Modeling Indian Pension Reform using Modgen

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Institutional Context:

- Modgen is a generic microsimulation language developed and maintained at Statistics Canada.
- MicroNPS is a simple model prototype implemented in Modgen; developed at IIASA for exploration of use of MS for study of poverty, health & social security in developing world.
- MicroNPS is currently being used in the context of a TA project of the Asian Development Bank (ADB) on the implementation of the New Pension System (NPS) in India. Note: ADB has not reviewed and in no way endorsed the presented work in progress.
- MicroNPS is also intended to be used for training and capacity building, e.g. @ Institute for Economic Growth (IEG); Delhi.
Outline:

- What is Modgen?
- MicroNPS as an example of a pension model implemented in Modgen: Look and feel
- How was it done? Code examples
What is Modgen? - Features

- Discrete or continuous time
- Interacting or non-interacting populations
- Modular development
- Multilingual models possible
- Powerful tabulation facilities
- Standard errors and coefficients of variation for tables
- Export of parameters and tables to Excel
- Unlimited number of dimensions for parameters and tables
- Visualization of individual life courses
- Common user interface for all models
- Scenario management
- Fully documented user interface
- Generation of detailed encyclopaedic model documentation
- Multi-threading and grid-computing possible
What is Modgen? - Applications

Modgen is available at:

Documentation includes a commented list of models.

- **Pohem (1994)** - Population Health Model (POHEM)
- **LifePaths (1994)** – Large general purpose Canadian model, extensively used for pension
- **XEcon (~1995)** - XEcon is an experimental non-empirical model of interacting firms and consumers.
- **PopModM (2002)** - PopModM was created as a proof of concept for the World Health Organization.
- **IDMM (2002)** - Infectious Disease Microsimulation Model
- **Health Forecasting Model (~2002)** - UCLA School of Public Health.
- **CVMM (~2003)** - The Child Vaccination Model co-developed with London School of Hygiene and Tropical Medicine
- **The HIV microsimulation model (HIVMM)** was co-developed with the WHO and SACEMA
- **PeriMod (2008)** - McGill University; simulates foetus histories from conception to birth
- **Persim (2008)** – personnel planning in public sector
- **CellMM (2008)** – Model demo to replicate differential equation
- **HealthPaths (2009)** – Bootstrapping ms
- **CareMod** - (based on Pohem) costs and benefits of interventions that reduce cancer in Canada.
- **MicroNPS** – Pension reform in India
What is Modgen? - Models

- Models are currently established or in development to:
  - Analyze, develop and cost government programs, such as public pension sustainability or post-secondary education
  - Estimate the life time costs of diseases, such as heart disease or lung cancer, and evaluate the potential impacts of public health interventions on those diseases
  - Generate detailed population projections
  - Perform human resources planning for large enterprises
  - Examine the spread of infectious diseases among interacting populations
  - Study foetal growth

- Modgen has also been used as an instructional tool to teach microsimulation itself to social scientists in both Canada and Europe.
What is Modgen? – Goals

- Facilitate development of dynamic microsimulation models by automating every aspect possible:
  - Interface
  - Event queuing
  - Interactions among actors
  - Tabulation
  - Exploring life histories

- Make it possible to create and maintain a microsimulation model without a professional programmer

Generic! Full flexibility of C++

- Integrated into Microsoft Visual Studio NET C++: “compiler pre-processor”
- Modgen program translated into C++ and then compiled as C++ application

New: Modgen Web: allows running models on web
MicroNPS

Pension reform for a population of 1.2 billion
A microsimulation analysis

Martin Spielauer
The NPS is a version of the public sector pension plan for “unorganized sector” = 89% of population

- Voluntary but with a minimum contribution of 500Rs / month
- Enhanced investment choices (investment strategy & 6 funds)
- Non-withdrawable
- EET tax regime: contribution & accrued earnings exempt, Taxable at withdrawal (ongoing discussion)
- Low fees compared to existing private plans
Existing experiences in Asia

... overall discouraging

- Irregular and low payments: low accumulations at high management costs

- Public control leading to poor investment return (allocation to state-run development funds)

- Early withdrawals: erode savings if allowed, discourage pension plan enrolment if not allowed

- Disability and survival protection limited

Indian context

- Dense financial infrastructure

- Same scheme as civil service expected to increase confidence

- Expertise in information technology
Assessing NPS

Pilot district activities
- Household survey (n=800) in Mangalore (urban) and Hamirpur (rural) districts; Institutional survey; Focus group discussions
- Some findings: Average work income ~3400 Rs/month (70US$)
  Average saving capacity reported (Mangalore) 140Rs/month

MacroNPS model
- Cell-based model
- Cohort component population projection ~UN
- Fixed rates: mortality decline, rural-urban migration, Imp, interest, wage growth, pension saving
- Used for “sizing the market”; Scenarios on plan enrolment
- Micro-foundation? 5% saving of av. 3600Rs = 180Rs; 500 min.
- Initial idea: model calculations for stylized individual life-courses scenarios; expected pensions, IRR, etc: “Microsimulation for one individual”
- Extended to cohort ms model; then to population ms
- Add distributional analysis into otherwise highly stylized modeling
- Add simple behavioural models for saving (boundary conditions, e.g. survival)
- Ability to reproduce macro scenarios and test/change/refine assumptions & models
Behaviours
- Fertility: distribution of “family types” by urban/rural & education
- Partnership & partner matching by age and education
- Mortality by sex and rural/urban; UN projections
- Rural-urban migration: 1%, urbanisation 30% -> 50%
- Education: by urban/rural and sex
- Labour market participation: age, sex, urban/rural; assumptions on duration in given state
- Wages & income mobility: Gini 0.36 log-normal; persons stay with parameterized probability in given decile
- Pension saving: saving rate accounting for subsistence minimum
- Sickness and disability: age specific rates; distribution of costs

