The Treasury Dynamic Microsimulation Model (T-DYMM)

MEF Dipartimento del Tesoro

sogei

Rome, 7 October 2019

Outline

- History
- General features of T-DYMM
- The AD-SILC dataset
- Structure of T-DYMM 2.0
- Simulation Results
- Future Implementations

History

- T-DYMM has been developed in 2 phases:
  1. 1° European Project (2010-2012): based on MIDAS and EconLav, developed in Liam 1.0, covers 2005-2060;
  2.
     a) 2° European Project (2014-2016): new and improved AD-SILC, move to Liam 2.0, update of the legislation, addition of private pension module, indexation of pensions, unemployment benefits;
     b) Publication of 'What are the consequences of the AWG 2018 projections and hypotheses on pension adequacy?' and aftermath: update of the legislation, taxation module expanded and moved to Liam 2.0, modelization of net migration

General features of T-DYMM

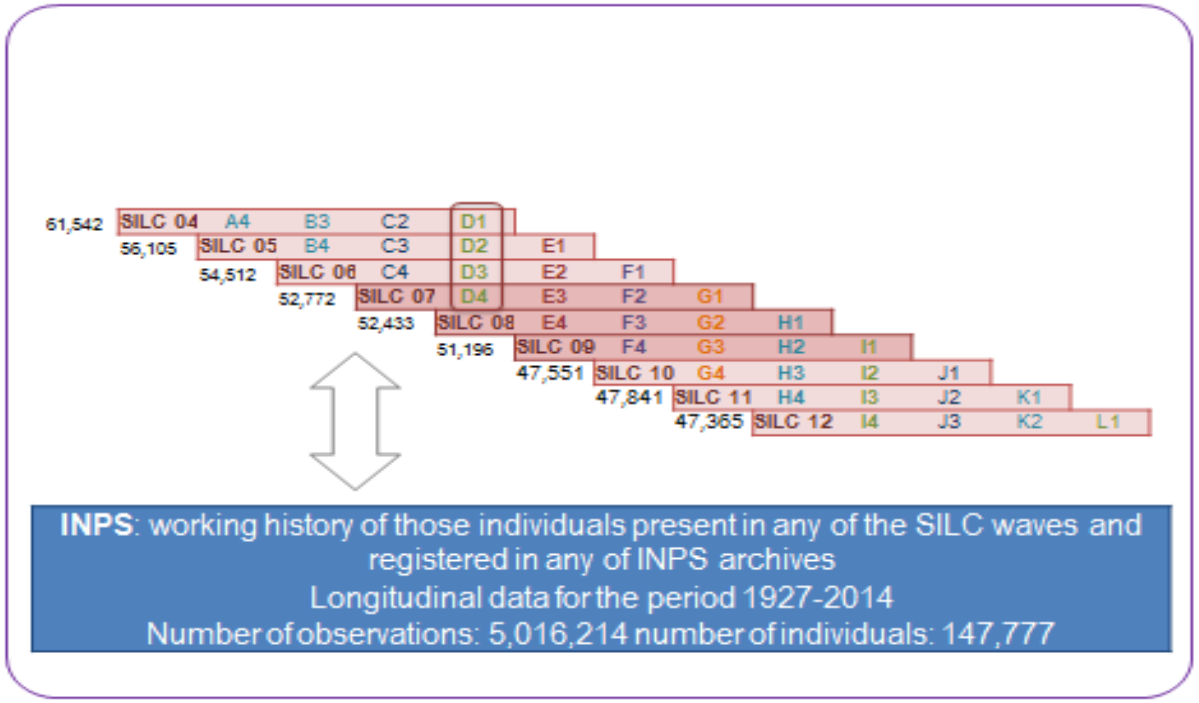
- It is a Dynamic Microsimulation Model (long-term projections)
- The unit of analysis is the individual
- It treats time as discrete
- It has a sequential structure
- Socio-economic events occur according to conditional transition probabilities (estimated on data available)
- It uses alignment procedures on demographic and macroeconomic projections

The AD-SILC dataset

- AD-SILC is composed by matching the observations contained in the survey SILC delivered by ISTAT with administrative data from INPS
- **Panel INPS**: longitudinal data of individuals' working history since their entry in the LM: occupational status, income evolution, contribution accumulation, etc.
- **Panel SILC**: longitudinal data of individual socio-economic characteristics (up to 4 years): education, marital status, number of children, etc.

AD-SILC dataset: contents and features

- **AD-SILC 2.0** comprises all SILC waves from **2004** to **2012**
- It is an **unbalanced panel** dataset derived from both data sources (INPS and ISTAT)
- It can also make use of the panel component inherent to SILC



AD-SILC uses:
Analyses, regressions and projections (1)

- Analyses of dynamics within the labor market:
  - Transition matrixes;
  - Earnings distribution trends;
  - Accumulation of pension contributions.

