ESM 201 W19 - Assignment 1

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2/2/2019

1) Calculate $\frac{dN}{Ndt}$

a) The per capita change in population over time is calculated by the following approximation:

$$(1) \quad \frac{dN}{Ndt} = ln(\frac{N_{t+1}}{N_t})$$

Equation (1) allows us to calculate per capita change over time having only population at time $t+1$ and t. The natural log is derived from equation (2):

$$(2) \quad N_{t+1} = N_t e^{r(1-\frac{N_t}{K})}$$

b) For $\frac{dN}{Ndt}$ by country between 1963 to 1964 we have:

Brazil: $ln(\frac{81972001}{79602001}) = 0.02933851$

India: $ln(\frac{486639001}{476632001}) = 0.02077787$

Japan: $ln(\frac{96959001}{95929001}) = 0.01120974$

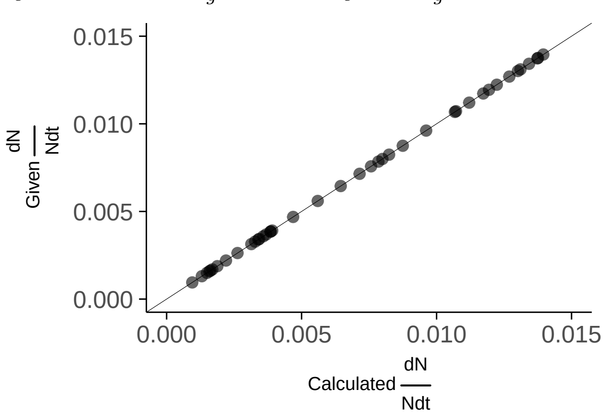
Mexico: $ln(\frac{43052001}{41715001}) = 0.03154791$

South Korea: $ln(\frac{27767001}{27138001}) = 0.02218870$

Compared to the given $\frac{dN}{Ndt}$ we have:

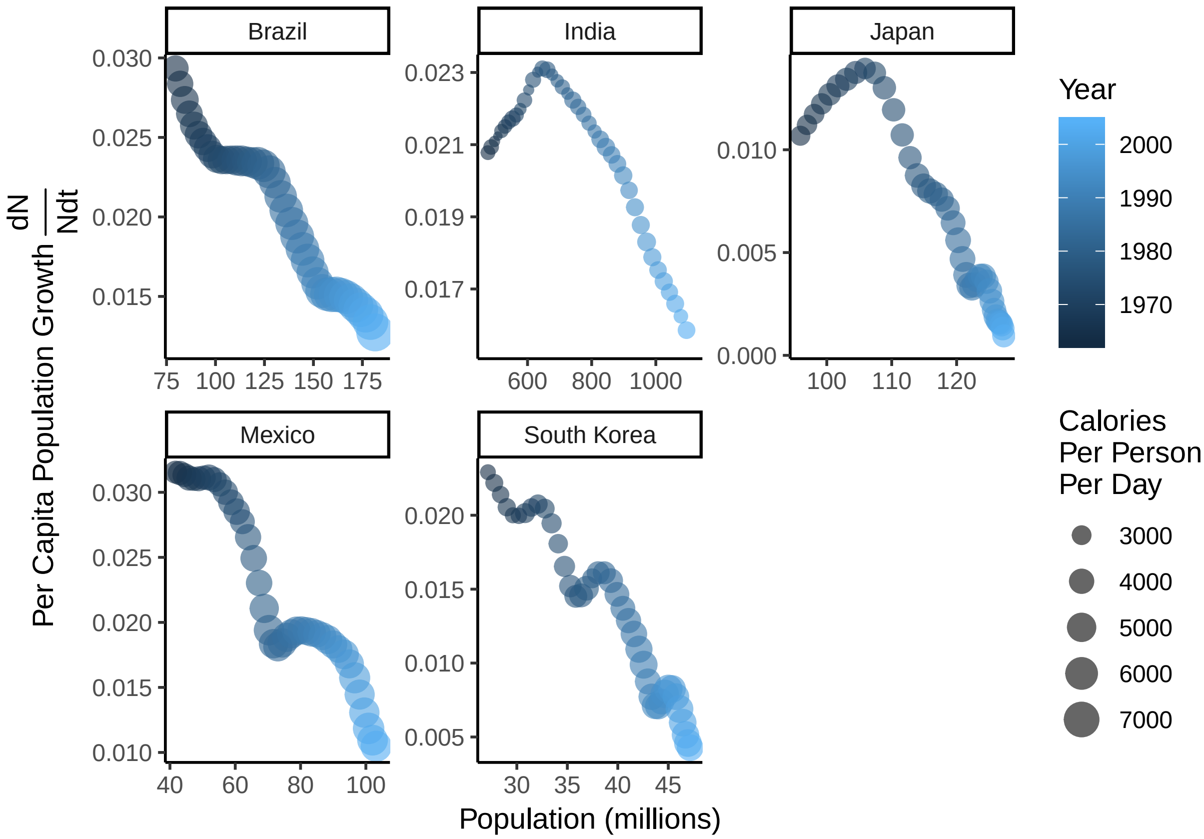
County	Year	Given dNNdt	Calculated dNNdt
Brazil	1963 to 1964	0.0293385	0.0293385
India	1963 to 1964	0.0207779	0.0207779
Japan	1963 to 1964	0.0106799	0.0106799
Mexico	1963 to 1964	0.0315479	0.0315479
South Korea	1963 to 1964	0.0229133	0.0229133

