RÉPUBLIQUE FRANÇAISE

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DIRECTION DE LA RECHERCHE, DES ÉTUDES, DE L'ÉVALUATION ET DES STATISTIQUES

Trajectoire: an empirical micro-simulated French pension system model

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A (very) short introduction to the (very) complicated french pension system

- The French pension system covers over 40 different regimes (42?) that concur with professional statuses (down from 70 a few years ago).
- To this day, it is globally redistributive and contributory and based on two obligatory pillars: the base schemes and the complementary schemes. Private pensions are voluntary and outside the scope of Trajectoire.
- Basically, contributory rights to pensions are accumulated depending on duration of contribution and wage level. Solidarity (mainly family bonuses, minimums, early retirements) also plays a role.

Presentation outline

1. Introduction (background and general presentation)
2. Survey data inputs, macroeconomic hypotheses and code structure
3. Differential mortality
4. Career transitions
5. Wage imputation
6. Retiring in Trajectoire
7. Some illustrative results

Introduction: Background

- The DREES hosting the Trajectoire team (mainly employees from the national statistics institute INSEE that depend on the Ministry of Economics) is the statistical service of the Ministries of Health and Solidarities, although the Ministry of Labour orders simulations of the pension system!

- **Genealogy of Trajectoire and other models:**

Trajectoire inherits from the DREES meso model PROMESS developed in 2010 that's was developed to study end of career transitions and departures for retirement.

Unlike PROMESS that is based on categories of individuals, Trajectoire simulates individual careers. It allows to study the accumulation of rights to diverse pension regimes for each individual.

- **Two other French models are:**

PRISME (covers all affiliates to the social security system, but pension rights of affiliates to the main private base regime only).

DESTINIE (uses the INSEE patrimonial survey, and covers couples).

Introduction – What is Trajectoire?

- Trajectoire is a **dynamic multi-scheme empirical microsimulation pension model** used to study reform impacts on aggregate expenditure and on individuals.

- **It is a pension rights model**.

The pension regimes included in Trajectoire are the main 30 base regimes (private employees, public employees, liberals, independents, farmers etc.) and 9 main complementary regimes.

- **It simulates pension expenditure** (and partially funding through contributions).

It covers individual contributory and solidarity rights served by pension funds but not tax funding, rights on deceased spouse pension (no couples) or social solidarity for seniors.

- **It is microsimulated** as it is based on individual careers.

There are no other sectors described (state, private sector employers, banks) so there is no macroeconomic closure.

- **It is open-source!**

Introduction: Goals of the model

- **Goals of the model :**

➢ To describe present and long term pension levels, retirement age, number of retirees, etc. by regime, generation and socio-economic characteristics.

➢ To determine the financial evolution of the pension system.

➢ To build alternative scenarios by modifying legislation or hypothesis and compare them with the baseline scenario (providing details of the impact of each divergence).

Data inputs – span of the model

- The model has a large span: it covers generations 1934 to 2004 and is simulated until 2100.

The quadriennial representative samples used in Trajectoire are the inter regime contributors sample (EIC) and the inter regime pensionners sample (EIR).

The field of the EIC is the active population in France (from 14 years old) since the generation 1934.

- The EIC is a survey of individuals' situation from the point of view of pension regimes. The information used in the model is also from that point of view. It will tell us to which pension "fund(s)" a person is contributing, if a person is working, sick, unemployed <u>but not which job it is occupying.</u>

Given hypotheses – macroeconomic targets

Macroeconomic and demographic hypotheses are taken as given from outside sources.

- Macroeconomic hypotheses : inflation, unemployment, productivity growth rate (several scenarios in the long run), headcount by pension regime

  → Short run : government (including public sector wages)

  → Long run : COR (Pensions Advisory Council)

- Demographic hypotheses : population increase, life expectancy, immigration

  → The National Institute of Statistics and Economic Studies (INSEE)

The code structure – inputs and hypotheses

- The model is coded on R with the data.table package (memory efficiency, no dependencies). The code is divided in 7 sections and 173 steps.

- **Section 1 prepares the model to run and deals with imports…**

  such as samples, macroeconomic targets, global hypotheses …

  and methodological choices by shaping inputs :

  differential mortality calibration, unclaim rates, working quotas, working population, extension method of parameters ...