Working conditions after 1 year of those employed in 2008 (by education)

At most lower-secondary

	2009				
2008	**Perm.**	**Fixed Term**	**Self-empl.**	**Atypical**	**Out of work**
Perm	**91.2**	2.4	0.5	0.1	5.8
Fixed Term	18.3	**60.6**	1.9	0.4	18.8
Self-empl.	0.9	1.1	**93.0**	0.4	4.6
Atypical	7.4	2.8	4.6	**76.9**	8.3

Upper-secondary

2008	**Perm.**	**Fixed term**	**Self-empl.**	**Atypical**	**Out of work**
Perm.	**94.6**	1.4	0.5	0.2	3.3
Fixed	19.5	**58.8**	2.8	1.5	17.5
Self-empl.	0.8	1.1	**94.8**	0.3	3.0
Atypical	4.1	3.7	2.5	**80.4**	9.4

Tertiary

2008	**Perm.**	**Fixed term**	**Self-empl.**	**Atypical**	**Out of work**
Perm.	**95.8**	1.4	0.5	0.5	1.8
Fixed	23.0	**53.6**	2.6	3.8	17.0
Self-empl.	1.0	1.0	**96.1**	0.4	1.5
Atypical	3.9	8.2	1.7	**80.3**	6.0

Note: workers aged 35-44 in 2008 are considered

Working conditions after 3 years of those employed in 2008 (by education)

At most lower-secondary

	2011				
2008	**Perm**	**Fixed Term**	**Self-empl.**	**Atypical**	**Out of work**
Perm	**85.0**	4.3	1.7	0.3	8.8
Fixed Term	29.4	**49.5**	2.8	0.8	17.5
Self-empl.	3.5	2.2	**86.9**	1.0	6.4
Atypical	20.4	6.1	9.2	**54.1**	10.2

Upper-secondary

2008	**Perm**	**Fixed term**	**Self-empl.**	**Atypical**	**Out of work**
Perm	**91.0**	2.6	1.5	0.5	4.5
Fixed	36.9	**40.6**	3.5	2.3	16.7
Self-empl.	2.8	1.6	**90.2**	1.0	4.4
Atypical	10.6	3.8	7.2	**67.8**	10.6

Tertiary

2008	**Perm**	**Fixed term**	**Self-empl.**	**Atypical**	**Out of work**
Perm	**93.4**	2.0	1.2	1.0	2.5
Fixed	37.1	**41.1**	5.7	4.4	11.8
Self-empl.	3.1	2.0	**92.2**	0.6	2.1
Atypical	12.6	6.7	4.5	**65.9**	10.3

Note: workers aged 35-44 in 2008 are considered

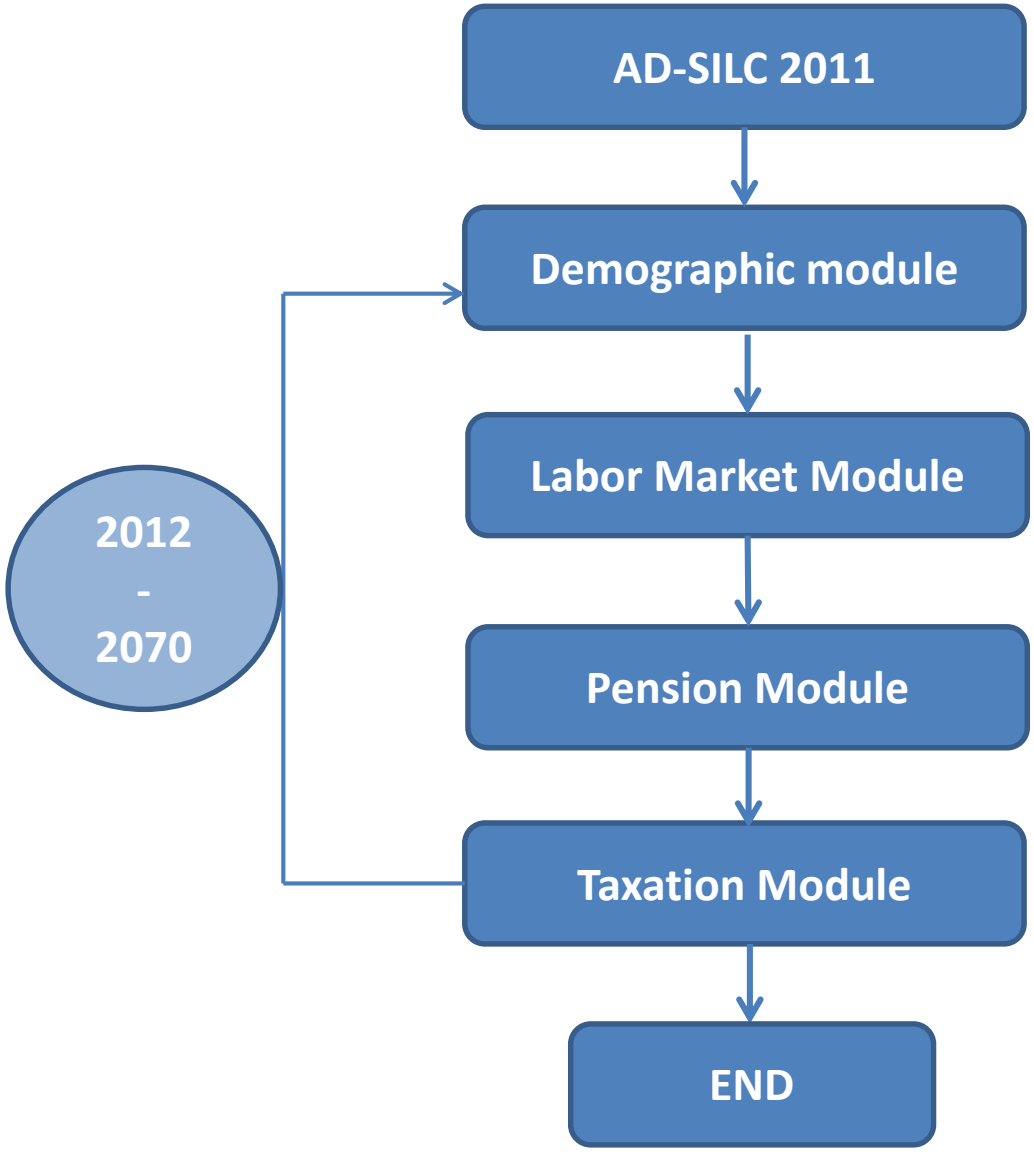
AD-SILC uses:
Analyses, **regressions** and projections (2)

