PENMICRO
Monitoring pension developments through micro socio-economic instruments based on individual data sources: feasibility study

Final Report
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Executive summary

1. Throughout this report we differentiate between standard (cohort or typical agent) models and microsimulation models.

Cohort models start from current cross-sectional information on labour market position and social security contributions of various social groups, most frequently cohorts, which are sometimes further disaggregated by gender and some labour-market attributes, including demographic features such as marital status, and level of education. Most cohort models are partial equilibrium deterministic models but there are also special overlapping generation general equilibrium cohort models in use incorporating the economic behaviour of households, firms and pension funds. *Typical agent models* draw typical histories of fictitious individuals (i.e. the unemployed or minimum wage earners as such, etc.), based on which the level of benefits is calculated. This method has a strong longitudinal element, but the cross-sectional view is rather *ad hoc*, especially as transitions across the fictitious sub-groups that form the basis of this model are usually not accounted for.

Microsimulation models simulate changes in a sample of a large number: thousands and sometimes hundreds of thousands of individuals. In their simplest form, *microsimulation* models are *static*, i.e. they compare two states of the world, or two different institutional settings and simulate "overnight effects". In contrast, *dynamic microsimulation* models include time, and hence introduce demographic ageing. There are two approaches to introducing ageing in a dynamic microsimulation model. The first is *dynamic microsimulation with static ageing*, in which cross-section characteristics are updated by exogenous future aggregate data, so that time is traced as a series of world states. In practice, dynamic microsimulation models with static ageing first reweigh the individual cases in order to adjust the sample to exogenous projected demographic and labour market developments. Then, as a second step the resulting aggregate results are adjusted by some exogenous developments, such as economic growth. This reweighing-updating process resembles what standard cohort models achieve, except that for microsimulation the number of cases reweighed and updated is much larger. *Dynamic microsimulation models with dynamic ageing* go further, by building up complete life histories of each individual in the dataset.

2. Approaches of Member States to pension modelling can be best classified by their use of microsimulation instruments and their modelling capacity. This implies two distinct fields of capacity building:

- establishing or improving in-house modelling activity in the administration, and
- creating or extending micro datasets that can be used in microsimulation.

The latter appears to be more urgent but also more demanding of the administration.

3. We used the following taxonomy for categorising national approaches (countries falling in the respective classes are in parentheses):

- Only standard (cohort, typical agent) model but no micro-simulation model
  - Import model from international or foreign agency customised to special needs (Bulgaria, Cyprus, Latvia, Lithuania, Malta, Portugal)
  - Model developed in-house
    - No steps towards microsimulation (Estonia, Greece, Ireland, Poland, Slovakia, Slovenia)
    - Steps towards microsimulation (Czech Republic, Spain, Hungary, Austria)
- Utilisation of microsimulation model
  - Microsimulation model as complement
    - Modelling work contracted out (Germany, Italy)

- Modelling work in-house (Belgium, Denmark, Luxemburg, Netherlands, Finland)
- Microsimulation as primary modelling instrument (France, Sweden, United Kingdom)

4. Several remarks need to be added to the above typology.

First, standard models can differ significantly from one another in their level of sophistication so less developed models, and imported models in particular, can be worth further improving.

Second, among microsimulation models the major step is introducing time into the model that is to move from static to dynamic.

Third, applying microsimulation models as complements is not necessarily a sign of the lack of administrative capacity but it could be an optimal use of resources available for the administration.

5. We found five successful ways of introducing micro datasets to microsimulation models starting from the minimal requirements to the ideal cases. These are the following (countries falling in the respective classes are in parentheses; in case of more models by country, the name of the model is also added):

- Using social insurance administrative data only (Hungary, Sweden-MiMESIS)
- Matching social insurance administrative data with tax records and/or census data (Spain, Netherlands-SADNAP, Austria, Finland)
- Using large household surveys (France-DESTINIE, Netherlands-MICROS, MIDAS (various countries))
- Matching social insurance administrative data with household surveys (France-PRISME, Luxemburg, United Kingdom)
- Matching numerous administrative datasets (Belgium, Denmark, Sweden-SESIM)

1. Introduction

TARKI Social Research Institute was awarded a contract by the European Commission to prepare a feasibility study on “Monitoring pension developments through micro socio-economic instruments based on individual data sources”. From the onset the project was designed so as to

- Inform on the state of development of instruments used by Member States to monitor life time earnings and related acquisition of pension rights
- Provide descriptions of available tools, such as data sets and models of prospective pension outcomes based on individual data sources
- Identify and characterise tools, in particular where they already exist and where they could be further developed (notably needs for adequate data sources, need for building models).
- Analyse and describe both the administrative and survey data used for the prospective models of pension outcomes across all Member States (where such instruments exist) and elaborate a classification of instruments built to assess future developments of pension benefits, based on individual information
- Characterise the various results available and review them as well as those likely to be derived through such instruments

This design allows the research team to provide a description of the available pension modelling instruments and the datasets behind them for each Member State; to describe the outcomes of these instruments (focusing mostly on Member States applying the most developed tools); and to present an evaluation of similarities and differences between the national models and approaches, all along the lines of the Invitation to tender No VT/2007/115 and the resulting Study Service Contract VC/2007/0443.

The research team used the following sources of information. In the exploratory phase we reviewed and analysed the report on *Pensions Schemes and Projection Models in EU-25 Member States* by The Economic Policy Committee and Directorate-General for Economic and Financial affairs; responses to the first questionnaire of the Indicator Sub-Groups of the Social Protection Committee (ISG); presentations of national delegates at the ISG workshop in Madrid in January 2008; as well as corresponded with the national delegates to the ISG and searched the internet. This phase resulted in an interim report, which contained a detailed questionnaire and a first inventory of instruments. In the second phase we turned again to the national delegates requesting them to complete the questionnaires and the relevant parts of the inventory. Finally, in the third phase, we used the collected material to write the comparative sections.

The research team is indebted to the national delegates of the ISG for their contribution.

There are also some caveats to be made in this introduction. The scope of the study is instruments in use by administrations. Academic or business models are left aside as long as they are not part of the administrative work. We covered only those models that were named by the national delegates or were clearly identifiable as administrative. Also, the information collected had its limits due to the number of no-responses.

The final report is organised into three sections. Section 2 offers a typology of pension modelling instruments and uses this structure to give a comparative view of models applied by Member State administrations. In Section 3, it is not models but administrations that are compared as to their approach to the use of micro data and microsimulation models in pension projections. The section also contains two subsections on the experiences of introducing microsimulation to the modelling toolkit and on the successful ways of putting micro datasets to work in pension modelling. Finally, Section 4 gives an all-European inventory of administrative pension models.

2. Types of pension models

In this section we describe, classify and characterise modelling instruments applied by administrations of Member States. The unit of analysis is the model. This is in contrast with Section 3, where the unit of analysis will be the administration, which may use more than one model for pension projections. In cooperation with the national delegates to the Indicator Sub-Groups of the Social Protection Committee we identified 44 such tools in 26 countries (see Table 1). In the table we present a list of the models by country. In some cases, in the absence of any official version we ascribed our own names to the models (such as German Pension Model). The emphasis is put on comparison of model properties. Detailed descriptions of the individual models can be found in Section 4, the inventory of administrative modelling instruments.

Table 1: Pension modelling instruments applied by governments of Member States

Belgium	MALTESE; MEP; MIDAS_BE; MIMOSIS
Bulgaria	ILO PENS (BG)
Czech Republic	Czech Pension Model
Denmark	Danish Pension Model; LAW
Germany	AVID; German Pension Model
Estonia	Estonian Long Term Pension Budget Model
Ireland	Irish Pension Model
Greece	Greek Pension Model
Spain	Spanish Pension Model
France	DESTINIE; PRISME
Italy	CAPP_DYN; CeRP models; RGS
Cyprus	ILO PENS (CY)
Latvia	Latvian Pension Model
Lithuania	PRISM
Luxemburg	LuxMod; REDIS; SOBOLUX
Hungary	Hungarian Pension Models; NYIKA
Malta	PROST (MT)
Netherlands	GAMMA; MICROS; SADNAP
Austria	Austrian Applied Projection Models; Austrian Microsimulation Model
Poland	FUS07
Portugal	ModPensPor
Romania	na
Slovenia	SIOLG 1.0
Slovakia	PROST (SK), MAJA
Finland	Finnish Centre for Pensions models
Sweden	MiMESIS, SESIM
United Kingdom	PENSIM2

We apply taxonomies by Zaidi and Rake (2001), Dupont, Hagneré and Touzé (2003), Dekkers (2007), Harding (2007) and European Commission (2007) in order to classify the instruments in use by European governments.

2.1 Standard models

2.1.1 Cohort models

The majority of models under study in this report can be best classified as *standard cohort models.* Instruments of this type start from current cross-sectional information on labour market position and social security contributions of various social groups, most frequently cohorts, which are sometimes further disaggregated by gender and some labour-market attributes, including demographic features such as marital status, and level of education. The information set, which consists of group-averages, is sometimes extended to include retrospective data on contributory or wage history. Current information is projected then into the future subject to assumptions on demographic and labour market developments. These parameters in effect re-weigh the group-averages. A partial equilibrium concept is usually applied in order to assure consistency among the aggregates resulting from the re-weighing process and some exogenous macroeconomic variables. In addition, often some mechanisms are applied in order to ensure internal consistency among the parameters of the projection. Standard cohort models have the advantage, as compared with the typical agent models (see below), that it is easier to obtain aggregate conclusions, such as future revenues or expenditures of the pension system. It requires special care from the modeller to secure consistency between projections on wages and those of employment levels and wages. Translating exogenous cross-section labour force assumptions into cohort average (longitudinal) career characteristics (length of service, benefit base) is often a critical point in these cohort models.

The main issues related to cohort models are the creation of sub-groups (usually cohorts and gender groups and sometimes even further disaggregated sub-groups), the assumptions regarding their future prospects, and the mechanism applied to reweigh these sub-groups in light of expected future developments and the updating process which warrants for the consistency among parameter settings, and that of aggregate results with exogenous macroeconomic and financial variables. Some other questions are also introduced to the form in order to capture potential extensions, such as the option of parallel work and retirement (more specifically, gradual retirement), the availability of retrospective data on the sub-groups and application of various empirical models to derive behavioural responses in savings, fertility and labour supply.