Pension
- Fees and operating costs
- IRR, distribution of benefits, Poverty
MicroNPS: Parameters and behaviours

- General Demography
  - Population by year of birth (alive at age 18 resp. 2010)
  - Rural-Urban migration rate
  - Mortality rate
  - Mortality decrease by year

- Family Demography
  - Family type definitions
  - Family type distribution
  - Age when moving out of parents' household
  - Average age difference between spouses (for partner matching by education)

- Health and Disability
  - Health risks

- Income
  - Median income at productivity 1 in 2010
  - Income growth
  - Income mobility between decades
  - Existence minimum per equivalence person
  - Equivalence scale and alimony

- Labor
  - Labor market participation and mobility
  - Age profile of labor productivity

- Saving and Pension
  - Pension saving rate (proportion of income put into pension saving if above minimum contribution)
  - Maximize pension saving rate (max., proportion of income put into pension saving to meet minimum)
  - Interest on pension savings
  - Minimum contribution to pension scheme
  - Pension conversion factor
  - Proportion of population entering plan when becoming eligible

- NPS fees
  - Monthly account maintenance fee
  - Average transaction fee
  - Account opening fee
  - Management fee

- Education
  - Education distribution

- Table Groups
  - Total population and life expectancy
  - Fertility
  - Disability and disability
  - Income and Poverty
  - Time spent in poverty age 18+ by age group
Population age 65 with Household Pension Income above Poverty Line by Initial Income Decile and Year of Birth: Base vs. Health Expenditure Scenario
Illustration: Expected IRR

IRR - 1992 BIRTH COHORT - ALL (2.5% WAGE GROWTH, 2.5% INTEREST)
MicroNPS: Time in poverty by age group and year

YEAR
20-50
50-60
60-70
70-80
80+
All
Life-Course Income and Pension by Type for the 2002 Birth Cohort; Male, 6th Earning Decile
table Person Tab12_IncomeTypes
[ integer_age >= 18 && integer_time >= 2010 ]
{
  sex+ *
  StartDecile+ *
  split(time_of_birth, COHORTSIMYEAR)+ *

  value_in(HHLaborIncome) / unit, //EN Household labor income
  value_in(HHNetLaborIncome) / unit, //EN Household labor income net pension contribut
  value_in(HHPensionIncome) / unit, //EN Household pension income
  value_in(SurviveIncome) / unit, //EN Survival minimum
  value_in(HHNetIncome) / unit, //EN Household net income
  value_in(HHIncome) / unit, //EN Household income
  value_in(AequiIncome) / unit, //EN Aequivalence income
  value_in(LaborIncome) / unit, //EN Individual labor income
  value_in(PensionIncome) / unit //EN Individual pension income
}

* split(integer_age, AGE1)
  //EN Age
A typical module: (1) Gen. Definitions

range LIFE //EN Age range
{
    0,100
};

range YOB //EN Year of Birth
{
    1955, 2032
};

classification SEX //EN Sex
{
    FEMALE, //EN Female
    MALE   //EN Male
};
A typical module: (2) Parameters

```plaintext
parameters
{
    double MortalityRate[MUNICIP][LIFE][SEX];  //EN Mortality rate
    double MortalityDecrease;  //EN Mortality decrease
};
```
A typical module: (3) Actor definitions

```c
actor Person
{
    // Simple States
    logical alive = {TRUE};

    // Events
    event timeMortalityEvent, MortalityEvent;

    // Functions
    double LifeExpectancy(int nYob, int nSex, int nMunicip, int nMinExp);

    // Derived states (automatically updated)
    //EN HH is poor (below survival income)
    logical isPoorHH = (SurviveIncome > HHIncome);

    //EN Current integer age
    integer integer_age = self_scheduling_int(age);
};
```
A typical module: (4) Events

```cpp
TIME Person::timeMortalityEvent()
{
    TIME tEventTime = TIME_INFINITY;
    if (integer_age < MAX(LIFE) && integer_age >= 18 && integer_time >= 2010)
    {
        double MortalityHazard = MortalityRate[municip][integer_age][sex] * pow((1-MortalityDec:
        tEventTime = WAIT( - TIME( log( RandUniform(1) ) / MortalityHazard) );
    }
    else if (integer_age >= MAX(LIFE))
    {
        tEventTime = WAIT(0);
    }
    return tEventTime;
}

void Person::MortalityEvent()
{
    alive = FALSE;
    TotalPensionSavings = 0;
    Finish();
}
table Person Tab11_PoorPerson
[ integer_age >= 18 && integer_time >= 2010 ]
{
  sex+ *
  {
    duration(isPoorHH, TRUE) / duration()
  }
  * split(integer_time, CALSIMYEAR)
  * age_class+
};

//EN Time spent in poverty

//EN Sex

//EN Poverty rate decimals=2

//EN Calendar year

//EN Age group
Summary & Conclusions

Information on Modgen is available at:
- Developer’s guide
- Commented list of models using Modgen
- Documented example models
- Software download: Modgen & examples

Teaching material also at: www.spielauer.ca

For programming MS VS08 is required, a free 90 day trial can be downloaded at www.microsoft.com (the academic license is 100$)

STC provides technical assistance, supports prototype development, open for project partnerships, technical centre & subscriptions

Modgen web goes public soon