- Regressions used in T-DYMM are based on the **entire** dataset AD-SILC
- All individuals in SILC 2004-2012 and the respective working and contribution history carried out by INPS are considered over the period 1998-2011 for:
  - Modelling the demographic dynamics;
  - Modelling the working statuses;
  - Modelling the earnings process.

AD-SILC uses:
Analyses, regressions and **projections** (3)

- Simulations are based on a **single extract** of AD-SILC
- For T-DYMM 2.0, **2011** is the **starting point** of the simulation
- The dataset is **cross-sectional** (SILC 2011), integrated with retrospective information about working conditions, acquired work experience, total number of years of contribution, etc.

The 4 Modules of T-DYMM



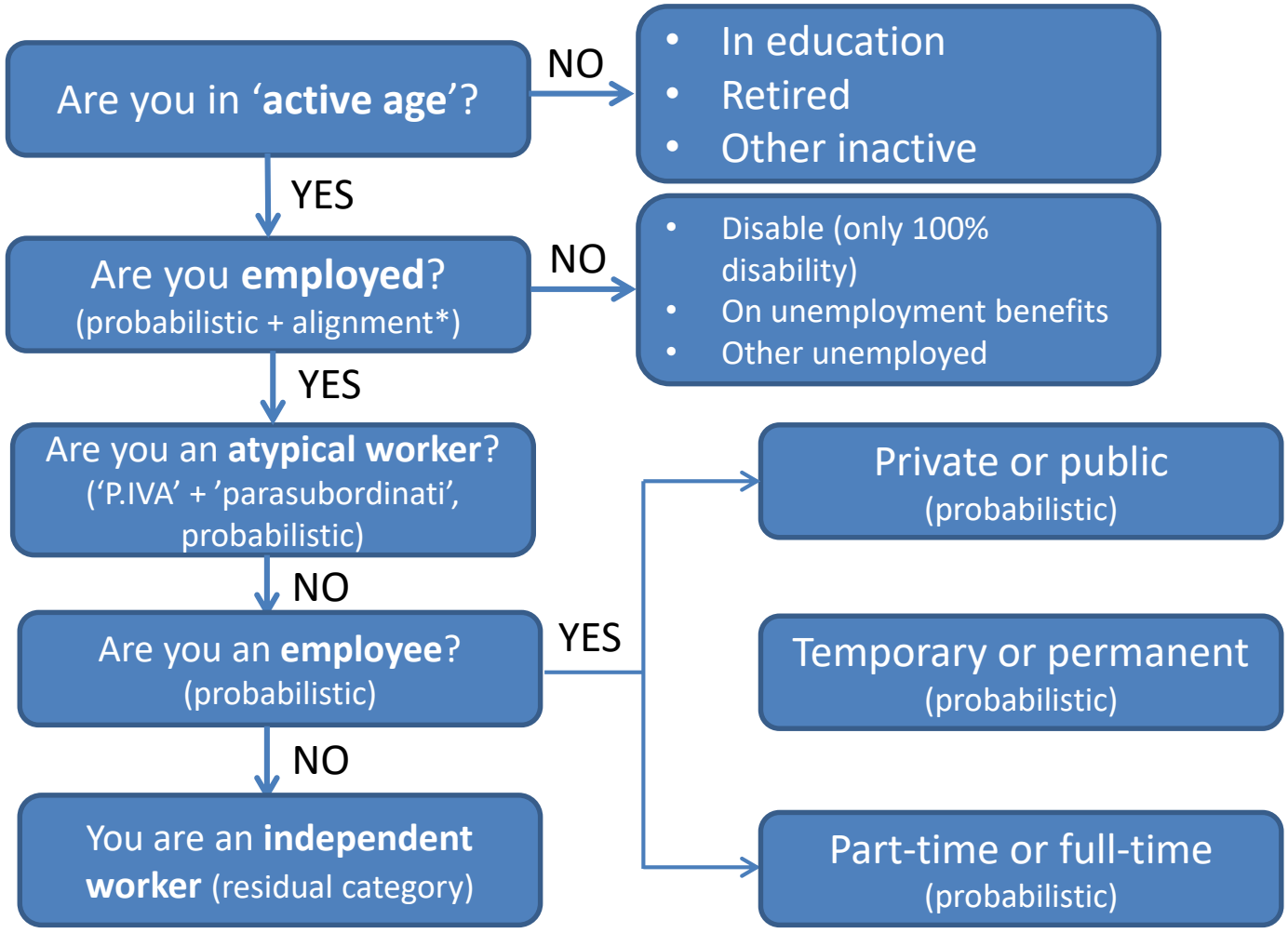
The Demographic Module

- Processes:

  1. Ageing (no heterogeneity, mortality rates aligned*);
  2. Births (probabilistic, fertility rates aligned*);
  3. Immigration (cloning procedure);
  4. Education (dependent on parents' education);
  5. Leaving household (deterministic);
  6. Coupling / marriage and divorce (probabilistic)

