

THE IMPACT OF ECONOMIC CONDITIONS ON MORTALITY OVER THE LIFETIME

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December 2014

Abstract Using historical mortality data covering over 100 birth cohorts in over 20 countries, this paper examines the contemporaneous and long-term impacts of the economic conditions on mortality. Both contemporaneous and early-life economic conditions have large but different impact on mortality: contemporaneous recessions are good for health but over the longer term recessions in early life reduce life expectancy. Although recessions in utero and childhood affect longevity, economic conditions around the time of graduation (from ages 10 to 30) have the largest impact on lifetime mortality, particularly for men. We also find strong evidence that the impacts of economic conditions on mortality are much larger and stronger for those countries with lower government expenditure/GDP rates, suggesting government expenditures can offset the negative effects of economic fluctuations on outcomes.

1. Data and Methodology

The data we are using are from The Human Mortality Database (HMD), which was created to provide detailed mortality and population data to researchers, students, journalists, policy analysts, and others interested in the history of human longevity.¹ At present the HMD contains detailed population and mortality data for 37 countries or areas, including live births, deaths and death rates by sex-age-year cell. Because of the different availability of the historical data for each country, the starting date for each country varies. Because we are interested in lifetime effects, we restrict attention to 25 countries with data in 1950 or earlier. Because old age mortality rates are measured with substantial error, we restrict the sample to those aged below 90 in this analysis.

¹ See <http://www.mortality.org/> for more details.

The historical GDP data are from the Gapminder website which combines the data from several official international statistics and various historical sources.² That the initial year for the GDP *per capita* is 1800 for most of the countries and thus the data cover most of the cohorts we studied since birth. To de-trend the series, we followed the methodology in van den Berg et al. (2006) by using the Hodrick-Prescott filter with smoothing parameter 500 to de-trend logarithm of GDP *per capita*, by country. Figure 1 shows the case for the United States. The dashed blue line shows the actual logarithm of GDP *per capita* over time and the red solid line presents the smoothed one. The de-trended GDP *per capita* or GDP fluctuation is defined as the actual value.

We are interested in both the *contemporaneous* and *long-term* impacts of the economic conditions measured by detrended GDP, therefore we kept those cohorts aged over 30. For each birth cohort in each country, we match the corresponding contemporaneous detrended log GDP per capita as well as detrended log GDP per capita at age 0 throughout age 30. For simplicity, we aggregate the de-trended log GDP per capita into 5-year categories: detrended log GDP age 0-5, 6-10 etc.

1.1 OLS models

To estimate *contemporaneous* and *long-term* impacts of the economic cycles, we estimate the following equation:

$$Mortality_{bct} = \beta_0 * GDPfluc_{ct} + \beta_1 * GDPfluc_{bc}^{0-5} + \beta_2 * GDPfluc_{bc}^{6-10} + \dots + \beta_6 * GDPfluc_{bc}^{26-30} + X_{bct} + \epsilon_{bct} \quad (1)$$

where the dependent variable is the mortality rate for birth cohort b in country c in calendar year t . $GDPfluc_{ct}$ is the contemporaneous GDP fluctuation in year t of country c . The coefficients β_0 on it, capture the impact of contemporaneous GDP fluctuations on mortality. The next few terms in the equation, $GDPfluc_{bc}^{x-y}$ in the equation denotes the mean value of the GDP fluctuations from age x to age y for birth cohort b in country c . X_{bct} captures a set of control variables including the contemporaneous smoothed log GDP as well as the fixed effects for calendar year, age, year of birth and countries. The coefficients on them, β_1 to β_6 , capture the long-term impact of the economic conditions in early life on the mortality of those aged over 30. The observations are weighted by population size.

² See <http://www.gapminder.org/downloads/> for more details.

1.2 Fixed effect models

Using the multi-country year-cohort level data, we are able to control for the country specific economic conditions for birth cohort when estimating the contemporaneous impacts. Specifically, we can estimate

$$Mortality_{bct} = \beta_0 * GDPfluc_{ct} + \delta_{cb} + X_{bct} + \epsilon_{bct} \quad (2)$$

where δ_{cb} captures the country-birth cohort fixed effects. By doing so, we control for the country specific contemporaneous economic conditions. By doing so, we actually control for the specific life experience for the particular birth cohort in each country. The GDP fluctuations in early life are perfectly collinear with this variable so they are dropped in the main equation.