Input

Standard cohort models covered in this report start out from cohort aggregate figures of administrative datasets, broken down by benefit type and pension scheme. The Italian CeRP-SAM takes into account also geographical differences (North vs. South), while the Danish model provides a breakdown by ethnic origin. The Irish model treats the self-employed separately.

The macro environment is exogenous in the standard models applied by EU administrations. Given that no feedback from the pension system parameters is captured, behavioural responses are absent altogether from the analysis. The internal consistency of macro variables such as wage growth, employment and inflation is usually ensured by the general principle that the labour share of GDP is held constant. This common assumption originates from the AWG comparative exercise on the economic consequences of ageing. In general, most standard models, as well as most micro models reviewed in this report, assure consistency of macro variables by an external mechanism, not endogenously. Exceptions are special standard models with more sophisticated equilibrium mechanisms (see the subsection on special cohort models below).

Demography is exogenous in the standard models covered here, with the exception of the Lithuanian version of PRISM, which is able to generate a demographic projection of its own. Generally, the same mortality rates are applied across all social groups. Exceptions are the Hungarian standard model, Poland's FUS07 and the standard model of the Finnish Centre for Pensions, which apply different mortality rates of certain types of benefit recipients (the disabled, in particular). Moreover, in the latter instrument, for persons drawing an old-age pension a high pension is connected with a low mortality risk when age and gender are standardised.

In all cases, aggregate labour market developments are exogenous as well. This does not exclude the possibility of taking into account other empirical phenomena impacting the labour market. In the Italian RGS, participation rates are affected by the following three factors: i) the direct and indirect effects brought about by the evolution of enrolment rates, the latter through changes in educational achievements, ii) the fulfilment of the eligibility requirements to be entitled to a pension, taking also into account the evolution of workers distributed by age and contribution years and iii) changes in the labour market equilibrium caused by the decrease in the working age population. In the Hungarian standard models, the participation rates are adjusted outside of the model to incorporate views on school enrolment (lower participation in younger cohorts today vs. higher participation of older cohorts in the decades to come).

Modelling

All standard models are deterministic by definition. They address the issue of fundamental uncertainty regarding the underlying assumptions and other types of model uncertainty by relying on sensitivity analyses and robustness checks, in order to test how unstable the results are when macro assumptions, demographic scenarios, age-profiles or future labour market scenario changes.

Most standard models under review here differentiate with respect to sex, age and benefit type, but some go further. For instance, to address the issue of immigration, the Danish instrument, as mentioned above, was designed to include dimensions such as ethnic origin. In order to take account of peculiarities of the Luxembourg labour market (high proportion of migrant workers), LuxMOD was designed to include dimensions such as country of origin or employment status (beyond the general breakdown by age, sex and benefit type). The Belgian MALTESE and the Czech model distinguish between employed and self-employed and the latter also on the basis of income ranges (10 per gender). SOBULUX, another instrument applied by the administration in Luxemburg, differentiates blue-collar workers, white-collar workers and civil servants. Households are not a unit of analysis in any of the models under study in this section.

Another important issue is whether the entry of new pensioners into the existing pool is explicitly modelled and how. This is highly pivotal given that the simulation of different policy scenarios is only possible if rules applying to new pensioners (i.e. the raising of the retirement age or a change in the pension formula) can be introduced to the model in a transparent way. Even more importantly, the effects of past measures, which take time to feed through the system, can only be captured explicitly in this way. Naturally, this issue is tackled by instruments, which track individuals through their life path, but this is not the case for most standard models. Most models, however, tend to have manually driven retirement. This means that retirement is modelled by the adjustment of retirement age profile based on changes in participation rates of older cohorts (as in the Estonian instrument's case), changes in retirement age legislation (in Hungary), etc. An exception is the Portuguese model, in which determining the flow of new retirees is performed in a simplified way: the proportion of a cohort becoming eligible for pensions is assumed to stay constant from the base year onwards. The average length of contributions is also held constant, without incorporating projected changes in the labour market. New disability pensioners are projected either assuming an evolution of the stock (as in the Irish model), or explicitly. In the latter case, most models covered in this study build upon past experience, holding the rate of new disability pensioners constant. MALTESE takes a more sophisticated approach by calculating entry probabilities into the disability scheme from the exogenous labour force projection (number of potentially active people).

A disadvantage of the cohort-based approach is that in cases where there are non-linear relationships in the pension systems (i.e. a minimum number of service years required for pension eligibility, minimum pension or different rates of benefit indexation based on benefit amount), the cohort averages may be distorted. In these cases the information on the distribution influences the updating of the average value. Most models do not address this issue or do so only partially. The Italian RGS model is cohort-based and follows an indirect method and supplements the mean value with an index of variability (the variation coefficient) and a distribution function, whenever the influence of the distribution is significant. Whilst the aforementioned example shows that some effort is made to overcome the distortion problem, the limits of the standard framework are clear.

Output

The most important output of the standard models considered here are aggregate revenues and expenditure and the number of contributors/beneficiaries to the schemes. Sustainability indicators produced in most cases are the deficit of the pension system (financing requirement beyond that provided by contributions) and cumulative indicators, such as the implicit debt of the system.

Modelling instruments are important to compare through the concept of replacement rate they apply. Theoretically, benefit levels are usually compared to wages (replacement rates) or to contributions (rate of return on contributions). Standard models under study in this report produce aggregate empirical replacement rates; households and individuals are not modelled. In these models, heterogeneous outcomes across the population, particularly poverty and inequality are not reflected in the projection outputs. Specifically, in most standard models covered here, the distribution of pension benefits cannot be obtained, therefore conclusions on adequacy and/or inequality cannot be drawn. An exception may be the Lithuanian PRISM, which can operate as an "average person parameter" model or as a distributional model. In this case new retirees are assigned a bivariate normal distribution of lifetime wages and of pension service. Czech old-age benefit projections are disaggregated on the basis of income ranges; this feature allows it to project the share of new retirees under the poverty line. Rate of return measures are provided by SOBULUX and CeRPSAM, but stock measures such as pension wealth are not computed in the standard models under study in this report.

Special cohort models

Most cohort models are partial equilibrium deterministic models, though the meaning of 'partial' may differ from one model to the other. For instance, as explained above, consistency between the growth rate of the workforce, productivity and GDP growth is almost always ensured through the assumption of a constant share of labour in total national income. However, other types of 'endogeneities' are more difficult to come by and are mostly incorporated indirectly. The Dutch GAMMA and the Slovenian SIOLG 1.0 are special overlapping generation general equilibrium cohort models incorporating the economic behaviour of households, firms and pension funds. LuxMOD is a computable general equilibrium model based on aggregate administrative data, which covers all social security schemes but does not simulate the acquisition of pension rights.

Whilst they incorporate less detail on the pension system itself (e.g. *GAMMA* relates the development of first pillar pension expenditure to two factors: productivity in the economy and the number of people over the age of 65), these models are better equipped to carry out welfare analysis of policy reforms. Also, given that agents are rational, forward looking and optimise in a consistent microeconomic framework, internal consistency is better ensured.

2.1.2 Typical agent models

Another branch of models is the typical agent model. Instruments of this type draw typical histories of fictitious individuals (i.e. the unemployed or minimum wage earners as such, etc.), based on which the level of benefits is calculated. This method has a strong longitudinal element, but the cross-sectional view is rather *ad hoc*, especially as transitions across the fictitious sub-groups that form the basis of this model are usually not accounted for. This approach yields a sophisticated estimate of replacement rates, given that this type of model usually contains the country-specific institutional setting with all its non-linearities, ceilings etc. In addition, the acquisition of pension rights is properly tracked, as full life histories are available. Typical agent models are well suited to assess incentives in the pension system to work longer as well as to compare the relative generosity of schemes across various life paths and/or countries. The main challenge of this approach is to come up with a fiscal projection, given that it is incapable of weighing the fictitious groups of individuals in a way that would reflect the composition of society. For the same reason, it is not possible to analyse distributional effects of policy alternatives. Also, this “typical agent” method does not incorporate a model for individual behaviour, e.g. the choice of the year of retirement, or macroeconomic repercussions (e.g. higher contribution rates reduce labour force participation).

Typical agent models may differ in the main features and life-path characteristics of typical agents, the motivations of choosing these particular fictitious actors, the way their life-paths are set, and the mechanism that ensures consistency between core scenarios/assumptions. In addition, there are different approaches to aggregating the results derived from typical life-paths as non-exhaustive components and the empirical models used to derive behavioural responses of typical agents to exogenous effects.

Among the models reviewed MEP (Microeconomic Pension Model) of Belgium is the only genuine typical agent standard simulation model. It is based on the option value approach. Four hypothetical private sector employees (male and female blue and white collar workers) are modelled, who are deemed to be representative for the purpose of examining actuarial neutrality of Belgian first pillar pensions. Individuals are assumed to be either single persons or the sole income earners in the household. It is assumed that the four typical employees were born in 1940 and entered the labour market at the age of 20. MEP calculates the flow of expected future benefits until death for every year in which the individual is eligible for the pension benefit. As outputs, it produces individual replacement rates, changes in pension wealth, implicit taxes and option values.

The Greek Pension Model also performs typical agent simulations, which produce individual theoretical replacement rates as their output. Simulations incorporate cases where people have just entered employment or social insurance or will join the labour force in the near future or became insured for the first time only a few years earlier. The fund modelled covers about 55 percent of all private sector employees.

The Czech and the Lithuanian model, as well as the versions of PROST operated by Slovakia and Malta have a special feature in that they are able to run both as typical agent models and as standard cohort models. The CeRP family of pension models also includes a typical agent model, which is capable of computing pension benefits and money's worth measures for a set of representative workers according to the rules of the legislation in effect. By aggregating individual results, CeRP evaluates the impact of alternative pension rules on pension expenditure.

2.2 Microsimulation models

Microsimulation models simulate changes in a sample of a large number: thousands and sometimes hundreds of thousands of individuals. Information on the sample can be collected in surveys or by the data processing of various government agencies such as the tax authority or the social security administration. They can be cross-sectional, if individuals appear in the sample only once, or panel, if individuals can be followed over a period of time. Some samples include information only on the individual; some also contain data on other household members. Administrative data have some obvious limitations compared to survey data, because administrative data are not collected for research purposes and thus usually lack some information that would be required. Questionnaires for survey data may be designed specifically for defined research purposes. On the other hand, administrative data is in general more detailed, complete, timely, regular and accurate than survey data.