* AWG 2018 Projections

The Labor Market Module

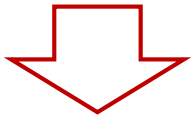


* AWG 2018 Projections

The Labor Market Module: LM transitions (1)

- Conditional probabilities of LM transitions across employment states are estimated based on a **sequence of binary behavioural choices** with the following logical order:

1. Probability to be **employed** (all individuals who are not students nor retired are included in the regressions);



2. Probability to be an **atypical worker** among all workers defined in step 1;

3. Probability to be an **employee** among workers defined in step 1 except atypical workers;

4. Probability to be **self-employed** (residual category).

The Labor Market Module: LM transitions (2)

Among **employees** the subsequent choices are concerned:

1. Economic sector (**private** vs **public**);

2. Contract duration (**temporary** vs **permanent**);

3. Time arrangements (**part-time** vs **full-time**).

The Labor Market Module: LM transitions

- Sample size: 1,105,456 observations, relative to 82,137 individuals aged 16-69 years old
- Estimation period: 1998-2011
- The estimations are carried out separately for **men** and **women**
- **Random effect logit models** for LM transitions in order to account for individual unobserved heterogeneity

NB: in none of our regressions do we include variables that are not present in the "simulation world" of T-DYMM because of the impracticability of projecting its evolution in time

The Labor Market Module: Estimations of earnings (1)

Yearly individual labour income gross of personal income taxation is the product of two components:

monthly gross wages

The earnings process is modelled separately for the three work typologies and by gender

months worked

Modelled in two steps:

1) The probability of being in work all year (concerns atypical and temporary workers)
2) Define the months worked for those workers who are not assigned to the «work all year» status

The Labor Market Module: Estimations of earnings (2)

- The functions for monthly earnings and months in work within the year are modelled as such:

$$y_{it} = \boldsymbol{X_{it}\beta} + u_i + \nu_{it}$$

Where $\boldsymbol{X_{it}}$ consists of a vector of observed variables, while unobserved variables are represented by a random component that captures permanent heterogeneity between individuals (u_i) and by a stochastic error component (ν_{it}):

- The permanent error component, u_i, (i.e. intellectual ability, soft skills, motivation) represents a constant wage deviation for each individual, where $u \sim N(0, {\sigma_u}^2)$
- The transitory component, ν_{it}, (i.e. bonuses, illness, overtime) follows an AR(1) process plus a white noise error, ε_{it}:

$$\nu_{it} = \rho\nu_{i,t-1} + \varepsilon_{it} \quad , \varepsilon \sim N(0, {\sigma_\varepsilon}^2) \text{ and } |\rho| < 1$$

Estimations of monthly wages

- A random effect GLS estimator has been utilised to estimate the wage equation on the AD-SILC panel data.
- Estimation period: 1998-2011
- The estimations are carried out separately for the three work categories and for men and women.
- Sample size: 632,762 observations for 79,009 individuals aged 20-60: about 75% are employees,19,5% are self-employed and 5,5% are atypical workers.

Estimations of months worked

1. Estimations of the probability of being in work all year:

- Random Effect Logit model;
- Sample size – 96,933 observations for 29,391 individuals: 48% are men and 52% are women;
- Estimation period: 1998-2011.

2. Estimations of months worked:

- Same model as for monthly wages;
- Sample size– 50,264 observations for 12,768 individuals: 41% are men and 59% are women;
- Estimation period: 1998-2011.

The Labor Market Module: Unemployment Benefits

- If individuals do not work and they fulfill entitlement criteria, they get unemployment benefits (i.e., take-up rate is assumed at 100%)
- Benefit amount and duration are both simulated, 'figurative' contributions are computed
- 'Ante-Fornero', 'Fornero' and 'Jobs Act' legislations are simulated