The code structure – careers and rights

- **Section 2 deals with careers…**

  such as preparing the horizon effect and generating the transition matrix, extending careers, workforce and unemployment targets determination…

- **and wages.**

  Many steps are imputations and distributions : missing generations, inflow of individuals (young people and immigrants), bonuses and part-times for civil servants…

- **Section 3 deals with calculation of rights and imputation of pension rights relevant variables.**

  Durations, contributions, points, net wages, family induced bonuses, age of death…

The code structure – departure, pension computation and aggregations

- **Section 4 deals with the end of the career and departure behaviour.**

  Early departures, invalidity, departure dates in primary and secondary regimes, conciliation of departure dates, death…

- **Section 5 deals with inter regime systems.**

  Settling of aligned regimes, regrouping of state and local public regimes, determination of main regime and final date of departure.

- **Section 6 calculates the pension amount.**

  Duration, bonuses, claim / unclaimed rights, average annual wage, gross payment rate, proration, premium, discount, markup, temporary modulations, revaluations…

- **Section 7 calculates indicators and prepares bases for output graphs and tables.**

Main features : differential mortality

INSEE's official mortality rates are given by sex, age, generation. If used as such, they would introduce a bias in measuring pension spending. We therefore use our survey data to estimate mortality rates by pension quartile.

Coefficients of mortality by pension quartile and margin adjustment

Coefficients of instantaneous mortality (during a given year) are estimated by quartiles of pension levels (to approach standard of living) for the last generations whose death happened between the last two waves of EIR sample surveys.

- They are then adjusted to margins obtained by INSEE for the general population.
- A categorical decreasing survival function is derived from the mortality coefficients giving probabilities of death for any given age, and a statistical hazard coefficient is drawn for each individual.
- Death occurs once there hazard coefficient is greater than the survival function curve.

Main features : differential mortality

Estimated coefficients of instantaneous mortality

margin adjustment

survival function

Individual statistical hazard coefficient

age of death

Main features : career year-to-year transitions

A matrix of probabilities of transitions will be used to extend careers until 70 years old in a efficient way. It allows to easily study alternative scenarios affecting end of career trajectories.

Employment states

For each individual and year, a principal state of employment with a pension regime affiliation is determined. The state of an individual can also be that of unemployed. A secondary state can be attributed, which will be the last observed before the principal, or secondary to the principal during the year, with regards to the accumulation of pension rights.

Observed weighted transitions

- Year to year state transitions occur between combinations of states of employment.
- The probabilities of transition are weighted by proximity in time, and estimated by sex, age of first employment (proxy for level of education), place of birth (domestic or foreign) and duration in the actual state of employment.

Main features : career year-to-year transitions

- These estimations occur until a certain age, from which the horizon effect will start to play a role (distance to the date of entitlement to pension affecting trajectory on the employment market).

Margin adjustments of probabilities to macroeconomic targets

In this margin adjustment, units are transitions and weights are the probabilities of transition.

- Whilst projecting careers, macroeconomic targets such as the employment and unemployment rates or contributing populations by regime in time will be used to carry out margin adjustments on probabilities of transitions.
- These margin adjustments are accepted once the normalization of probabilities minimally distorts the matrix of transitions.
- Individual transitions can then be obtained by confronting the matrix of probabilities of transition and the individual transition hazard.

Main features : annual wage imputation

Wages are imputed using a matching method inside categories of regime affiliation, sex and education level, by age and socio-economic characteristics. They are defined relatively to the average wage per capita (SMPT).

Quantiles of remuneration

- The individual observations will allow to generate a distribution of quantiles to which a relative wage will be associated as well as calculate individual effects that will serve for imputation.
- For each category, a **reference table of quantile** is determined from individual observations by crossing the aforementioned variables, associated to a relative wage.
- In the **destination table** of missing wages, an individual annual quantile is calculated, from an individual fixed effect (average quantile per variable crossing per id), and a hazard coefficient centered around the standard deviation of the quantile.
- A common variable to the reference series and destination series is calculated and is used to join tables along with the quantile variables.

Main features : annual wage imputation

Observed series (reference)
Category: sex, regime, education

Quantiles

Key variable

By

- age,
- duration of employment, principal state (i.e. regime),
- duration in state,
- existence of inactivity during the year

Individual fixed effect (average quantile) and standard deviation

Individual statistical hazard coefficient

Individual annual quantile

Rolling join on key and quantile

Imputed annual relative wage

Individual wages annual series
Category: sex, regime, education

Main features : departing to retirement

The parametric method used is easily interpretable.