In their simplest form, *microsimulation* models are *static*, i.e. they compare two states of the world, or two different institutional settings and simulate "overnight effects" (Dekkers 2007). In contrast, *dynamic microsimulation* models include time, and explicitly model life paths of individual units as they age. Zaidi and Rake (2001) point out that while static models do not attempt to incorporate behavioural changes, dynamic models are concerned to take on board behavioural responses as well as simulating the policy environment.

Zaidi and Rake (2001) distinguish two approaches to introducing ageing in a dynamic microsimulation model. The first is *dynamic microsimulation with static ageing*, in which cross-section characteristics are updated by exogenous future aggregate data, so that time is traced as a series of world states. In practice, dynamic microsimulation models with static ageing first reweigh the individual cases in order to adjust the sample to projected demographic and labour market developments. Then, as a second step the resulting aggregate results are adjusted by some exogenous developments, such as economic growth (Harding 1996, Dekkers 2007). This reweighing-updating process resembles what standard cohort models achieve, except that for microsimulation the number of cases reweighed and updated is much larger.

Table 2: Simulation properties of pension microsimulation models used by European administrations

	Country	Type of microsimulation	Cross-sectional vs. cohort / longitudinal	Ageing process	Initial database	Database matching	Information on the household
AMM[1]	Austria	?	?	?	administrative	yes	no
AVID	Germany	dynamic	longitudinal	dynamic	sample of administrative	yes	y
CAPP_DYN	Italy	dynamic	cross-sectional	dynamic	survey	no	y
DESTINIE	France	dynamic	cross-sectional	dynamic	survey	no	y
FCP[2] **models**	Finland	?	?	?	administrative	yes	no
LAW	Denmark	static	-	-	administrative	yes	y
MICROS	Netherlands	dynamic	cross-sectional	static and dynamic	survey	?	?
MIDAS	Belgium	dynamic	cross-sectional	dynamic	survey	yes	y
MiMESIS	Sweden	dynamic	cross-sectional	dynamic	sample of administrative	yes	?
MIMOSIS	Belgium	static	-	-	sample of administrative	no	no
NYIKA	Hungary	dynamic	cross-sectional	dynamic	administrative	yes	no
REDIS	Luxemburg	static	-	-	administrative	yes	y
PENSIM2	United Kingdom	dynamic	cross-sectional	dynamic	sample of administrative	yes	y
PRISME	France	dynamic	cross-sectional	dynamic	administrative	no	no
SADNAP	Netherlands	dynamic	cross-sectional	dynamic	administrative	yes	y
SESIM	Sweden	dynamic	cross-sectional	dynamic	sample of administrative	yes	y

[1] *Austrian Microsimulation Model; under construction.*
[2] *Finnish Centre for Pensions models.*

Dynamic microsimulation models with dynamic ageing go further, by building up complete life histories of each individual in the dataset. Within this latter group, Dekkers (2007) differentiates between *cross-sectional* models and *cohort/longitudinal* models as being two major directions. In the former, individuals, who are the basic unit of modelling, are moved ahead in time one-by-one a period, while each of their attributes is updated. In the latter an entire individual life cycle is followed through from birth to death before the model takes in the next individual. The advantage of cross-sectional models is that they allow for interactions between individuals, such as a marriage or death of a partner, in a straightforward way. In contrast, longitudinal models make it possible to introduce forward-looking elements to individual behaviour. Zaidi and Rake (2001) also draw a distinction between models where the relationships are entirely determined by the parameters defined within the model (deterministic models) and models where random processes are also applied (stochastic models).

Most of the micro models under study in this project are dynamic, cross-sectional microsimulation models with dynamic ageing (see the summary of the simulation properties in Table 2). Exceptions are the Danish LAW and the stochastic lifecycle model of the Finnish Centre for Pension, both auxiliary models from a pension modelling perspective, which provide cross-section snapshots of new retirees benefit distributions. Other exceptions are static models, the REDIS project of Luxemburg and the Belgian MIMOSIS, which are used for simulating and comparing policy scenarios. The Dutch MICROS is capable of performing both static and dynamic ageing. Below in a separate subsection of Section 3, we will return to the issue of micro databases.

The initial databases used for these simulations may be various. While standard simulation models are most frequently based on administrative data, microsimulation models tend to rely on samples from censuses or surveys. Some tools use administrative databases or samples thereof, others take surveys as a starting point. The crucial issues are whether surveys are representative and whether one database (survey or administrative) contains the level of detail necessary to capture all relevant attributes of individuals. The matching of databases provides some help in both of these matters. Out of the 16 micro models covered in this report, 10 rely on matched databases.

Dynamic models with dynamic ageing carry individuals through life-events. The level of detail provided in the initial database determines to a great extent what life-events may be tracked in the simulation (see the summary of life events tracked by administrative instruments in Table 3). Individuals' age and sex, as in standard models, is known of course, so all models include birth and death. The Dutch MICROS, the Belgian MIDAS, the French PRISME and DESTINIE simulate school-leaving age, first "marriage"/cohabitation, recoupling, rupture, and children born. With the exception of PRISME, they provide detailed information on household structure, including size and combined income. DESTINIE also simulates kinship ties between non-core people, for instance the survival of parents or siblings and applies differentiated mortality rates depending on age at leaving school. SESIM provides the highest level of detail on the education front, while also tracking the age at which children leave home. Hungary's NYIKA model is only concerned with life and death among the demographic parameters.

Table 3: Summary of life events tracked by selected administrative microsimulation models

	Education	Marital status	Birth, adoption	Labour market position	Occupation	Retirement	Health	Other: …
AVID 1996, 2002/2004	labour market states : 1) employed, subject to social insurance contributions, 2) child care, 3) housekeeping, 4) nursing relatives in need of care, 5) long-term sickness, 6) unemployment, 7) old-age pensioner, 8) unpaid work in family businesses, 9) low-paid employment, not subject to social insurance contributions, 10) civil servant, 11) self-employed, 12) limited earning capacity, 13) education, 14) other ; working hours and income position are also modelled for the relevant states, as well as the specific category in case of self-employment							
CAPP_DYN	compulsory, upper secondary school, tertiary school (3 year/5 year degree)	single, married/cohabiting, divorced, widower	mortality, fertility, migration, exit from household of origin	type of status (full time, part time, out of the labour market, unemployed), type of contract (typical, atypical, permanent, fixed term)	dependent (private or public), self-employed,	Old-age; disability, survivor, social assistance	three disability statuses based on classification of the ISTAT survey	
DESTINIE	school leaving age	first "marriage", recoupling, rupture	all births from successive unions (up to 6)	Transitions between employment, unemployment and non-participation (including pre-retirement)	Transitions between self-employed/private sector employee/public sector employee, but only in the new version of the model (in version 1, sectoral allocation was considered fixed all over the career)	Transition to retirement simulated on the basis of a behavioural model	An ad hoc module on disability had been added to Destinie I. It will be probably updated for Destinie II. An additional module is currently being built for the projection of health expenditures	Since the model simulates complete kinship ties, we have information not only on what directly happens to the individual but on what happens to related individuals (e.g. death or disability of his parents...)
MICROS	finish education/leaving school	divorce/marriage	birth child(ren)	become unemployed/disabled	finding a job/change hours worked	early retirement / retirement		migration/housing market (rent/buy)
MIDAS	ISCED levels 1-5/6	single, married, living in cohabitation, divorced, widow	birth	in work, disabled, unemployed, retired, other inactive	legislators/officials/managers; professionals; tech. and ass. prof.; clerks; service and sales workers; skilled agric. workers; craft workers; plant operators and assemblers; elementary occ.	wage-earners retirement scheme, civil servants retirement scheme, old-age guaranteed minimum income	reporting being chronically ill	
NYIKA	school leaving age	empirical probabilities	empirical probabilities	Transitions between employment, unemployment and non-participation	No	Transition to retirement simulated on the basis of past patterns		
PENSIM2	Yes	Yes including co-	Birth	Yes	Yes	Yes	disability and institu-	mortality

		habitation but not same sex partnerships					tional care	Pensioner savings, housing, taxes and benefits
PRISME	school completion	yes, including household structure and kinship ties	children completion	1) labour market participation CNAVTS, 2) LMP CNAVTS-analogous, 3) LMP non-CNAVTS, 4) unemployment 5) sick leave, 6) disability, 7) other	-	working life completion		death completion
SESIM	- upper secondary (drop-out, completing) - university (drop-out, completing) - labour market (to university or adult education) - adult education (to university)	cohabitation, marriage, separation, divorce	adoption, fertility, children leaving home	unemployment, employment, miscellaneous status				wealth accumulation, housing

The sophistication of labour market positions is equally critical in these models. All models simulate labour market entry, unemployment, disability and retirement. NYIKA distinguishes 6 labour market states depending on the frequency of being employed beside the above characteristics. The list of labour market positions is highly detailed in AVID including 14 different states (employed, subject to social insurance contributions; child care; housekeeping; nursing relatives in need of care; long-term sickness; unemployment; old-age pensioner; unpaid work in family businesses; low-paid employment, not subject to social insurance contributions; civil servant; self-employed; limited earning capacity; education; other. The French PRISME and the Hungarian NYIKA are both capable of handling employees participating in different (public) pension schemes. In PENSIM2 of the United Kingdom the self-employed are treated separately. MICROS, MIMOSIS, REDIS and PENSIM2 can also handle post-retirement work, while in MICROS it is also possible to change the hours worked, which allows incorporating part-time work.

As a general rule, transitions between states are simulated using estimated probabilities from the initial dataset. Other, auxiliary datasets are often used to estimate certain transition parameters (e.g. LFS data in the case of PRISME and NYIKA, ISFol Plus survey on educational attainments and work income in the case of Italy's CAPP_DYN). Predicted probabilities based on micro data are calibrated to long-term demographic projections and official labour force forecast, as is the case of DESTINIE or PENSIM2. Looking beyond the aforementioned deterministic method, economic and demographic transitions among states can be simulated by Monte Carlo processes, like in CAPP_DYN and CeRPSIM. MIDAS, finally, applies alignment to have its result being in line with exogenous retirement probabilities, in this case pertaining to the AWG projections.