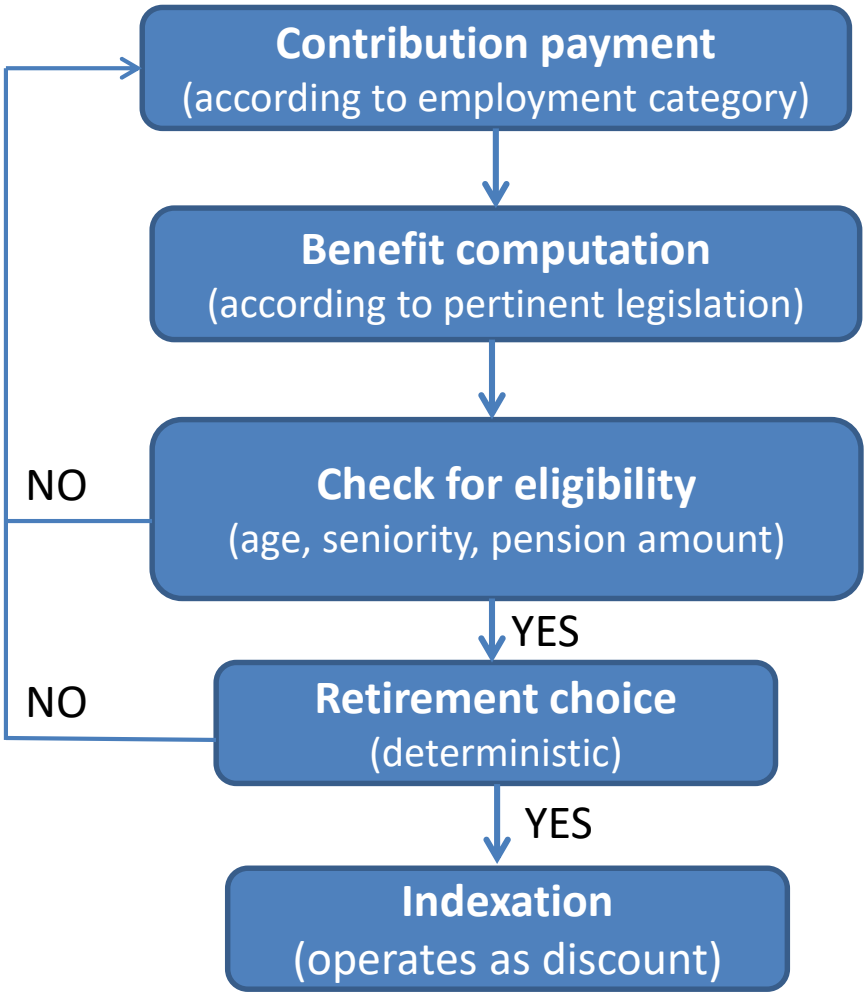
The Labor Market Module: Disability

- The occurrence of disability happens randomly
- Ad hoc alignment processes ensure stability in size of the phenomenon
- No difference is outlined between work-related disability and ‘invalidità civile’

The Pension Module

Public scheme (1)

Old-age / Seniority Pensions



The Pension Module

Public scheme (2)

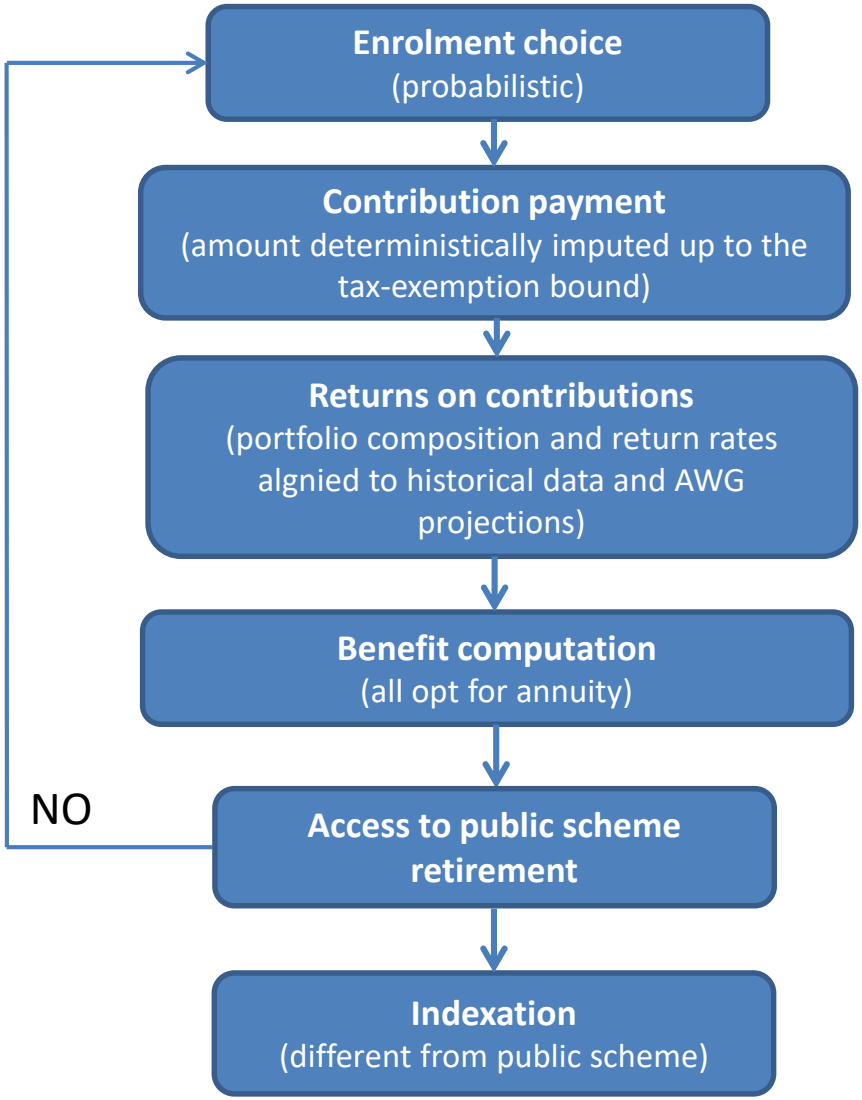
Other benefits simulated

- “Quattordicesima”
- “Integrazione al minimo”
- “Assegno sociale”
- Disability Pensions
- Survivor Pensions