Similarly, we can also control for the country specific birth cohort fixed effect when estimating the contemporaneous impact of economic conditions, by estimating the following equation:

$$Mortality_{bct} = \beta_1 * GDPfluc_{bc}^{0-5} + \beta_2 * GDPfluc_{bc}^{6-10} + \dots + \beta_6 * GDPfluc_{bc}^{26-30} + X_{bct} + \delta_{ct} + \epsilon_{bct} \quad (3)$$

The difference between equation (2) and equation (1) is the addition of country-calendar year fixed effects, δ_{ct} . By including these we control for the country specific contemporaneous economic conditions—thus in this specification the contemporaneous economic condition are dropped from the estimation because it is collinear with the newly added dummies.

2. The short term effects of recession

2.1 OLS results

Table 1 presents the results from estimating Equation (1) with all standard errors clustered at country level. The square term of contemporaneous GDP fluctuation is added to capture possible non-linearities. First column shows the results for the full sample, and the next two show the results separately by gender. Consistently, we find the square term on the de-trended log GDP is positive and significant. Further examination shows that only large deviations (economic booms or large economic recessions) matter. Between the 5th percentile and 95th percentile of the GDP fluctuation, the relationship between economic fluctuations and mortality is positive, consistent with the findings in Ruhm (2000).

For the impact of economic conditions in early life, we find consistent negative associations in all three columns, indicating that the economic booms (recessions) in early life will be negatively (positively) associated with mortality later. These associations are much more significant for men. Specifically, we find the most important period in early life is from age 11 to age 20 given the coefficients on the GDP fluctuations during then are largest in magnitude. The magnitude is large: one point increase in log GDP at age 11-20 is associated with a 0.6 percentage points decrease in mortality rates after 30.

2.2 FE model for the impact of contemporaneous economic conditions

Table 2 reports the results from the FE model in Equation (2), with country-specific birth-cohort fixed effects. Panel A show the results for contemporary GDP are consistent with those in Table 1, where we control for the history of economic conditions since birth instead of using fixed effects. Panel B shows the results hold if we drop World War I and World War II periods.

Panel C and Panel D show the results by the countries with different level of government expenditures, measured by the ratio of government expenditure to the total GDP. Because the government expenditures data are available only for recent years, we just calculate the ratio of government expenditure to the total GDP from 1998 onwards and use the median level of government expenditure in the sample as the threshold, which is 0.42 to separate countries into high and low expenditure countries. The results in Panel C show an insignificant and small impact of contemporaneous GDP fluctuations among high expenditure countries. But the effects in Panel D (low expenditure countries) are significant and larger magnitude, suggesting that government expenditure is potentially mitigating the effect of fluctuations on health.

Furthermore the results in Panels E and F show that the contemporaneous impact of GDP fluctuations is mostly driven by earlier periods also consistent with the increase in expenditure over time in all countries. Finally the comparison between Panels G and H indicates that the main effects are driven by those aged over 60.

3. The impact of economic conditions in early life

Table 3 shows the impact of economic conditions in early life on the mortality of adults ages 30 and above, controlling for country-calendar year fixed effects. The coefficients, β_1 to β_6 , are reported in the columns with different specifications.

All coefficients are negative, suggesting that unfavorable economic conditions between 0 and 30 lower subsequent mortality. However the largest effects are for those ages 10-25, these are the years when individuals enter the labor force. This is particularly true of males for whom all coefficients are negative and statistically significant. For women the coefficients are smaller, and although they follow the same age-pattern, only the coefficients from early childhood conditions are statistically significant.

In the next two columns (i.e. column 4 and column 5), we find again that the impact of the early economic conditions is much larger in countries with lower government expenditure level (relative to GDP). Differences between columns 4 and column 5 are large and significant, though results are not reported here. The final two columns, however, we find that the associations are larger for later cohorts, which is puzzling. Analysis in the future will shed some light on these issues and phenomenon.