There are also various approaches to simulating the retirement process itself. The most basic technique (and the most common one for that matter) is to rely on estimated probabilities as in the case of other types of transitions. In SESIM, on the other hand, retirement is modelled endogenously based on optimisation of pension wealth. CAPP_DYN also applies measures of inter-temporal optimisation based on net social security wealth, but only for early pensions (below statutory retirement age) and alongside an exogenously set adequacy condition (replacement rates need to reach a certain threshold). DESTINIE goes even further and offers several behavioural patterns relating to retirement decisions: 1) retirement as soon as fulfilling eligibility conditions for a full rate pension; 2) retirement based on utility maximization with an income-leisure trade-off; 3) retirement based on relative changes in the pension wealth.

Most micro models deliver the results that standard models produce, such as the number of retirees, contributors, aggregate indicators of revenues, expenditures and aggregate as well as longitudinal individual replacement rates. On top of that, microsimulation models are capable of producing indicators on intra-generational as well as intergenerational distributive effects (in terms of replacement rate, or internal rate of returns). Income-related measures of poverty are based on the Leyden poverty line, and various median poverty lines. Measures of inequality include the Gini, Theil, and decile ratios.

In models, which are founded on integrated micro databases, comparisons between labour and social security income (possibly also other types of incomes) is also feasible, while some even have the potential to move from the individual level to the household and take into account alternative sources of income after retirement, including private savings (AVID, LAW). Other models (PRISME is an example) are able to track the effects of reductions in the case of early exit and supplements for working longer years.

3. Approaches to pension modelling

In this section we characterise the approaches of administrations to pension modelling. In contrast to Section 2, the unit of analysis is the administration, not the model. The emphasis is not on model properties but on the way the process of modelling is embedded in the administrative work. We will use the simple taxonomy of Table 4.

The crucial dimension of the classification is the absence or presence of instruments processing micro datasets. We found 16 administrations that do not apply microsimulation models in pension modelling. This is not to say that they do not use micro data or microsimulations at all; it may well happen that microsimulations are available for the administration in these countries for other purposes. We discuss them in Section 3.1, whereas countries applying microsimulation models in pension projections are dealt with in Section 3.3. Section 3.2 gives a summary of the micro datasets in use.

The other dimension of the taxonomy is loosely related to the modelling capacity of the administration. Countries that use only standard models may import available general-purpose instruments or they may develop their own. Modelling capacity also affects administrations applying microsimulation. Some of them outsource this activity, while others do it by themselves or in cases they organise special units for such purposes and make microsimulation their primary modelling tools.

Table 4. Classification of administrations according to modelling pensions

Exclusive use of standard models			
	Imported models customised to special needs		Bulgaria, Cyprus, Latvia, Lithuania, Malta, Portugal, Slovakia (MoF)
	Own developments		
		No steps toward microsimulation	Estonia, Greece, Ireland, Poland, Slovakia (MoLSAF) Slovenia
		Steps toward microsimulation	Czech Republic, Spain, Hungary, Austria
Utilisation of microsimulation models			
	Microsimulation models as complements		
		Modelling work contracted out	Germany, Italy
		Modelling work by administration	Belgium, Denmark, Luxemburg, Netherlands, Finland
	Microsimulation as primary modelling tool		France, Sweden, United Kingdom

Note: No information was available on Romania.

3.1 Exclusive use of standard models

Many administrations do not use micro data directly in pension projections but rather base calculations on cohort averages, fictitious typical careers or macro models. The models applied in these cases are either imported from international agencies, such as the International Labour Organisation (ILO) and the World Bank (WB), or developed by the administration itself. We will handle these two groups separately in subsections 3.1.1 and 3.1.2, respectively. In subsection 3.1.3 we collect some experiences of administrations that have made the necessary steps of introducing microsimulation techniques in pension projections.

3.1.1 Imported models customised to special needs

Of the EU national administrations, Bulgaria and Cyprus reported to have applied the ILO pension model. Bulgaria employs the entire ILO Social Budget Model, of which ILO PENS is a sub-program. It is employed in the annual budget planning but the administration also tests policy reforms in terms of the budgetary consequences and makes medium-term projections. In Cyprus the model is updated tri-annually and employed in actuarial valuations and long-term budget planning. Another frequently used model is PROST (Pension Reform Options Simulation Toolkit), a general-purpose model of the World Bank, which has been applied in over 80 countries. This number includes nearly all EU Member States with the exceptions of Bulgaria, Latvia, the Czech Republic and the United Kingdom. Responding to our questionnaire, however, only two administrations, Malta and Slovakia, mentioned this toolkit as currently applied to pension modelling. In Malta, it is not part of the routine budgeting process but mainly used in long-term planning and estimating the effects of various policy scenarios. In Slovakia, a background institute of the Ministry of Finance employs PROST, whereas the Ministry of Labour, Social Affairs and Family has its own model, MAJA, which was developed in cooperation with the ILO and the World Bank. A further development by the World Bank is PRISM (Pension Reform Illustration and Simulation Model). It has been in use in various Central-Asian countries and in Eastern Europe (Czech Republic, Hungary, Macedonia). Among EU countries currently Lithuania applies PRISM. Portugal also reported on an imported model, an adaptation of ModPens, developed by the Spanish FEDEA. The Portuguese version is updated on an annual basis and used for the assessment of financial sustainability of the social security system. The Latvian administration might also use an imported tool from Sweden. The PENMICRO team got access to a presentation but no answer was received from the administration as to this aspect of the model.

Countries, which imported macro or cohort-based models, can be further divided into two subgroups, depending on how sophisticated their projection methodologies are. In the first subgroup there are countries where the modelling instrument does not differentiate between stock and entry pensions but it simply extrapolates the number of stock beneficiaries, usually assuming there to be a constant proportion of the cohort population at different ages. Such models, like the ModPensPor, can take on board neither the effects of changing labour market situation nor the implications of regulatory amendments; hence they are often complemented by external adjustments ('expert judgement'). These countries may want first to consider the advantages of introducing a distinction between stock and entry benefits. This would enable them to capture certain effects of legislative moves or labour market developments, which gradually filter into stock pensions through changes in the number and average amount of entry benefits. Data on new benefit awards broken down by gender and the age of retirement are available in all EU Member States, although in certain cases they can only be collected from more than one agency. Obviously, the modelling framework should also be adjusted so that it can handle entry benefits separately from stock benefits.

Other countries use more developed imported models that already include this distinction between entry and stock benefits, such as the World Bank's PROST. These cohort-based models usually calculate entry pensions based on average characteristics as observed in the past. However, in most cases they assume these characteristics (e.g. length of contributory period, average wage assessment base, household composition etc.) to remain constant throughout the projection horizon. These models are usually apt for simulating various effects of certain parametric changes (for example, a change in the method of benefit indexation) and, although to a very limited extent, might be able to take account of recent trends in employment patterns.

Still, these instruments have major shortcomings when it comes to the simulation of legislative modifications in the field of benefit calculation, or there are trend changes in the labour market or significant developments with regard to scheme coverage. Most of these models fail to take on board the implications of past labour market trends and the resulting shifts in pension entitlements. Even if some aggregate data on contribution history are available at the pension or tax authorities, these models usually cannot handle such input. Different characteristics of migrants or changes in educational attainment are as a rule omitted by these instruments, even on an aggregate level.

In return for these shortcomings, imported models are a useful first step in pension modelling. They are easy to adopt by the administration and the costs involved are also modest. However, for the same reasons their applicability is limited. Since they are usually made for general use, they frequently resist more specific analysis. In particular, they are usually difficult to parameterise with regard to interaction of various effects, such as the effect of education or family structure on labour supply and wages. Consequently, these models are frequently no more than simple projections of the current situation combined with ad-hoc parameterisation of the future. In addition, adaptability often entails that imported models cannot accommodate all subtleties of the national legislation. These are not problems in themselves as long as interpretation of the results is constrained by these limits.

Furthermore, adopting a model implies a reliable knowledge by the administration of how to use it, but does not necessarily create capacity for further development or modelling for more specific purposes. As the model was not developed from scratch by those who become responsible for taking care of it, the risk remains that the tool is regarded as a black box. This may increase the likelihood of misinterpretation of results, especially in circumstances when the impacts of regulatory changes are assessed. It is crucial in such cases to build up a modelling capacity by the administration of its own as well as to create a routine, which assures that the model outcomes are used in long term planning.

For all these reasons, countries using imported models may want to consider the construction of an instrument of their own development. This does not mean that imported models ought to be discarded at once: work can be started with rewriting a certain module, if the general framework still seems to be appropriate. Below we list some tools developed by other countries that might offer useful hints about projection techniques. Areas where further development would generally result in significant improvements include the following three points.

Aggregate administrative data on past pension accruals allow for valuable conclusions on the likely evolution of new benefit awards. Historical data on the acquisition of pension rights could also help in establishing a tentative link between employment (contribution payment) or participation rates on one hand and arising pension rights on the other hand. The effects of certain policy measures - such as the gradual introduction of notional defined contribution schemes - cannot really be simulated without data on past accruals. A number of examples can be mentioned on how cohort-based models can incorporate information on pension rights acquired in the past. The Danish pension model is based on data gained from administrative panel data. The Italian RGS model also makes use of historical data about workers with a contribution past.

Countries, which are not in a position to collect real career profiles, may also try to feed their cohort-based instruments from typical agent simulations. In certain cases this may also lead to a better estimation of trends on the average amount of newly granted benefits. For example, when a final salary scheme is gradually turned into an average salary scheme (i.e. the wage assessment period of the pension calculation is extended), new pensions will grow at a lower-than-earlier rate due to the normally concave shape of the longitudinal wage path. The magnitude of such effects can also be estimated with 'typical' theoretical careers and then the results imputed to the cohort model. For example, a similar approach was used in Hungary in the model operated by the Ministry of Finance. In the Belgian MALTESE the average amount of newly granted old-age pension was also estimated for a number of careers, which were considered typical.

Cohort-based models as such distinguish between groups within the population based on age and gender. These groups are usually further divided along the dimensions of employment status, benefit type and sometimes according to other aspects, as well. However, important characteristics of these sub-groups are not always taken into account. For example, most cohort-based models do no apply mortality rates differentiated across various statuses, although mortality rates can differ significantly according to health status, ethnic origin, marital status etc. Some models have already applied such differentiation with success. For example, the Finnish Centre for Pensions used a mortality projection adjusted for disabled people. Similarly, the pension model of the Ministry of Finance of Hungary made a downward adjustment to mortality rates of disability pension beneficiaries and an upward adjustment to all other cohort members as compared to cohort average rates, based on historical averages. On the contribution side, the Danish pension model imputes different earnings levels and employment rates to immigrants or descendants of immigrants. The Lithuanian version of the PRISM model distinguishes 5 earnings categories (however, we could not clarify whether mortality rates have also been differentiated according to these categories or the benefit amount only).