Logit model

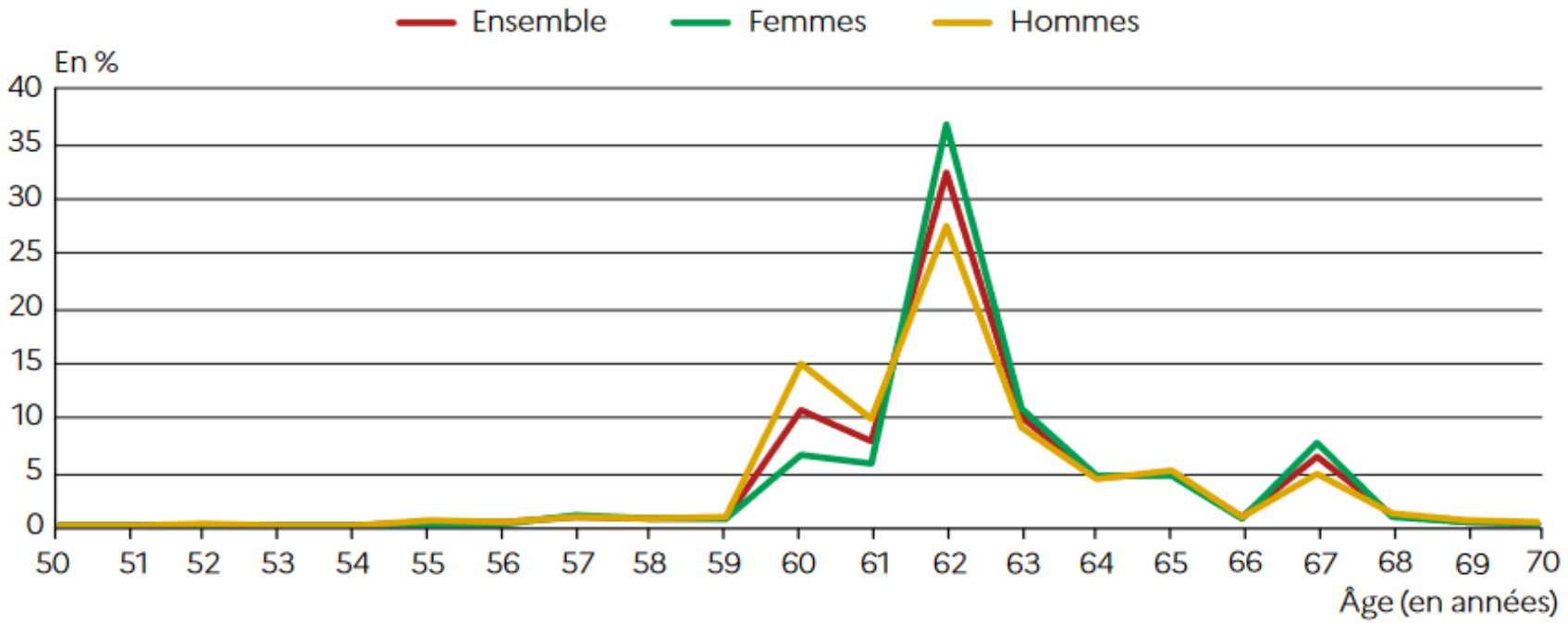
This model is used to estimate the probability to retire each quarter.

- Training data : generation 1950 fully observed.
- One model by sex*regime.
- The model is chosen by cross validation.
- Variables :

Distance to full pension rate in quarters; quarter when the full pension rate is reached; indicator if the full pension can be reached; quarter of birth; indicator of poly affiliation; eligibility quarter; first possible quarter without a discount rate.