Table 1: Impact of Contemp. And Earlier life GDP fluc. On Mortality rates aged over 30

VARIABLES	(1)	(2)	(3)
	Dependent var. is Mortality rates in percentage		
	All population	Men	Women
<i>Contemporaneous GDP fluc.</i>			
GDP Fluc.	0.0582 (0.113)	-0.100 (0.115)	0.179 (0.128)
GDP Fluc. Square	1.673** (0.799)	1.846* (0.998)	1.607** (0.706)
<i>GDP Fluc.at ealier life</i>			
Age 0	-0.125** (0.0446)	-0.144*** (0.0448)	-0.105** (0.0429)
Age 1 - 5	-0.247** (0.100)	-0.327*** (0.106)	-0.177* (0.0986)
Age 6 - 10	-0.329* (0.161)	-0.466*** (0.156)	-0.221 (0.171)
Age 11 - 15	-0.406* (0.206)	-0.608*** (0.203)	-0.245 (0.220)
Age 16 - 20	-0.393* (0.227)	-0.638*** (0.206)	-0.170 (0.245)
Age 21 - 25	-0.267 (0.158)	-0.490*** (0.139)	-0.112 (0.180)
Age 26 - 30	-0.0767 (0.155)	-0.304** (0.146)	0.0644 (0.185)
Observations	132,288	132,288	132,288
R-squared	0.955	0.964	0.945
Mean of Y	1.570	1.765	1.393
SD of Y	2.582	2.792	2.488
Contemp. GDP level	Yes	Yes	Yes
Smoothed GDP before 30	Yes	Yes	Yes
Calendar Year FE	Yes	Yes	Yes
Age in years FE	Yes	Yes	Yes
Year of Birth FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes

Notes: Robust standard errors in parentheses are clustered at country level.

*** p<0.01, ** p<0.05, * p<0.1

Table 2 Contemporaneous Economic Conditions and Death Rates (FE model)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent var. is Mortality rates in percentage					
	All population	Men	Women	All population	Men	Women
	Panel A. Full sample			Panel B. Drop WW1 and WW2 period		
<i>Contemporaneous GDP fluc.</i>						
GDP Fluc.	0.137 (0.177)	0.0146 (0.190)	0.229 (0.191)	0.334 (0.268)	0.307 (0.224)	0.296 (0.307)
GDP Fluc. Square	1.706** (0.737)	1.509 (0.927)	1.963** (0.707)	2.282** (1.071)	2.392* (1.226)	2.330* (1.172)
Observations	132,288	132,288	132,288	122,808	122,808	122,808
	Panel C. Higher Government Expenditure Countries			Panel D. Lower Government Expenditure Countries		
<i>Contemporaneous GDP fluc.</i>						
GDP Fluc.	0.120 (0.197)	0.0122 (0.217)	0.207 (0.208)	0.479* (0.241)	0.242 (0.184)	0.661* (0.309)
GDP Fluc. Square	1.512 (1.195)	1.232 (1.247)	1.607 (1.204)	1.716** (0.609)	1.427** (0.646)	1.956** (0.719)
Observations	67,660	67,660	67,660	61,124	61,124	61,124
	Panel E. Earlier Years (Years before meidan in each specific country)			Panel F. Later Years (Years after meidan in each specific country)		
<i>Contemporaneous GDP fluc.</i>						
GDP Fluc.	0.425 (0.337)	0.425 (0.388)	0.431 (0.308)	-0.111 (0.191)	-0.158 (0.208)	-0.0692 (0.212)
GDP Fluc. Square	2.286** (0.996)	2.560** (1.101)	2.029** (0.904)	0.950 (0.809)	0.624 (0.937)	1.150 (0.818)
Observations	93,313	93,313	93,313	92,145	92,145	92,145
	Panel G. Aged 30 - 60			Panel H. Aged 61+		
<i>Contemporaneous GDP fluc.</i>						
GDP Fluc.	-0.0628 (0.0778)	-0.188 (0.139)	0.0439 (0.0336)	-0.314 (0.571)	-0.265 (0.592)	-0.228 (0.615)
GDP Fluc. Square	0.577 (0.460)	0.550 (0.604)	0.620 (0.369)	5.206*** (1.636)	5.427*** (1.908)	5.133*** (1.620)
Observations	68,899	68,899	68,899	63,389	63,389	63,389
<i>Covariates controlled for</i>						
Contemp. smoothed GDP	Yes	Yes	Yes	Yes	Yes	Yes
Calendar Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Year of Birth FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Country*Birth year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses are clustered at Country level.