3.1.2 Own developments

Many administrations applying only standard models have developed instruments specifically for their own purposes. Some governments belonging to this group have signalled steps toward microsimulation. These are the Czech Republic, Spain, Hungary, and Austria. Those that do not belong to this sub-group may also have started working in this direction but they have not informed us. The countries belonging to this group are Estonia, Greece, Ireland, Poland, Slovakia (Ministry of Labour, Social Affairs and Families, MoLSAF) and Slovenia.

Own developments vary by type, sophistication and the way models are administered. Poland and Greece assign the task to institutes specialised in pensions, such as the Social Insurance Institute and the National Actuarial Authority, respectively. Consequently, these models are more focused on pensions with no special reference to the rest of the tax-transfer system. In Poland, even the farmers' pension scheme is set aside and projected by Polmodel, a simulation model of the social policy budget, which is not under the authority of the social insurance system. In Greece, the need for modelling replacement rates appeared only in the framework of the ISG exercise. The resulting model calculates only theoretical replacement rates and its scope is limited to IKA-ETAM, the largest social insurance fund, which, as mentioned above, covers about 55 percent of the employed population.

The second group comprises models, which are operated by government ministries. This is usually the Finance Ministry (Estonia, Hungary, Ireland, Slovenia and Spain), or the Ministry of Labour and Welfare (Austria and the Czech Republic). The Slovakian administration applies two models one by the Finance Ministry (see above) and one by the MoLSAF. The latter is an actuarial model with little reference to current or future labour market trends or individual characteristics other than age and gender. The Czech pension model differentiates, beyond age and gender, between employment types (employed/self-employed). In addition, old-age benefit projections are also disaggregated by income deciles. With regard to entry pensions, cohort members are classified by earnings and career lengths although these parameters are not realigned with prospective changes in the projected labour market situation. The Estonian model is by one degree even more complex in that it also incorporates an age and gender-specific relative wage structure. The internal consistency of the parameters is assured by a partial equilibrium model. In contrast, the Slovenian SIOLG is a complex dynamic overlapping generations (OLG) model with a general focus on sustainability of the entire tax-transfer system, even though intergenerational transfer schemes, such as pensions, health care and long-term care, can be analysed separately. This assures a more consistent parameterisation.

Of the countries that reported on steps made toward microsimulation, we learned that the Czech administration is currently in the process of preparation of the databases that would allow enriching the analytical capabilities of the government and building a microsimulation model complementing or replacing the currently available standard cohort model.

In Spain the Social Security Administration disclosed the records of 1.2 million people, 4 percent of the reference population, containing information on individual work histories (employment, wages, contributions) and pensions. This dataset can be extended with additional fiscal and census information by matching it with the population registry and the income tax databases. We received conflicting information as to whether this matching has actually occurred or just planned.

In Austria a microsimulation model is already under construction by an external contractor of the Federal Ministry of Social Affairs and Consumer Protection. It will be based on various micro datasets such as the data on the pension stock (Stand Pensionen, SP), the annual statistics of pensioners (Pensionversicherung Jahresstatistik, PJ) and the condensed insurance history of pensioners (Verdichteter Versicherungsverlauf Pensionen, VVP). The SP set covers the whole population and contains data on pensions and various other allowances such as e.g. childcare. The PJ dataset, also covering the entire population, contains various pieces of information required for calculating entry pensions as well as exits from the system due to e.g. loss of disability status or death. The VVP set, in addition to information derived from previous data, also contains the entire employment and wage career of the people covered. All three datasets include social security ID numbers, which lend the opportunity to directly match the data with tax records and other administrative data. Here again, we are uncertain if this matching is just a possibility or it has actually happened.

In Hungary the set of models available for the administration have been recently extended with the NYIKA model. Whereas the Ministry of Finance and the National Bank apply standard cohort models, the NYIKA is based on a large administrative panel dataset, KELEN, containing information on contributors to the pay-as-you-go pillar. The data cover the period of 1997-2006 and include over 6 million records (about 4.2 million each year). It is matched with contributory records of the mandatory private funds of the second pillar (KPN). The model also gains further information on current pensioners (from the NYUFUR micro dataset of the pension administration) and contributors (from the Labour Force Survey). The first results produced by the NYIKA have been recently released. Despite the current focus on assessing the extent of future old age poverty, the model can also be used for the analysis of fiscal sustainability. It belongs to the family of imported models in that modelling was contracted out to an international consultancy. The administration currently does not have the capacity neither to maintain nor to further develop the model. This and the data background (since 2007 individual contribution files are no longer held by the pension administration) make the future of the model uncertain. A further weakness is the actuarial nature of the model.

Cohort models developed in-house are usually considered to provide a fair estimation on the aggregate number of beneficiaries, revenues and expenditures, while they are still able to preserve some degree of transparency and relative ease in projection techniques. However, the cohort-based methodology as such has but limited means for capturing effects of various distributional changes. This comes as a drawback not only when various indicators of income inequality are being looked for, but often leaves the main outcomes (revenues, expenditures) of the modelling distorted. Let us highlight some issues that would pose a challenge to most cohort-based instruments.

Countries that experience marked changes in the development of migration will be faced with difficulties in producing reliable budgetary projections with simple standard models. For example, entitlements for state pensions based on the length of residence (where such schemes exist) depend heavily on the age structure of new migrants. Furthermore, immigrants tend to have participation rates and educational attainment different from the indigenous average in most countries, which might have a sizeable impact on the earnings related components of social security benefits.

Second, changing patterns of behaviour in the field of marriage, cohabitation and divorce can also have important implications on pension spending and income in old age. In a couple of countries, single persons may receive lower or higher benefits than those with a spouse or partner. If the number of single persons among the pensioner population rises, the cost of pensions might also go down or up depending on the benefit formula. Survivors' benefits will also be affected by changing household structures. In a number of countries, the ever more prevalent partnership forms are still treated more or less differently when it comes to pension entitlements, as compared with marriage.

Third, the composition of society based on educational attainment is also expected to bring about changes in the pensions landscape. In most countries, people with only basic education can count on a lower-than-average life expectancy and a significantly higher probability of getting disabled before reaching standard retirement age. Hence, the growing share of people with higher education is likely to alter take-up ratios and average beneficiary characteristics in the future.

Fourth, changes in the labour market (both past and future) will have a substantial impact on the evolution of newly granted pension benefits. Especially countries that have experienced major economic changes in the last decades will see changes in the composition of their population according to acquired pension entitlements. For example, in the majority of new Member States in Central and Eastern Europe the labour market was hit severely in the 1990s following the collapse of the communist era. Cohorts retiring today started their careers sometime around 1965-1970, so they have spent about half of their career prior to the regime change and another half in periods characterized by far lower employment rates. The distribution of people within subsequent cohorts according to the length of contribution period varies quite significantly year by year since the fraction of working lives spent in the pre-1990 years is shrinking as we proceed in time. The assumption of constant entry characteristics would therefore mean a simplification with adverse effects on projection results.

Cohort-based models are awkward in taking on board the effects of such socio-economic changes. Even if modellers have access to data on retrospective pension accruals, the process of pension rights acquisition can only be simulated in a limited form if only a standard model is available. For example, the link between the evolution of the labour force, which is normally imputed to standard models from an external source, and the acquisition of pension rights is far from being evident. A one per cent increase in the age-specific employment rate from one year to another does not give way to straightforward conclusions about the development of pension rights within that cohort. Do those already employed in the previous year work more hours or more frequently or do other people enter the market who had been unemployed or inactive beforehand? The answer would be vital in assessing cohort-average pension accruals at retirement, not to mention the distribution of accrued rights within cohorts, which would also be essential for giving an appropriate estimate of overall expenses. For example, in countries where there exist minimum requirements on the lengths of service or contributory period, the share of those fulfilling these requirements can ideally be approximated on the basis of such distributions. The same applies to the modelling of taxation: without information on intra-cohort distributions, projections on average tax rates may easily become distorted. For the same reason, models built on cohort averages are incapable of giving a good estimation on how the share of people eligible for a top-up to minimum benefit amount will evolve in the future.

Therefore, administrations working exclusively with standard models can be suggested to make a step further and turn their attention to microsimulation models, which have better capabilities in tackling such distributional effects. The first step towards this would be taking stock of existing administrative databases and surveys to find out what efforts would be needed to use them for the setting up of new microsimulation instruments. While the software background for microsimulation models can be imported from abroad as well as for cohort-based tools (if necessary), good quality data on all individuals or at least on a sufficiently large sample of individuals is essential.

3.1.3 Experiences of introducing microsimulation to the modelling toolkit

The range and quality of micro level data available for the exercise determines the complexity of the model that can be constructed, along with a number of other factors, such as the allotted timeframe, financial resources, personnel, etc. Evidently, the objective of the model should be set carefully and one should avoid being overly ambitious in situations of data constraints or limited resources. Setting priorities is key in starting with a new development. For a start, modellers may want to consider focusing on selected fields instead of aiming from the outset at a comprehensive model. The most common simplifications in practice are the following.

Initially, modelling work could be limited to certain elements of the pension system, with the aim to extend it with new schemes or components later on. For example, the SADNAP model (Netherlands) is currently capable of projecting state pension expenditures, but there are plans to upgrade it later to cover private pensions, as well.

Most microsimulation models take the form of a relatively flexible modular structure, which allows for a more gradual development. At the first stage, models can be regarded as operational even if certain modules would need further refinement but otherwise the instrument is able to produce some basic analyses it is primarily aimed at. Developers should, however, take care of preserving the capacity of the model for later upgrades and extensions. The modular structure also increases the transparency of the model. For example, the SADNAP model currently uses a simple random procedure to distinguish between single pensioners and couples, but the construction of a proper marriage market module is already envisaged. In the case of the Belgian MIMOSIS, an elaborated module for calculating pensions based on past career information is currently being developed and shall be integrated into the next version. A similar extension is planned in the framework of the REDIS project of Luxemburg.