c) Japan's calculated $\frac{dN}{Ndt}_c$ vs. given $\frac{dN}{Ndt}_g$ with $\frac{dN}{Ndt}_c = \frac{dN}{Ndt}_g$ line segment:



2) Graph $\frac{dN}{Ndt}$ vs. N_t

a) (c *extra*) Plots of N_t (Population) vs. $\frac{dN}{Ndt}$ for each country:



b) Japan's carrying capacity $\hat{K}_J$:

$$\widehat{\frac{dN}{Ndt}} = 0.05554 - 4.189 * 10^{-10}(\widehat{population}) + \epsilon \ = 0 \implies \hat{K}_J = 132585000$$

Mexico's carrying capacity $\hat{K}_M$:

$$\widehat{\frac{dN}{Ndt}} = 0.04736 - 3.443 * 10^{-10}(\widehat{population}) + \epsilon \ = 0 \implies \hat{K}_M = 137554000$$

3) What influences growth?

a) model (1) and b) models (2-6): Table 1 shows 6 different multivariate linear regression models. Model (1) included all countries and predicts Per Capita Population Growth Rate ($\frac{dN}{Ndt}$) based on years of education (education) and calories from food per person per day (calories). For example, for an additional year of education, model (1) predicts -0.002 change in $\frac{dN}{Ndt}$ holding calories constant — calories in (1) is not significant meaning a positive or negative relationship can not be determined from this model. Models (2-6) show each country's predicted

$\frac{dN}{Ndt}$ based on education and calories. For each model there is a negative relationship between years of education and $\frac{dN}{Ndt}$. Notably, Brazil (2), Japan (4) and Mexico (5) have negative relationships between calories and $\frac{dN}{Ndt}$ that has a statistically significant result. However, these models rely on several assumptions and most likely suffer from omitted variable bias. Thus, the reader should impart skepticism when drawing conclusions about these socioeconomic effects on $\frac{dN}{Ndt}$.

Table 1: Multivariate Regression Results

	Dependent variable:					
	Per Capita Population Growth Rate					
	All	Brazil	India	Japan	Mexico	South Korea
	(1)	(2)	(3)	(4)	(5)	(6)
Years of Education	-0.00225^{***}	-0.00242^{***}	-0.00152^{***}	-0.00383^{***}	-0.00228^{***}	-0.00276^{***}
	(0.00009)	(0.00034)	(0.00029)	(0.00025)	(0.00026)	(0.00036)
Food Calories per person per day	0.0000001	-0.000001^{**}	-0.0000004	-0.000002^{**}	-0.00001^{***}	-0.0000004
	(0.0000002)	(0.000001)	(0.000002)	(0.000001)	(0.000001)	(0.000001)
Constant	0.02975^{***}	0.03631^{***}	0.02600^{***}	0.05061^{***}	0.05888^{***}	0.03858^{***}
	(0.00098)	(0.00193)	(0.00379)	(0.00280)	(0.00215)	(0.00115)
Observations	205	41	41	41	41	41
Log Likelihood	859.48470	213.82310	214.21030	214.01330	214.69620	215.30490
Akaike Inf. Crit.	$-1{,}712.96900$	-421.64620	-422.42070	-422.02670	-423.39230	-424.60980
Note:						*p<0.1; **p<0.05; ***p<0.01