*** p<0.01, ** p<0.05, * p<0.1

Table 3 Impact of Economic Conditions on mortality at later ages (30+)

Sample VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable is Death Rates in Percentage						
	Full sample			High Gov. exp Ctys	Low Gov. exp Ctys	Ealier Cohorts	Later Cohorts
	All	Men	Women	All	All	All	All
GDP Fluc. at birth	-0.129** (0.0616)	-0.119* (0.0628)	-0.137** (0.0563)	-0.108*** (0.0252)	-0.223** (0.0935)	-0.0345 (0.0941)	-0.348*** (0.0885)
GDP Fluc. 1-5	-0.279* (0.145)	-0.298* (0.150)	-0.267* (0.140)	-0.250*** (0.0605)	-0.484** (0.171)	-0.198 (0.171)	-0.607*** (0.159)
GDP Fluc. 6-10	-0.414* (0.223)	-0.458** (0.211)	-0.396 (0.234)	-0.257* (0.134)	-0.613** (0.208)	-0.127 (0.212)	-1.042*** (0.315)
GDP Fluc. 11-15	-0.517* (0.285)	-0.613** (0.274)	-0.456 (0.297)	-0.289 (0.167)	-0.833** (0.303)	-0.212 (0.236)	-1.279*** (0.395)
GDP Fluc. 16-20	-0.518 (0.302)	-0.661** (0.275)	-0.390 (0.320)	-0.176 (0.191)	-0.824** (0.267)	-0.151 (0.202)	-1.262*** (0.386)
GDP Fluc. 21-25	-0.363* (0.207)	-0.502** (0.187)	-0.288 (0.230)	-0.0961 (0.174)	-0.567** (0.252)	-0.113 (0.156)	-0.954*** (0.322)
GDP Fluc. 26-30	-0.242 (0.217)	-0.432* (0.209)	-0.138 (0.246)	0.0505 (0.182)	-0.617 (0.373)	-0.0891 (0.109)	-0.493 (0.377)
Observations	132,288	132,288	132,288	67,660	61,124	66,732	65,556
R-squared	0.958	0.967	0.948	0.959	0.969	0.972	0.977
Mean of Y	1.570	1.765	1.393	1.762	1.419	1.819	1.414
SD of Y	2.582	2.792	2.488	2.811	2.370	2.779	2.438
<i>Covariates controlled for</i>							
Age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses are clustered at Country level.

*** p<0.01, ** p<0.05, * p<0.1

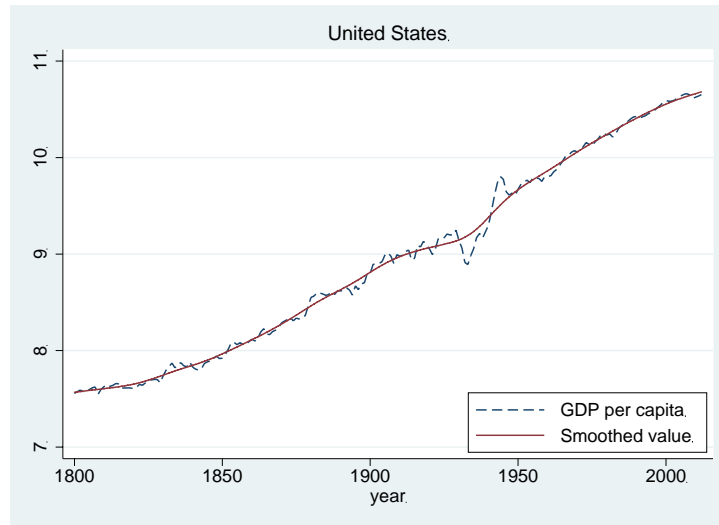


Figure 1 Logarithm of GDP *per capita* and the Smoothed Value, the United States 1800-2012

Notes: GDP Data comes from Gapminder (<http://www.gapminder.org/downloads/>). The smoothed GDP is derived from Hodrick-Prescott filter with smoothing parameter 500. The de-trended GDP is defined as the actual value (Blue line) subtracting the smoothed value (Red line).