Beyond these initial or temporary simplifications and building strategies, the setting up of a new microsimulation model can also be assisted by professional help from those who have already had experience with microsimulations. This can take the form of a personal collaboration, a referral to literature on modelling experiences or – most directly – the usage of platform or source code of an already existing foreign or academic microsimulation instrument. This latter option can considerably accelerate the process of model construction. For example, SESIM (Sweden) utilized the CORSIM (US) methodology first developed at the Cornell University. In Hungary, the NYIKA microsimulation is built on the Prophet actuarial software, which has been in use in several countries for the projection of defined benefit occupational schemes. The REDIS project took the static EUROMOD simulation as its starting point for their plans to develop a dynamic microsimulation model with enhanced capabilities in the area of social policy analysis.

Countries might also want to combine their efforts in developing a good quality dynamic microsimulation. Currently, this is the case with the MIDAS project, encompassing Belgium, Germany and Italy. The instrument also has the potential to be utilised in an international context and produce comparable outputs. While datasets need to be supplied from national sources, the main processes can be programmed in a joint effort, thus sharing costs and expertise. Collaboration between governments and academics can also boost the chances of a new microsimulation tool. For example, SESIM as well as the PENSIM2 were supported by renowned academic experts.

3.2 Micro datasets

Social security administrative databases most often contain information on employment / wage / contribution history, which could be a good starting point for building up a micro dataset (see the various examples of micro data utilisation summed up in Table 5). The Swedish MiMESIS, the oldest of the microsimulation models sampled here, and the Hungarian NYIKA, the latest development, both use only administrative data of the social insurance system. In the Hungarian case it means matching two sets, one of the administration of the pay-as-you-go scheme (KELEN) and another one of the supervisory agency of mandatory private funds (KPN). In subsection 3.1.2 we have given a brief description of the KELEN; further details can be found in Section 4, the model inventory.

Table 5:
Examples for utilisation of micro datasets in administrative microsimulation models

social insurance administrative data	
	Hungary-NYIKA (KELEN and KPN)
	Sweden-MiMESIS (ATP)
social insurance administrative data matched with tax records, census data	
	Spain
	Netherlands-SADNAP (Statistics Netherlands and Social Insurance Bank)
	Austria (SP, PJ, VVP)
	Finland-Finnish Stochastic Life-cycle Model (Statistics Finland and Finnish Centre for Pensions)
large household survey	
	France-DESTINIE (INSEE Financial Assets Survey (Enquete Patrimoine))
	Netherlands-MICROS
social insurance administrative data matched with household surveys	
	France-PRISME (CNAV and LFS, the Inter-scheme Pensioners Sample, Family History Survey)
	Luxemburg-REDIS (Luxemburg Social Security Data Warehouse and EU-SILC)
	United Kingdom-PENSIM2 (LLMDB, BHPS, FRS)
matching numerous administrative datasets	
	Belgium-MIMOSIS (Data Warehouse of the Crossroads Bank for Social Security)
	Denmark-LAW (Statistics Denmark)
	Sweden-SESIM (LINDA)

However, the analysis based solely on social insurance data often encounters difficulties. The scope of such databases is usually limited. They allow projections of future contributors, beneficiaries, revenues and expenditures but do not give the chance for simulating the effects of changing enrolment rates, household formation and even certain labour market developments. In addition, projected income distributions and calculations of poverty measures are limited, since alternative income sources as well as household and kinship resources are not accounted for.

Some of these details can be gained by matching social insurance data with other administrative datasets, such as tax records or census data. If legal constraints do not hinder it, this can be carried out relatively easily either through natural identification numbers or by the use of artificial connection codes. For example, the Finnish stochastic life-cycle model links two separate administrative databases (pensions related information from the Finnish Centre for Pensions and employment data from Statistics Finland). As mentioned above in Section 3.1.2, this is the road taken by Spain and Austria as well. The Dutch SADNAP model is also based on contribution data from Statistics Netherlands and benefit data from the Social Insurance Bank (SVB). Further details of the data background of this and selected other models can be found in Table 6.

Census data extend the information set available for analysis but they still often lack detail, which could only be gained from surveys. The Dutch MICROS is based on a dataset consisting of more than 60,000 households. It comprises information on household composition, income and housing costs. The French DESTINIE has its background in the Enquête Patrimoine, a household survey covering 65,000 people. Such large survey samples are rich in information but if the analysis is multidimensional, cell frequencies can be too small and standard errors too high. In addition, such surveys need re-weighting to macro controls not only in the calibration phase of the simulation, but also in the base year. The Enquête Patrimoine, for instance, is adjusted to survey and administrative data such as the Labour Force Survey, the Family History Survey, the FQP (survey on training and skills), the Annual Declarations of Social Data, the Permanent Demographic Sample and the Fiscal Income Survey (see Table 6).

A further step ahead is matching social security administrative data with surveys. This is the path taken by the Model Development Unit of the Department of Work and Pensions of the UK government. Their model, the PENSIM2 is based on three data sources. The Lifetime Labour Market Database (LLMDB) is a panel of 1 percent of the individual population (1975-2006) containing information on state pension contributory histories, private pension membership (some schemes only), employment, and wages. The British Household Panel Study (BHPS) is a longitudinal household survey based on annual interview 1991-2006 and the annual cross-sectional Family Resources Survey (FRS) containing data on housing, demography, household composition and other contextual information. The three data sources are matched by a statistical procedure, not by personal ID numbers, to form a dataset of synthetic records.

The Luxemburg administration also matched administrative data drawn from the Luxemburg Social Security Data Warehouse with the Socio-Economic Panel "Living in Luxemburg"/European Union Statistics on Income and Living Conditions (PSELL3/EU-SILC) survey. The administrative data contain information on the whole population of Luxemburg (449,000 observations for residents in 2003). It is comparable to the data warehouse of the Belgian Crossroads Bank (see below), although it is simpler. It contains no information on education, wealth and capital income but it will be extended with data on health care and long-term care utilisation in the future. The survey data is derived from a representative sample of around 3,600 private households (9,800 individuals) residing in Luxemburg. It comprises detailed information on income, household structure and socio-economic information.

Table 6: Micro datasets processed by administrative microsimulation models

model	country	name of the dataset	administrative or survey	units in dataset	sample size (as % of population)	level of information	sampling scheme	adjustments (elimination of bias, alignment)	work and earnings history
AK-analysis	Finland	AK	administrative	appr. 5,000 individuals	appr. 0.1%	individual	400 to 1000 people from every fifth birth-cohorts between 1905 and 1970		detailed career information, including earnings (1963-2005)
AMM	Austria	SP (pension stock), annual statistics of pensioners (PJ), insurance history (VVP)	administrative	population	total population	individual			condensed insurance history
AVID, 1996, 2002/2004	Germany	individual pension records	administrative and survey	net sample size appr. 14,000 people	appr. 0.02%	individual + spouse	1996: sample of people having a social security record and eligible for old-age pension at 65 representing cohorts born between 1936-1955 surveyed; 2002/2004: survey data of sample representing cohorots born 1942-1961 matched with social security records		entire work history of sampled individuals
CAPP_DYN	Italy	SHIW_02 (Bank of Italy's Survey of Households Income and Wealth, 2002)	survey	21,148 individuals within 8,011 households	appr. 0.04%	individual	two-staged: in the first stage, municipalities selected in 51 strata, in the second step, households selected randomly within each stratum	post-stratification procedure applied: original sample weights adjusted on the basis of the last ISTAT census	working path and earnings are reconstructed retrospectively by means of econometric estimations
DESTINIE	France	Financial Assets Survey (Enquête Patrimoine)	survey	65,000 individuals	appr. 0.1%	individual + household + kinship		calibrated to survey and administrative data such as the LFS, the Family History Survey, the FQP (survey on training and skills), the Annual Declarations of Social Data, the Permanent Demographic Sample and the Fiscal Income Survey	
MIDAS_BE	Belgium	Panel Dataset of Belgian Households	survey	8,488 individuals	appr. 0.08%	individual + household	na.	na.	complete history of earnings (1994-2002) for the selected sample of individuals

MIMOSIS	Belgium	Datawarehouse Labour Market and Social Protection	administrative	100,000 individuals completed with all household members	appr. 3%	individual	random sample based on the National Register	na.	data available on wages between 1954 and 2001, but no data on past pension accruals
NYIKA	Hungary	KELEN (database of the Pension Insurance of entitlements) and KPN (database of pension fund supervisory agency)	administrative	6 million records	total contributing population	individual			retrospective data on contribution payment, 1996-2007
PENSIM2	United Kingdom	LLMDB2 (Lifetime Labour Market Database) matched with the Family Resources Survey, a standard cross-sectional household survey	administrative + survey	11,000 and 57,000 samples of LLMDB2 used for simulation.	1%	individual + household	National Insurance Recording System (NIRS) containing details of National Insurance records for over 60 million individuals	British Household Panel Study (BHPS) longitudinal survey data as a "bridge" to improve the match of LLMDB2 and FRS	1975/1978
PRISME	France	CNAV	administrative	4.4. million records (5% sample); first results published on 1% sample)	5% of registered population between 1900-2005	individual			
REDIS	Luxemburg	Luxembourg Social Security Data Warehouse; PSELL/EU-SILC survey	administrative + survey	SSDW: 449,000 observations; PSELL/EU-SILC: 9,800 individuals within 3,600 households	SSDW: 100% (whole population); PSELL/EU-SILC: appr. 2.2%	individual + household	random sample	na.	cumulated periods of insurance; data on wages reaching back to 40 years is planned for the dynamic MSM arm of the project
SADNAP	Netherlands	CBS micro data file (Statistics Netherlands) on general old-age pension (AOW) entitlements; SVB data on existing beneficiaries (Social Insurance Bank)	administrative	CBS: 16 million records (whole population); SVB: 2.6 million records (all AOW beneficiaries)	na.	individual	random sample	CBS data from 2004 were simulated to 2006, which is the year of origin for the SVB data	information on the acquired years of entitlements is contained in the CBS dataset
SESIM	Sweden	LINDA, based on Income Registers and Population and Housing Censuses and extended with 9 smaller administrative datasets	administrative	380, 000 people (1999); combined with household members: 786,000,	appr. 3.5%	individual + household	two distinct samples: random sample of entire population and a no overlapping 20% sample of immigrants		data on pensionable income available from 1960, on pension income from 1974

The French PRISME model is built on a similar matched dataset as well. The sample base contains 1/20 of the insured from generations between 1900 and 2005 (around 45,000 persons by generation), and since 2006, the projections have been made on the 1/20 sample. The first results published are based on a 1/100 sample. Data of the Labour Force Survey, the Inter-scheme Pensioners Sample and the Family History Survey are matched to arrive at the complete dataset.

