Micro-simulation of Sustainable Development Goals Indicators using the DYNAMIS model

Martin Spielauer, June 2017

DYNAMIS in its current implementation focuses on population projections (DYNAMIS-POP) and developments are underway to extend the model (1) including more detailed education modules, allowing (2) more disaggregation by individual characteristics (e.g. by ethnicity), and (3) allowing more flexible scenarios of internal migration. Once implemented, this model can serve as a base for model extensions in various dimensions. DYNAMIS is an interacting population model, as such it supports the modeling of linked lives (e.g. families, households), transmission processes (inter-generational; transmission of diseases), and interactions between people and institutions (e.g. schools, hospitals) and the environment. In the medium term, this opens a wide range of opportunities to develop the model to a tool supporting the projection and analysis of processes of sustainable development and related indicators.

Information on DYNAMIS-POP: dynamis.ihsn.org

Currently available indicators

Different to macro population projections, DYNAMIS-POP has specific modules addressing child mortality by mother's characteristics, first unions by education, and births by union status, education, and parity. In this respect, three DGI indicators can not only be projected, but the model can be used for analysis of policy effects (e.g. educational expansion, marriage age restrictions) on demographic outcomes.

Goal 3. Ensure healthy lives and promote well-being for all at all ages

- C030201 Under-five mortality rate
- C030702 Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000 women in that age group

Goal 5. Achieve gender equality and empower all women and girls

- C050301 Proportion of women aged 20-24 years who were married or in a union before age 15 and before age 18

Indicators which could be added easily to the current model framework

Potential direct straightforward extensions within the existing model framework mostly concern mortality and education.

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Child mortality is currently modeled by years of age; singling out neonatal deaths (defined as a death during the first 28 days of life) by applying separate mortality rates for this early phase of life is a possible refinement of the child mortality module. Also, a module for maternal mortality could be added.

- C030101 Maternal mortality ratio
- C030202 Neonatal mortality rate

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

A second set of rather direct model extensions concern education indicators. A specific module of early childhood education (with downstream effects on future educational careers and performance) could be added.

- C040202 Participation rate in organized learning (one year before the official primary entry age), by sex

Microsimulation projections allow to generate general participation rates (at least in formal education) and support the disaggregation of all indicators to specific population groups, at least covering parts of the required disaggregation.

- C040301 Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex
- C040501 Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated

Adding a model on proficiency levels might be easy too [?] While the model so far will allow tracking students through the formal school system by grade, we could also add a module which links school attendance and careers with proficiency outcomes as formulated in the context of SDGs.

- C040101 Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex
- C040601 Proportion of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex

Potential 'non-economic' extensions and applications

Extension of individual characteristics allowing further disaggregation and addressing specific population groups

- **Geography:** refining the internal migration module is already a priority in model development. We might want to explicitly model the urban-rural dimension.
- **Ethnicity:** already a priority in model development.
- **Disability:** People with disabilities are addressed specifically in various indicators. Maybe already a simple module introducing a dichotomous disability status would be sufficient and useful in the context of SDGs?

Extending coverage of indicators of Goal 3: Ensure healthy lives and promote well-being for all at all ages

(a) Adding Health Infrastructure

Adding Health Infrastructure information is already in discussion in the context of modeling internal migration (by attractiveness of province/region) and for refining modules on child mortality (and when

adding maternal mortality). Various indicators address health infrastructure, most relevant for modeling are probably:

- C030c01 Health worker density and distribution
- C030801 Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)

Some outcomes which to a large extent depend on infrastructure could be modeled specifically

- C030102 Proportion of births attended by skilled health personnel
- C030b01 Proportion of the target population covered by all vaccines included in their national program

(b) Modeling of diseases and cause-specific mortality

Modeling of cause-specific mortality as well as the spread of diseases are common microsimulation applications. Depending on national priorities, DYNAMIS might be used as base of the modeling of specific diseases (e.g. Malaria, HIV) and interventions.

- C030301 Number of new HIV infections per 1,000 uninfected population, by sex, age and key populations
- C030302 Tuberculosis incidence per 100,000 population
- C030303 Malaria incidence per 1,000 population
- C030304 Hepatitis B incidence per 100,000 population
- C030305 Number of people requiring interventions against neglected tropical diseases
- C030401 Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease

Incidence rates of diseases typically have an age profile and regional variation, this might make even simple models concentrating on population projections by few characteristics useful for projecting future rates and distinguishing policy and behavioral effects from composition effects.

(c) Health-related behaviors

Another typical application field of microsimulation for which DYNAMIS could serve as base are health-related behaviors like alcohol and tobacco consumption.

- C030502 Harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol
- C030a01 Age-standardized prevalence of current tobacco use among persons aged 15 years and older

Specialized applications for Goal 6: Ensure availability and sustainable management of water and sanitation for all

Specialized model applications are also thinkable for unsafe water/sanitation and related diseases and mortality. Such an application would draw on the ability of microsimulation to combine infrastructure data, fine-grained geography, and individual behavior.

- C060101 Proportion of population using safely managed drinking water services

- C060201 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water
- C030902 Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)

Economic modeling

This involves the modeling of labor force participation, employment, income and wealth and probably requires the modeling of families/households as well as some social insurance and policy systems. Such extensions require extensive planning and research but would extend the range of applications to a wide range of SDG indicators.

Entry point might be cross-sectional imputation models -- something envisioned with WorldPop [?]

Two SDGs could be specifically targeted: end of poverty, food security, and the reduction of inequality

Goal 1. End poverty in all its forms everywhere

- C010101 Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)
- C010201 Proportion of population living below the national poverty line, by sex and age
- C010202 Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
- C010301 Proportion of population covered by social protection floors/systems, by sex, distinguishing children, unemployed persons, older persons, persons with disabilities, pregnant women, newborns, work-injury victims and the poor and the vulnerable
- C010401 Proportion of population living in households with access to basic services

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

- C020101 Prevalence of undernourishment
- C020102 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)
- C020201 Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age
- C020202 Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)

C030802 Proportion of population with large household expenditures on health as a share of total household expenditure or income

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

- C080601 Proportion of youth (aged 15-24 years) not in education, employment or training
- C080701 Proportion and number of children aged 5-17 years engaged in child labor, by sex and age

Goal 10. Reduce inequality within and among countries

- C100201 Proportion of people living below 50 per cent of median income, by sex, age and persons with disabilities