Exemple : year 2021

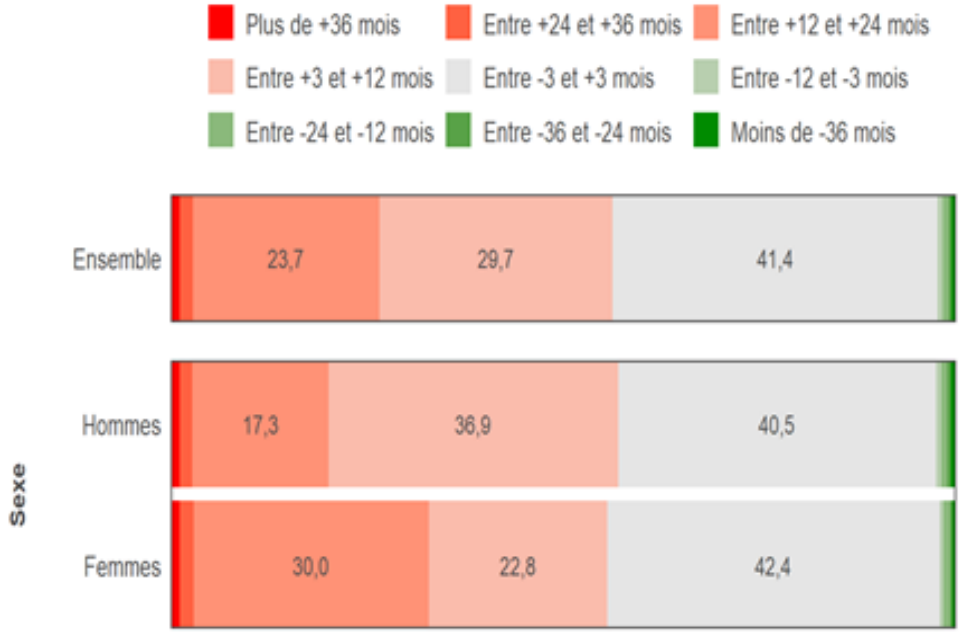
- Rate of new retirees, by age and sex, in 2021

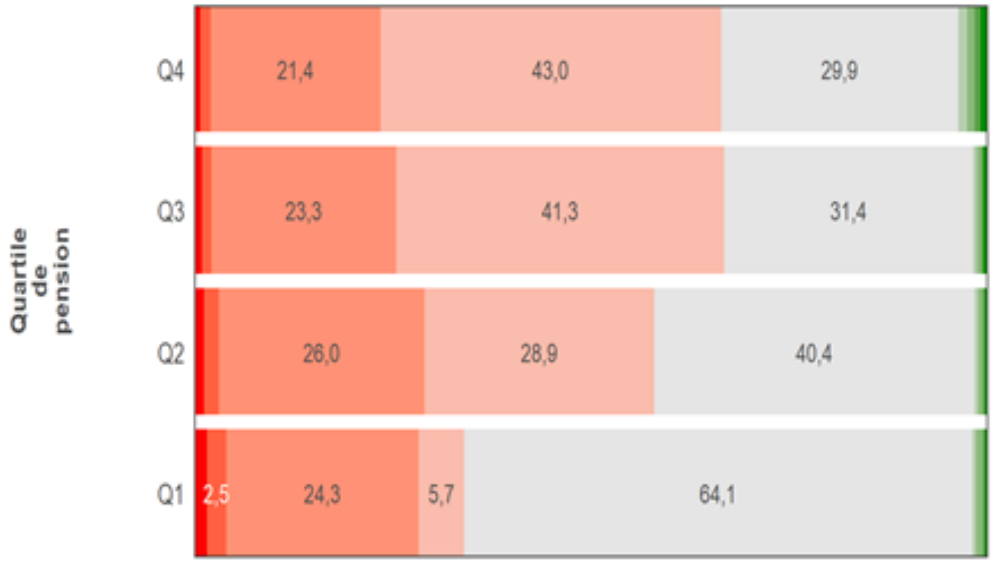


Lecture > Parmi les personnes âgées de 60 ans au 31 décembre 2021, 22 % des hommes et 11 % des femmes ont déjà liquidé un droit direct de retraite. 15 % des hommes et 7 % des femmes ont liquidé leur premier droit à retraite l'année de leurs 60 ans.
Champ > Personnes résidant en France.
Sources > DREES, modèle ANCETRE ; Insee, bilan démographique 2021.