The final step in this gradual improvement of micro datasets is matching social insurance administrative data with other administrative datasets that contain information on subjects usually covered only by surveys, such as family composition, alternative social assistance revenues, income, wealth or health. The Statistics Denmark created a panel dataset by matching 25-30 different administrative databases by the identification number of Danish residents. Although these sets have the individual as their unit, address and some other features allow the reconstruction of households.

The Belgian Crossroads Bank for Social Security maintains a data warehouse, which is created by matching administrative datasets generated by the national bureaus for social security, employment, health insurance, child allowances, industrial accidents and occupational diseases, old-age pension and the national register as well as the regional employment services and the public service for social integration. The data warehouse contains individual level information on date of birth, gender, nationality, wages, employer, social security contributions, labour regime (full time / part time), unemployment spells, old-age pensions (benefits, entry date), incapacities to work and child care allowance, among other pieces of information. Household members can be linked. This background facilitates a sampling procedure of randomly selecting a sizeable sample from the national register (100,000 people in the case of the MIMOSIS model), extending it with household members and filling the dataset with the available information.

A similar process can be executed in Sweden, where the LINDA (Longitudinal Individual Data for Sweden) set contains information from 11 administrative registers properly matched. The core of LINDA is the Income Register (tax files available retrospectively from 1968) and the Population and Housing Census (repeated in every five years between 1960 and 1990). These two files were extended, partly from the late 1970s but mainly from the 1990s, with separate registers of pensionable income, pensions, unemployment spells and unemployment benefit, higher education and adult education, sick-leave, parental leave and wages. We were informed that the set is being broadened with health data as well.

3.3 Utilisation of microsimulation models

With reference to Table 4 in the introduction of Section 3 we turn to another group of Member States, notably Belgium, Denmark, Germany, France, Italy, Luxemburg, the Netherlands, Sweden, Finland and the United Kingdom, which made more advances in the use of microsimulation techniques in pension modelling. We distinguished two sub-groups within this class: administrations that use microsimulation as a complement of their, sometimes highly sophisticated, standard models and administrations that apply microsimulation as the primary modelling tool. The borderline is not clear-cut and some countries could be put to either class.

Microsimulation models as complements

The general pattern in the first subgroup is to have a standard cohort model for budget planning and a microsimulation model for special purposes, such as evaluating reform scenarios, calculating longitudinal replacement rates and measuring income distribution, inequalities and poverty in old age. In some cases microsimulation is outsourced, which possibly reflects the lack of capacities in the administration. Our impression was that Germany and Italy belong to this subgroup. In some other cases, however, giving microsimulation a supporting role is an approach, apparently. The administration may well trust the standard model as a reliable source of budget forecasts and feels no urgency to replace it with microsimulation. We found Belgium, Denmark, the Netherlands, Finland and possibly Luxemburg fitting in this subgroup.

Germany employs an administrative expert team for regular projections of future revenues and expenditures representing the relevant government agencies. However, in order to extend the scope and go beyond aggregate cash flows and also to identify risk groups and simulate the impact of various reform measures on the lower edge of the income distribution, it launched the AVID project. AVID is a non-regular extension of the usual projection procedure. So far it was conducted twice, in 1996 and in 2002/2004. The project aimed at selecting a sizable sample of people having social insurance record and having been eligible for old-age pension upon reaching the age 65 years. The sampling process set off with social insurance records in the 1996 round, which served as the sample frame for the survey. In the second round, in 2002, the order was turned to the opposite. A sample representing 20 cohorts of contributors born between 1942-1961 was surveyed and this information set was extended with social security records. The surveys extended the detailed information on employment career held by the social insurance agency with a rich set of data on the household and alternative income sources. The information collected were utilised in a dynamic microsimulation exercise, which the administration, notably the Federal Ministry of Labour and Social Affairs and the Federation of German Statutory Pension Insurance Institutes outsourced to small private contractors. Apparently, this practice was repeated in the second round as well so the government have not internalised the simulating capacity yet.

The Italian administration, as we were informed, also extends the scope of its pension projections based on its own standard cohort model with microsimulations carried out by external actors. In this case external actors are academic institutes, the Center for the Analysis of Public Policy, a joint venture of the Universities of Modena and Bologna, which built up CAPP_DYN, and the Centre for Research on Pensions and Welfare (CeRP) in Turin, developer of a family of models, including a microsimulation. Both are recent developments and it was unclear to the PENMICRO research team of how these models, named by our Italian contact, are actually employed in the administrative work. Both models seem to face a problem of access to micro data. Both use relatively small income surveys, the Survey of Household Income and Wealth of the Bank of Italy (about 21,000 respondents) and the Italian EU-SILC, which cannot be matched with administrative data due partly to legal constraints on data matching and partly to difficulties to obtain such data to start with.

This is in sharp contrast with the situation in Belgium, Denmark, Luxemburg, the Netherlands and Finland. In particular in Belgium and Denmark, authorities created large data warehouses by matching various administrative datasets (see Section 3.2). In addition, these administrations are well prepared for developing and maintaining microsimulation models of their own. In Belgium, special government units, the Federal Planning Bureau (FPB) and the social security administration (Federal Public Service Social Security, FPSSS) are responsible for such exercises. The FPB has a range of models including a standard cohort model (MALTESE), a standard typical agent model (MEP) and a dynamic microsimulation model (MIDAS_BE), whereas the FPSSS uses MIMOSIS, a static microsimulation. MIDAS_BE works with the Belgian PSBH, the production dataset of the ECHP; MIMOSIS is fed with a large sample of matched administrative data.

In Denmark, the Ministry of Finance can also choose, depending on the research question, which model to use. The ministry has a standard cohort-based actuarial valuation model and a static microsimulation model. The former is drawn on when it comes to long term stability issues, whereas the latter is consulted with if income distribution is the question. The opinion of the ministry is that, in light of the institutional structure of the Danish pension system, this variety of modelling instruments is sufficient. Access to data is less of a problem. The administration has an administrative dataset, created by matching 25-30 various smaller sets, of its avail.

The Dutch administration has a variety of instruments to use for various analyses. GAMMA (General Accounting Model with Maximizing Agents) is a dynamic overlapping generations general equilibrium model of the Dutch economy with the capability of welfare analysis of policy reforms. It is maintained by the CPB Netherlands Bureau for Economic Policy Analysis, an independent research centre. In addition, the Ministry of Social Affairs and Employment has a dynamic microsimulation model, which can simulate ageing in a static, as well as a dynamic way, although in practice, the ministry primarily focuses on the static ageing version of the model and applies it in analyses of poverty and income distribution. The ministry also has a recent special-purpose dynamic microsimulation model, SADNAP (Social Affairs Department of the Netherlands Ageing and Pensions Model), also an in-house development.

In Finland, like in Belgium, it is a specialised institution, the Finnish Centre for Pensions, which is in charge with pension projections. The approach is similar to that of the Danish and Dutch administrations: a combination of a sophisticated standard model and a smaller microsimulation model for special purpose projections. Benefit data are generated by the Centre itself; contribution data come from Statistics Finland.

Microsimulation models as primary modelling tools

France may be best classified somewhere between the complementary and the primary role of microsimulation for pension projections. These exercises have been coordinated by the Pensions Advisory Committee (Conseil d'Orientation des Reraites, COR) since 2000. National projections are based on projections made separately by all the major pension schemes with their own tools, on the basis of some common assumptions provided by the coordinating agency. The COR also uses a standard model managed by the Ministry of Social Affairs for some macro variants (for instance variants concerning demographic trends, unemployment rates). Microsimulation currently plays a role in these projections at two levels. The PRISME model produces the projections for the most important of all these schemes, the CNAV. In addition, the COR has used the DESTINIE model for building its global assumptions concerning the potential impact of the 2003 reform on retirement ages, the reason being that DESTINIE was the only model with a behavioural module. Both DESTINIE and PRISME are also used by the COR for exercises outside core projections. For instance, DESTINIE has been used for simulating consequences of changing rules for survivors benefits, for benefits linked to number of children or for variants concerning bonuses for people who postpone retirement.

In Sweden and in the United Kingdom, microsimulation is given an even more important role. These administrations show some special characteristics. First of all, the microsimulation procedure is highly institutionalised. The responsible ministries assign significant resources and separate a special unit for this job. These units handle various simulation instruments. Pension modelling can be part of general purpose models of life-cycle financing or of tax-transfer simulation. The instruments process large administrative datasets and/or household surveys, which are duly matched. They are applied in budget forecasts as well, not only in distribution analyses.

Sweden has a long tradition of using microsimulation in pension projections. The predecessor of the currently used MiMESIS model was put to work in 1973. This instrument is specialised to pension analysis, in particular budget projections. SESIM, however, was developed as a model of student loans and it was only later extended to become a tool in pension analysis, or, for that matter, in various analyses with regard to life-cycle financing. The model is cross sectional with the explicit capability of matching household members. It covers a whole range of processes with a large number of stata among which transitions are simulated, such as education (upper secondary: drop-out, completing; university: drop-out, completing; labour market: to university or adult education; adult education: to university); marital status (cohabitation, marriage, separation, divorce); change in number of children (birth, adoption, child leaving home); labour market (unemployment, employment, miscellaneous stata), retirement (modelled endogenously based on optimisation of pension wealth), wealth accumulation, housing. The latest version also includes health. This long list reveals that SESIM is capable of simulating a large variety of potential life-paths.

PENSIM2 of the UK administration was developed by the Department of Work and Pensions (DWP) between 2000 and 2004 and has been maintained and further developed since then. The DWP Model Development Unit has 19 full-time equivalent staff working on the Department's major microsimulation models, of which 3.5 undertake the maintenance and ongoing development of PENSIM2. MDU is a multi-disciplinary unit and has contained economists, statisticians, operational researchers, systems analysts, and social researchers. MDU models also include a static microsimulation model of the tax-benefit system, a behavioural model for estimating labour supply responses to various tax and benefit policies, and a dynamic microsimulation for forecasting disability benefits caseload and expenditure. MDU cooperates on a regular basis with academics working in this field and with other microsimulation modellers.