The Pension Module

Private scheme

2° and 3° pillar



The Taxation Module

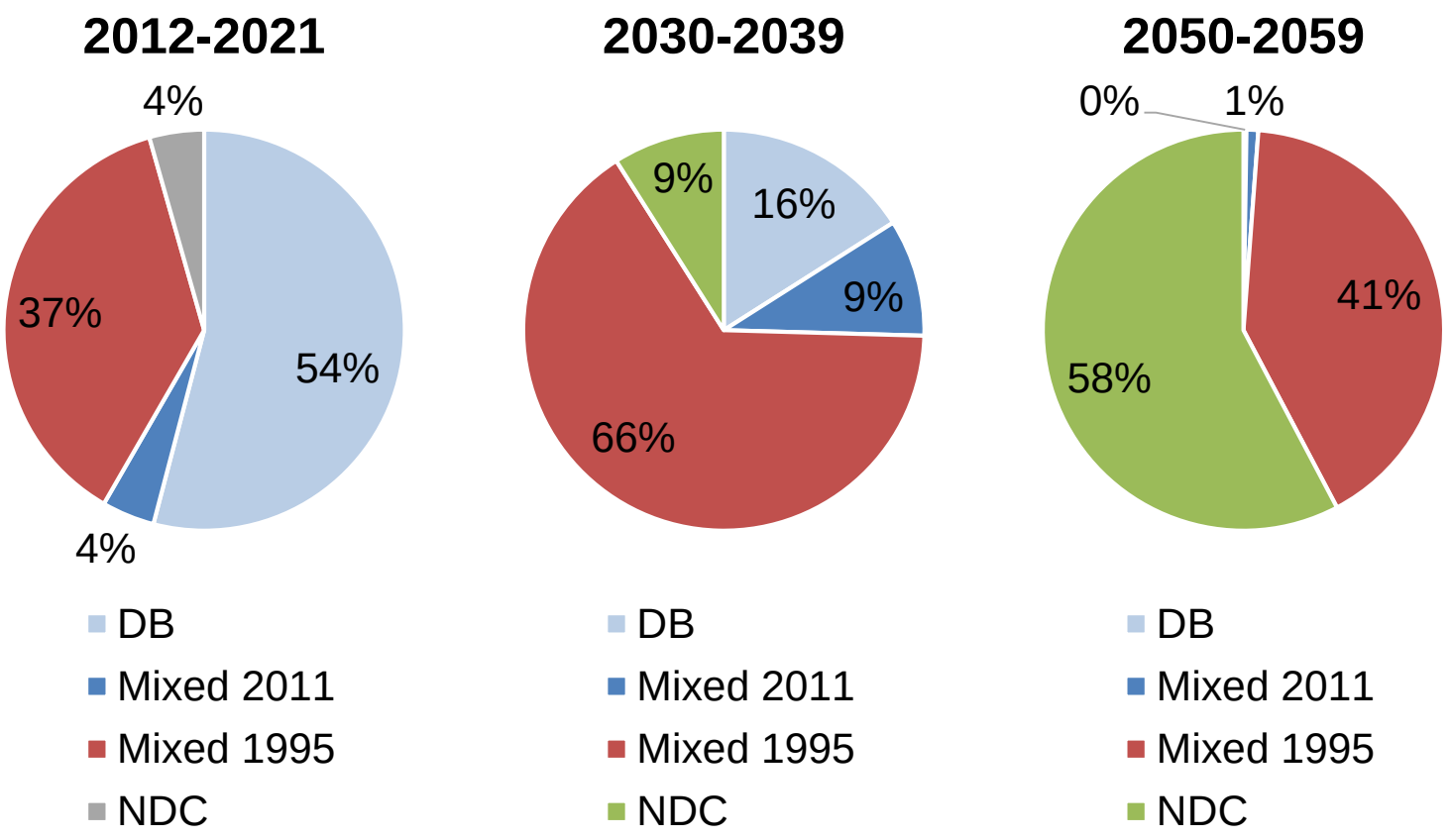
	Gross income
-	Social contributions
-	Private pension contributions
=	**Taxable income**
-	IRPEF
-	Tax credits (employee, independent, pensioner, family-related)
=	**Net income**

Simulation Results (IESS project, 2016)

- T-DYMM has generally been used to assess the *adequacy* of the Italian pension system. Published results inculde:
  - Average retirement age;
  - Average duration of retirement at death;
  - Replacement rate at retirement;
  - Gini index;
  - Income quintile share ratio;
  - At-Risk-of-Poverty Rate.
- Results have generally been proposed on a number of sensitivity and policy scenarios

