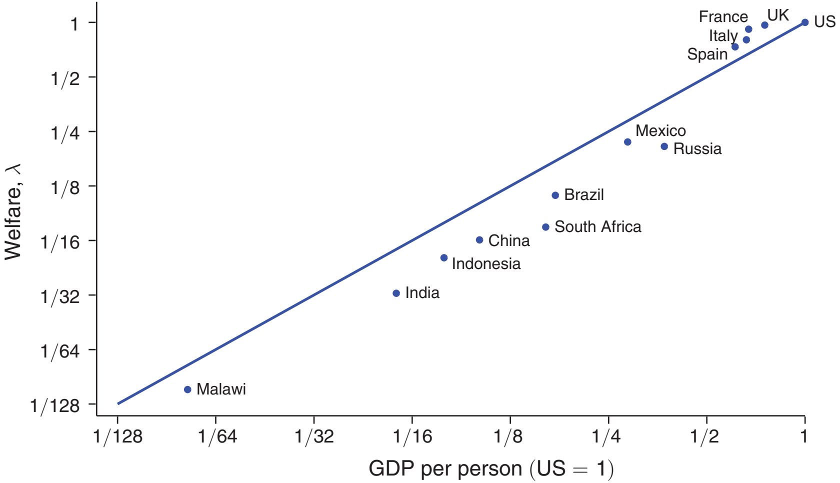
Results summary

1. GDP per capita highly correlated with Rawlsian measure. But substantial differences between the two possible.

2. Rawlsian adjustment reduces gap between U.S. and Western Europe.

3. Rawlsian adjustment increases gap between U.S. and poor countries because of lower life expectancy, lower consumption relative to output, and higher inequality.

Panel A. Welfare and income are highly correlated at 0.98



Panel B. But this masks substantial variation in the ratio of λ to GDP per capita

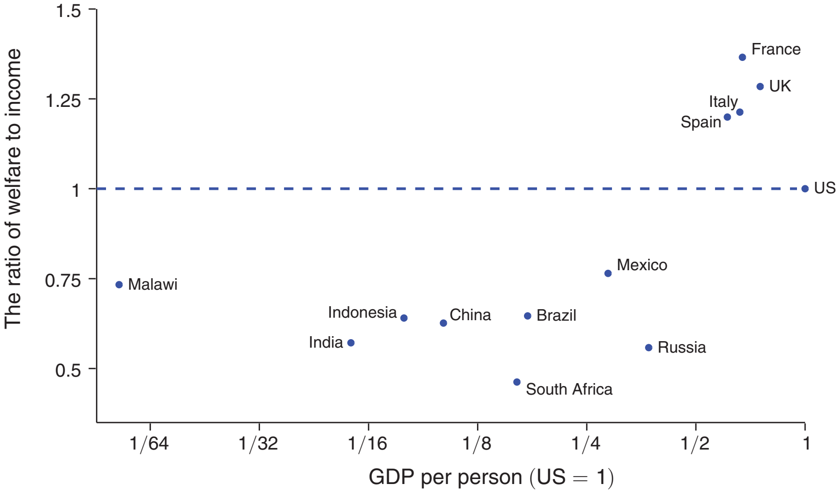


TABLE 2—WELFARE ACROSS COUNTRIES

	Welfare λ	Income	log ratio	Decomposition				
				Life exp.	C/Y	Leisure	Cons. ineq.	Leis. ineq.
US	100.0	100.0	0.000	0.000	0.000	0.000	0.000	0.000
				77.4	*0.897*	*877*	*0.538*	*1,091*
UK	96.6	75.2	0.250	0.086	−0.143	0.073	0.136	0.097
				78.7	*0.823*	*579*	*0.445*	*826*
France	91.8	67.2	0.312	0.155	−0.152	0.083	0.102	0.124
				80.1	*0.790*	*535*	*0.422*	*747*
Italy	80.2	66.1	0.193	0.182	−0.228	0.078	0.086	0.075
				80.7	*0.720*	*578*	*0.421*	*905*
Spain	73.3	61.1	0.182	0.133	−0.111	0.070	0.017	0.073
				79.1	*0.786*	*619*	*0.541*	*904*
Mexico	21.9	28.6	−0.268	−0.156	−0.021	−0.010	−0.076	−0.005
				74.2	*0.879*	*906*	*0.634*	*1,100*
Russia	20.7	37.0	−0.583	−0.501	−0.248	0.035	0.098	0.032
				67.1	*0.733*	*753*	*0.489*	*1,027*
Brazil	11.1	17.2	−0.436	−0.242	0.004	0.005	−0.209	0.006
				71.2	*0.872*	*831*	*0.724*	*1,046*
S. Africa	7.4	16.0	−0.771	−0.555	0.018	0.054	−0.283	−0.006
				60.9	*0.887*	*650*	*0.864*	*1,093*
China	6.3	10.1	−0.468	−0.174	−0.311	−0.016	0.048	−0.014
				71.7	*0.658*	*888*	*0.508*	*1,093*
Indonesia	5.0	7.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2—Welfare across Countries

				Decomposition				
	Welfare λ	Income	log ratio	Life exp.	C/Y	Leisure	Cons. ineq.	Leis. ineq.
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S. Africa	7.4	16.0	–0.771	–0.555	0.018	0.054	–0.283	–0.006
				60.9	*0.887*	*650*	*0.864*	*1,093*
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				71.7	*0.658*	*888*	*0.508*	*1,093*
Indonesia	5.0	7.8	–0.445	–0.340	–0.178	–0.001	0.114	–0.041
				67.2	*0.779*	*883*	*0.445*	*1,178*
India	3.2	5.6	–0.559	–0.440	–0.158	–0.019	0.085	–0.028
				62.8	*0.785*	*918*	*0.438*	*1,143*
Malawi	0.9	1.3	–0.310	–0.389	0.012	–0.020	0.058	0.028
				50.4	*0.923*	*934*	*0.533*	*997*

Notes: The table shows the consumption-equivalent welfare calculation based on equation (19). See Table 1 f sources and years. The second line for each country shows life expectancy, the ratio of consumption to incom annual hours worked per capita, the standard deviation of log consumption, and the standard deviation of annu hours worked, all computed from the cross-sectional micro data, with no discounting or growth.

Outline