# An introduction to demography

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#### Introduction

- Definition of demography
- Demographic equation
- Variables and observations
- Demographic models
- Cohorts and generations
- Lexis diagram



## Definition of demography

- The scientific study of human population
- The term was coined by the Belgian statistician Achille Guillard in his 1855 book
  - Éléments de Statistique Humaine ou Démographie Comparée



#### Demography is destiny

- This phrase is attributed to the French mathematician and philosopher, Auguste Comte (1798–1857)
  - He is known as the "father of sociology"
  - Demography shapes the world, even if it does not determine it
  - Population change is an underlying component of almost everything happening in the world today, and therefore in the future as well



## John Graunt (1620–1674)

- English statistician
  - Considered to be the founder of demography
  - Analyzed vital statistics of the London population
  - Studied the bills of mortality (weekly statistics of deaths) in early modern London
  - More specifically, studied death records that had been kept by London parishes since 1532
- Noticed certain regularities in death phenomena
  - Published in the book "Natural and Political Observations Made upon the Bills of Mortality" (1662)



## Graunt's substantive contributions

- Recognized phenomenon of rural-urban migration
  - Urban death rate exceeded rural death rate
- Population was divided almost evenly by sex
   Male birth rate was higher than female birth rate
  - Less females are born than males
  - Male death rate was higher than female death rate
    - Females live longer than males
- Presented mortality in terms of survivorship

   He was the first to attempt to construct a life table..

### Graunt's life table

Age	Number surviving	Age	Number surviving	
0	100	46	10	
6	64	56	6	
16	40	66	3	
26	25	76	1	
36	16	86	0	



# Graunt's methodological contributions

- Paid attention to quality of data
- Exhibited a healthy skepticism
- Questioned the validity and reliability of data



## Poston's definition

 Demography is the scientific study of the size, composition, and spatial distribution of human populations

 It investigates changes in population size, composition, and distribution, resulting from fertility, mortality, and migration



## Concerns of demography

- Population size
- Population growth or decline
- Population processes/components
- Population distribution
- Population structure
- Population characteristics



## Primary demographic questions

- How large (or small) is the population?
- How is the population composed, in terms of age, sex, race, marital status, and so forth?
  - What are the characteristics of the population?
- How is the population distributed spatially?

Populations are not randomly distributed in space

How population changes happen over time?





PopulationPyramid.net

## Why is demography important?

- Demography helps understand what the past says about the future, given expected population changes
  - Population change is a prime force behind social and technological change, because societies must adjust to demographic change
  - Population change is often provocative, bursting other dilemmas that face human society



## Population and earth's resources

- How will we feed an even larger population than we currently have?
- Will we have enough fresh water?
- Where will we get energy to sustain our lifestyle?
- Who will build housing and infrastructure for an increasing urban population?
- How do we minimize the environmental impact?



#### Carbon emissions

AFRICA Central America China Russian Federation United States of America

#### Annual Emissions

#### Per-person Emissions

#### **Cumulative Emissions**



Annual and cumulative emissions in million tonnes of carbon. Per-person emissions in tonnes of carbon.

#### PopulationPyramid.net



## Answers to these questions

- These demographic questions are answered in terms of the three demographic processes (components of demographic change)
  - Fertility
  - Mortality
  - Migration





## **Demographic equation**

- Population size can change only through the processes of fertility, mortality, and migration
- Two ways of entering a population
   Being born or moving into it
- Two ways of leaving a population
   Dying or moving out of it
- Population can only change by way of a limited, countable number of events

## Basic demographic equation

 $P_{t+1} = P_t + B_{t \text{ to } t+1} - D_{t \text{ to } t+1} + I_{t \text{ to } t+1} - E_{t \text{ to } t+1}$ 

- $-P_{t+1}$ : population at time *t*+1
- $-P_t$ : population at time *t*
- $-B_{t to t+1}$ : births between times *t* and *t*+1
- $-D_{t to t+1}$ : deaths between times *t* and *t*+1
- $I_{t to t+1}$ : immigrants (or in-migrants) to the population between times *t* and *t*+1
- $-E_{t to t+1}$ : emigrants (or out-migrants) from the population between times *t* and *t+1*



### Components of equation

- $P_{t+1} = P_t + B_{t \text{ to } t+1} D_{t \text{ to } t+1} + I_{t \text{ to } t+1} E_{t \text{ to } t+1}$
- Natural increase:  $B_{t to t+1} > D_{t to t+1}$
- Natural decrease: B<sub>t to t+1</sub> < D<sub>t to t+1</sub>
   Negative natural increase



## Migration components of equation

- $I_{t \ to \ t+1} E_{t \ to \ t+1}$ 
  - Net international migration
    - Immigration minus emigration
  - Net internal migration
    - In-migration minus out-migration

• 
$$I_{t \text{ to } t+1} < E_{t \text{ to } t+1}$$

- Negative net international migration (sending countries)
- Negative net internal migration (net out-migration)
- $I_{t \text{ to } t+1} > E_{t \text{ to } t+1}$ 
  - Positive net international migration (receiving countries)
  - Positive net internal migration (net in-migration)





### Variables and observations

#### Variables

- Characteristics that can change values from case to case
- E.g. gender, age, income, political party affiliation...