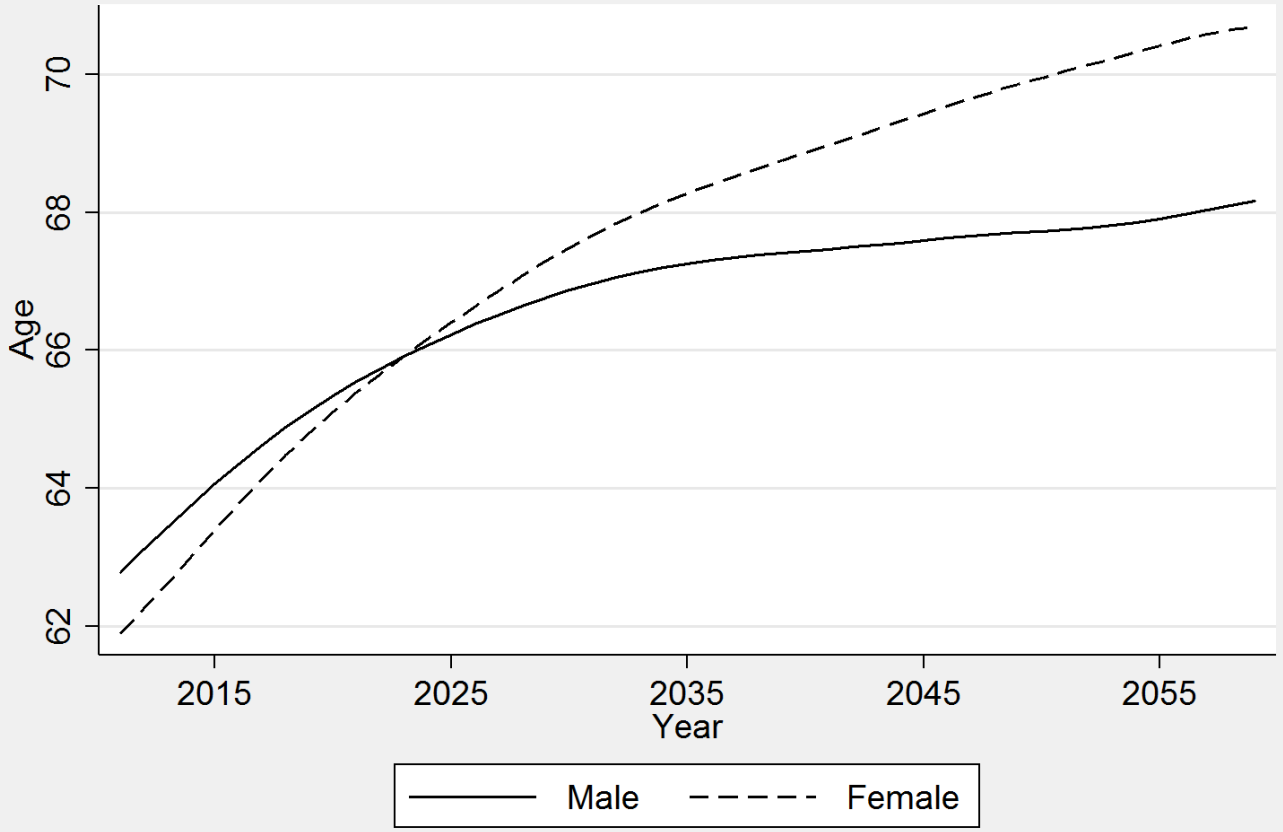
Sample evolution: computation rules

Stock of pensioners



Average effective retirement age

New pensioners



Note: Lowess smoothing

Source: T-DYMM 2.0 - own elaborations

Condition at retirement by birth cohort (1)

New pensioners. All pensions

Birth cohort	Age	Years of contribution	Gross replacement rate	Pension / *assegno sociale*
1950-59	65.9	33.2	63%	3.6
1960-69	67.2	34.3	55%	3.2
1970-79	68.1	34.1	50%	2.9
1980-89	68.6	34.3	50%	3

Averages on simulation period, 2012-2059

Condition at retirement by birth cohort (2)

New pensioners. Pensions ≥ 3*AS

Birth cohort	Age	Years of contribution	Gross replacement rate	Pension / *assegno sociale*
1950-59	64.6	39.7	72%	5.3
1960-69	65.9	41	62%	4.9
1970-79	66.3	40.5	53%	4.4
1980-89	66.4	39.5	50%	4.3

Averages on simulation period, 2012-2059

Condition at retirement by birth cohort (3)