Illustrative results – categorical distributions

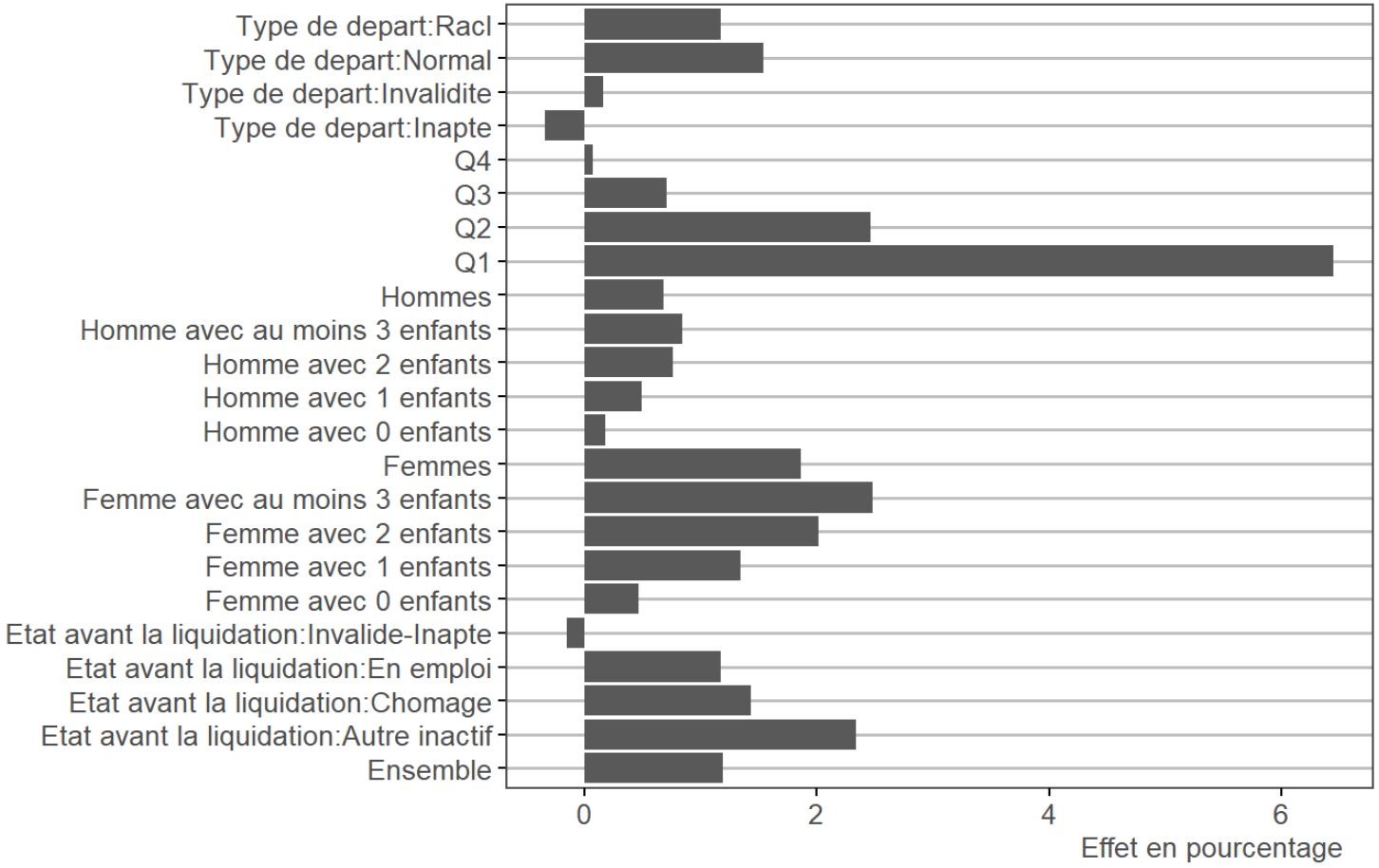
- Distribution of changes in retirement age after the 2023 reform, by sub-population and for the 1966 generation





Illustrative results – categorical average

- Average variation in retirement pension (constant euros, %) by sub-population of the 1966 generation



Illustrative results

- Comparative analysis of pension rights in the private and public sectors : contribution to the mean pension evolution per regulatory determinant (%, generation 1958)

References

- Documentation : https://drees_code_public.pages.drees.fr/modeles/trajectoire
- Open-source code : https://git.drees.fr/DREES_code/OSOL/bret/trajectoire
- Studies carried out with Trajectoire available here : https://drees.solidarites-sante.gouv.fr/sources-outils-et-enquetes/le-modele-trajectoire