#### Observations (cases)

- Refer to the entity from which data are collected
- Also known as "unit of analysis"
- E.g. individuals, households, states, countries.



#### Variables

- Variable: a characteristic/phenomenon whose value varies (changes) from case to case, and is empirically quantifiable
- **Dependent variable:** a variable whose variation depends on another variable
- Independent variable: a variable whose variation produces ("causes") variation in another variable



#### Causation

- Theories and hypotheses are often stated in terms of the relationships between variables
  - Causes: independent variables
  - Effects or results: dependent variables

У	x	Use	
Dependent variable	Independent variable	Econometrics	
Explained variable	Explanatory variable		
Response variable	Control variable	Experimental science	
Predicted variable	Predictor variable		
Outcome variable	Covariate		
Regressand	Regressor		



#### Observations

- Observations (cases) are collected information used to test hypotheses
- Decide how variables will be measured and how cases will be selected and tested
- Measure social reality: collect numerical data
- Information can be organized in databases
  - Variables as columns
  - Observations as rows



#### Example of a database

Observation	Salary per hour	Years of schooling	Years of experience in the labor market	Female	Marital status (married)
1	3.10	11	2	1	0
2	3.24	12	22	1	1
3	3.00	11	2	0	0
4	6.00	8	44	0	1
5	5.30	12	7	0	1
525	11.56	16	5	0	1
526	3.50	14	5	1	0





## **Demographic models**

- Formal demography
- Population studies I
- Population studies II



## Formal demography

#### Independent variable

Demographic

#### Dependent variable

→ Demographic

#### Examples

- 1. Age composition
- 2. Birth rate
- 3. Sex composition of in-migrants to a city

- $\rightarrow$  Birth rate
- $\rightarrow$  Age composition
  - → Sex ratio of the total population of the city



# Population studies I (social demography)

#### Independent variable

Non-demographic

#### Examples

- 1. Social class (sociological)
- 2. Attitude about motherhood (social psychology)
- 3. Annual rainfall (geographical)
- 4. Economic opportunity (economic)

#### **Dependent variable**

→ Demographic

- $\rightarrow$  Death rate
- $\rightarrow$  Number of children
- → Population density
- → Migration

# Population studies II (social demography)

#### Independent variable

Demographic

#### **Dependent variable**

 $\rightarrow$  Non-demographic

#### Examples

- 1. Age composition
- 2. Migration

3. Birth rate

- → Voting behavior (political)
- → Social change (sociology)
- → Need for infant & child goods/services (public health)





## Cohorts and generations

#### Cohort

- Group of persons who have experienced a common event during a given time interval
- Birth cohorts are sometimes referred to as generations
- Why study birth cohorts?
  - If you understand what distinctive opportunities and problems you have faced, you can find common ground with others in your generation and in other generations (Elwood Carlson)



## Examples of cohorts

- People born during the same period who experience similar social circumstances throughout their lives
  - Lucky Few: from around 1929 through 1945
  - Baby boomers: between around 1946 and 1964
  - Baby bust cohort (Gen. X): from mid-1960s to early 1980s
  - Millennials (Gen. Y): born in the 1980s and 1990s (or up to early 2000s)
  - Gen. Z: start around mid-1990s (or mid-2000s)



## Lucky Few cohort

#### • Lucky Few cohort, born between 1929–1945

- They were fewer compared to the much larger number of persons in the following cohort
- Baby Boomer cohort, born between 1946–1964
- The smaller size of the Lucky Few has enabled them to experience
  - Higher employment rates
  - Greater variety of social opportunities than members in the preceding or following cohorts



#### Seven birth cohorts by size, 1900–2010







#### Lexis diagram: Age, period, cohort



## Game of pretend

 When we calculate a period measure, we pretend that age-specific rates we see today for different age groups continue unchanged into the future

 We are creating an imaginary cohort whose life experience is pieced together from the experiences of different people found at different ages in one period of time







## Synthetic cohort

- We call this imaginary cohort the synthetic cohort
  - syn: "together"
  - thetic: "pieced"
  - synthetic: "pieced together"
- Age-specific cohort rates of the synthetic cohort are the age-specific period rates of the period population
- The concept of a synthetic cohort is central to demography



#### References

Healey JF. 2015. "Statistics: A Tool for Social Research." Stamford: Cengage Learning.

- Hugo G. 2011. "Future demographic change and its interactions with migration and climate change." Global Environmental Change, 21(Supplement 1): S21–S33.
- Poston DL, Bouvier LF. 2017. Population and Society: An Introduction to Demography. New York: Cambridge University Press. 2nd edition. Chapter 1 (pp. 3–16).
- Weeks JR. 2015. Population: An Introduction to Concepts and Issues. Boston: Cengage Learning. 12th edition. Chapters 1 (pp. 1–24), 2 (pp. 25–57).
- Wooldridge JM. 2015. "Introductory Econometrics: A Modern Approach." Boston: Cengage Learning.