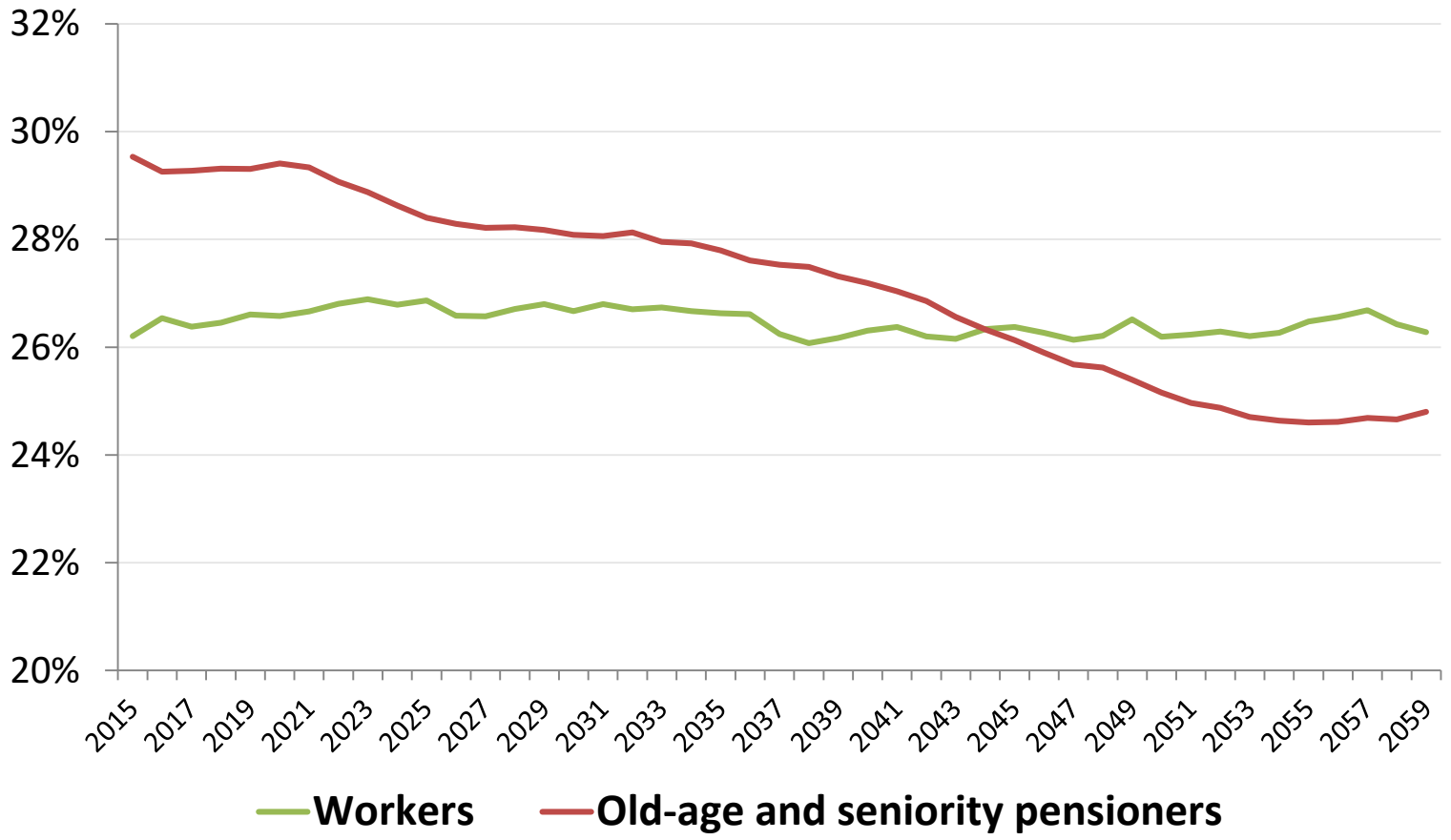
New pensioners. Pensions < 3*AS

Birth cohort	Age	Years of contribution	Gross replacement rate	Pension / *assegno sociale*
1950-59	67.3	26.4	51%	1.8
1960-69	68.2	29	49%	1.9
1970-79	69.3	30	48%	2
1980-89	69.9	31.3	50%	2.2

Averages on simulation period, 2012-2059

The evolution of inequality indicators

Stock of pensioners. Gini index



Net pension incomes are considered

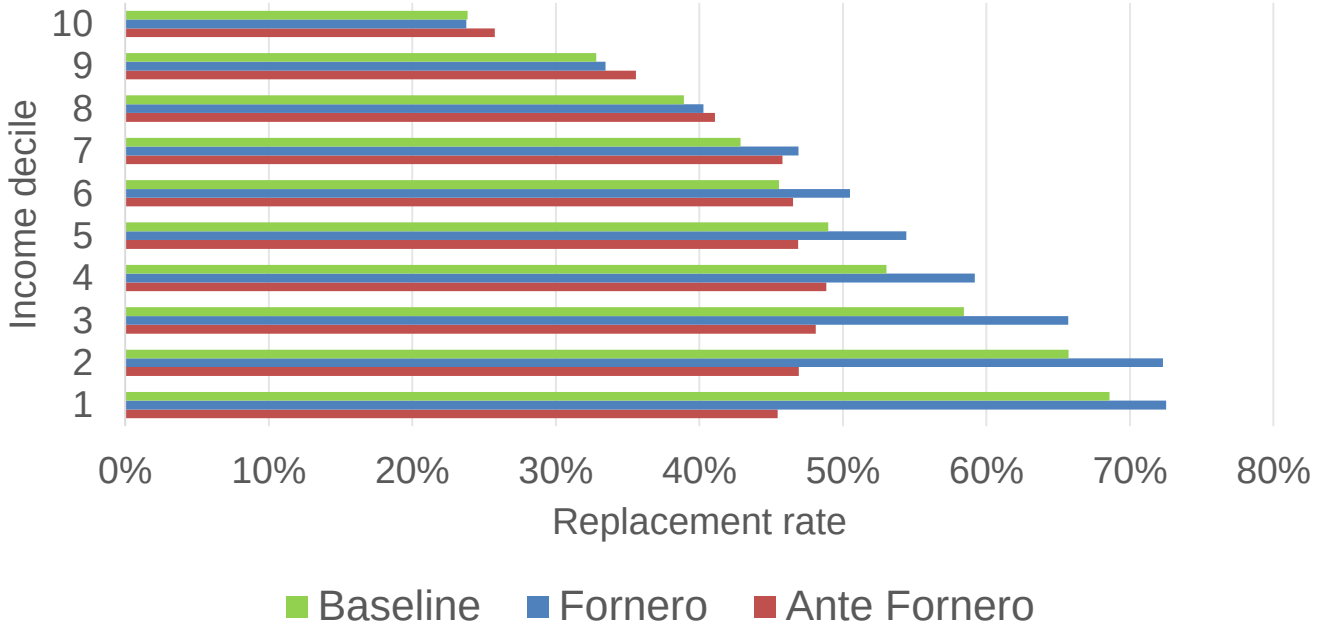
Unemployment Benefits

Replacement rate of unemployment benefits, 2015-2059

Overall

	Jobs Act	Fornero	Ante Fornero
2015-2059	54.8%	58.4%	45.4%

By income decile



Future Implementations

- Development of a ‘Wealth Module’ (financial, real-estate wealth, TFR)
- Development of a ‘Migration Module’ (immigration and emigration, characterized patterns for migrant workers)
- Inclusion of working pensioners (retirement is now an ‘absorbment state’)
- Expansion of ‘Disability Module’ (probabilistic, improve alignment procedures)
- Expansion and update of welfare and fiscal modules
- Improvement of sample representativeness
- Focus on atypical workers

Thank you for your attention

MEF Dipartimento del Tesoro

sogei