4. An inventory of pension projection models

In this section we give an inventory of the 44 pension projection models applied by 26 governments of the European Union. The descriptions below largely benefited from comments by the national delegates to the ISG for which the PENMICRO team is sincerely grateful.

Belgium

MALTESE

MALTESE (Model for Analysis of Long Term Evolution of Social Expenditure) is a socio-demographic and budgetary model, covering the receipts and benefits of different social security schemes. Besides pensions (for wage-earners, self-employed and civil servants, public enterprises schemes and assistance schemes), the model covers a wide range of other health care (acute care, long-term care), social (e.g. disability allowances), family and education expenditure items. Indicators produced by the model range from aggregate fiscal indicators to average benefits by social status and type of career. MALTESE has been developed and maintained by the FPB (Federal Planning Bureau).

MALTESE is a system of interconnected models, comprising sub-models such as PENSION (wage earners' pensions), MoSES (self-employed people's pensions) and PUBLIC (civil servants' pensions). These sub-models are deterministic, cohort-based standard simulation instruments based on administrative datasets. Generally, the old-age retirement rate at 65 for males is assumed to be constant. The female 'coverage' rate is held constant at 65 (coverage equals own pension entitlement, survival pension and the cases where the husband has a pension for both spouses). The entry probabilities into the disability scheme have been calculated from the exogenous labour force projection (number of potentially active people). The average amount of newly-granted old-age pension is estimated for a number of typical careers based on specific career profiles. The general average pension amount per scheme (employees, self-employed, civil servants) is weighted by its share in the total number of pensioners of each type. The income distribution is supposed to remain constant in the projection.

MEP

MEP (Microeconomic Pension Model) is a typical agent standard simulation model based on the option value approach. The model has been prepared by the FPB (Federal Planning Bureau) in 2006, using the SAS macro language. Four hypothetical private sector employees (male and female blue and white collar workers) are modelled, who are deemed to be representative for the purpose of examining actuarial neutrality of Belgian first pillar pensions (individual replacement rates, changes in pension wealth, implicit tax, option value). MEP calculates for every year in which the individual is eligible for the pension benefit the flow of expected future benefits until death. All benefits are then discounted back using a discount rate and a survival probability. As regards data on past individual income, the model includes a matrix containing wages per day for every combination of wages and labour market status, for all ages between 20 and 64 and for all the years between 1955 and 2004. To keep things simple, individuals are assumed to be either singles or the sole income earners in the household. It is assumed that the four typical employees were born in 1940 and entered the labour market at the age of 20.

MIDAS_BE

MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability') was developed as part of the *Adequacy of Old-Age Income Maintenance in the EU* (AIM) 6th Framework project in order to simulate the adequacy of pensions in Italy, Germany and Belgium. MIDAS is a dynamic microsimulation with dynamic cross-sectional ageing, i.e. it starts from a cross-sectional dataset representing a population of all ages at a certain point in time. Estimates of behavioural equations in the Belgian version of the model are based on individual survey data of the Panel Set of Belgian Households. Other survey data are also incorporated into the instrument, e.g. educational attainment is determined on the basis of observed probabilities from the Labour Force Survey. In Germany, the model is based on the German Socio-Economic Panel (GSOEP); in Italy it is based on the European Community Household Panel (ECHP) linked to other datasets.

MIDAS was produced by three public research institutions in close cooperation (FPB, DIW and the Italian ISAE), with FPB as project manager. It has a modular form consisting of a demographic module (with four sub modules, namely the birth process, the survival process, the education process and the marriage market, a labour market module and a country-specific pension module. The demographic and labour market modules are common between all three countries, though behavioural equations are naturally estimated and calibrated on country-specific data.

Individuals are born, go through education, marry or cohabit, enter the labour market, divorce, retire and, finally, die. All these main events in a lifecycle are simulated by the model. Transition probabilities for a number of these processes are produced by logit regressions (e.g. marriage market, labour market position). Assumptions of the model are aligned to those of the Ageing Working Group, wherever possible, with the help of econometric alignment procedures. The model therefore aligns to AWG demographic and macroeconomic projections, and generates a wide variety of indicators of income inequality, poverty and (re)distribution, both for workers and retirees, and potentially also indicators of nonneutrality.

The model is written in the programming language LIAM, which was designed by Cathal O'Donoghue (TEAGASC) and further developed by the Belgian Federal Planning Bureau (FPB) and the German Institute for Economic Research (DIW).

MIDAS is in the final development phase and it will deliver its first results in November 2008.

MIMOSIS

MIMOSIS (Microsimulation Model for Belgian Social Insurance Systems) is a static microsimulation model without behavioural responses for social security and personal income taxes in Belgium, programmed in FORTRAN 95. The model has been developed by the University of Antwerp, the University of Leuven the University of Liège and the FPS Social Security in close collaboration with the Crossroads Bank for Social Security who provided the input data.

MIMOSIS runs on a sample of 305.019 individuals, which is about 3 percent of the total population. The sample has been constructed by sampling at random 100.000 individuals from the National Register. After this, all other household members of the sampled individuals have been included in an extended sample. Weights have been constructed to aggregate results at sample level to the level of the overall population. For all individuals in the extended sample, administrative data have been taken from the Datawarehouse Labour Market and Social Protection, which is maintained by the Crossroads Bank for Social Security.

This sample with administrative data is exploited to program the legislation, applicable to the most important social security policy domains, in different modules. The final tool then allows for the (re)calculation of benefits received and taxes paid for each individual and/or households in the dataset. The modules cover the following areas: contributions, family allowances, sickness and disability benefits, unemployment benefits, pensions, personal income taxes, social assistance benefits plus a module for the assessment of budgetary and distributional impact of reforms. In order to assure great flexibility, a large number of external variables have been endogenised, i.e. calculation rules of the tax-benefit system have been parameterized to allow for the computation of disposable income.

Simulation possibilities for pensions are currently restricted to changes in observed pensions only (so called 'welfare adaptations', one-off benefit increases). Changes in the benefit formula cannot be modelled, as of yet but a more elaborate module for calculating pensions based on past career information is currently being developed and shall be integrated in a next version of MIMOSIS.

The evaluation tool covers and models the majority of policy relevant income concepts, except for income from property such as imputed rents and income from capital. Mortgage interest payments and housing allowances are also excluded from modelling.

Currently MIMOSIS offers the possibility to change the policy parameters of the 2001 legislation but parameter files of more recent tax-benefit years can easily be integrated. Changes in the legislation beyond changes in parameter values, e.g. a whole new way of calculating social security benefits, cannot be simulated without changing the source code. In the pension module, the effects of benefit increases can be investigated according to type of pension, type of scheme (wage-earner, self-employed) and date of pension award.

The main outcome of the model is a comparison of net disposable incomes before and after a reform. When evaluating distributional consequences of a reform, the user can choose from among a number of poverty benchmarks, equivalence scales, units of analysis. The basic unit of analysis is the individual but also households can be used as unit of analysis. Apart from tables per decile of equivalised income of losers and gainers, poverty incidence and intensity, replacement rates and various measures of income inequality, results are also produced for different socio-economic classifications and age groups. The model also calculates at-risk-of-poverty rate by age and gender, by most frequent activity and by household type.

Bulgaria

ILO PENS (BG)

The Bulgarian government applies an upgraded version of the ILO PENS, a sub-program of the ILO Social Budget Model, tailored to the needs of pension budgeting in Bulgaria. It is part of the annual process of preparing the budget for the general government but it is also in use for medium term projections and for analysing short term budgetary consequences of policy changes.

The ILO PENS (BG) covers old-age pensions, disability benefits and survivors' benefits. It is managed and maintained by the National Social Security Institute (NSSI). In terms of organisation, it is part of the general social budgeting process. The authorities employ three people working on the social budget model and another three working on the pension sub-program.

The ILO PENS is a sub-program of the ILO Social Budget Model developed and maintained by the ILO FACTS, the International Financial and Actuarial Service of the ILO. It is a standard deterministic cohort-based projection model. For each generation, the transition of an insured person (active, inactive and pensioner) is mapped into the next year's status by using actuarially assumed transition probabilities (mortality rates, incapacity rates, retirement rates, etc) and applying eligibility conditions and pension formula. The ILO PENS is written in Visual Basic with an Excel face. Its aim is to give short-term projections on key aggregate variables such as the number of beneficiaries and the overall expenditures, revenues and deficit of the system.

Czech Republic

Czech Pension Model

The Czech Republic has standard simulation pension models, which enable both typical agent and cohort-based modelling. The instruments have been conceived by an expert team in 2004/05 and since then maintained and updated by the Ministry of Labour and Social Affairs. The models were applied in the evaluation of various parametric and paradigmatic reform proposals. For the AWG projections a model based on similar principles and methodology is used.

Both modules (typical agent and cohort based) are built on administrative datasets of the social security authority, which are complemented by survey data on labour force characteristics as well as census data on family features.

Beyond age, gender and employment type (employed/self-employed), old-age benefit projections are also disaggregated on the basis of income ranges (10 per gender). When assessing newly granted pensions, cohort members are classified into several groups based on their average earnings and career lengths. However, the model is currently not able to realign these parameters to prospective changes in the projected labour market situation.

The main outcomes of the cohort-based module include various fiscal indicators (expenditures, revenues, accumulated surplus/debt), an overall replacement ratio and the share of new retirees under the poverty line. The typical agent module calculates individual replacement rates, internal rate of return and implicit tax rate.

Regarding datasets, an administrative database on pension accruals is currently in the process of preparation, as part of setting up individual accounts for administrative purposes.

Denmark

Danish Pension Model

The Danish Pension Model used in the context of the Ageing Working Group was developed and is maintained in-house. It is an actuarial valuation model taking the standard cohort-based approach, projecting public pensions. The projection does not only takes into account age, gender and labour market position in the exercise, but also ethnic origin (native, immigrant, descendant of immigrant).

Assumptions on the future age and sex composition and the corresponding mortality and fertility rates are taken from Eurostat. The ethnic/racial composition is assumed constant. Internal consistency of macro variables such as wage growth, the real rate of return, employment and inflation is ensured by the production function approach of the AWG, which sets the labour share of GDP constant. The basis for the projection is the RAS administrative survey.

The model is not suited to produce micro level output, as results are limited to the number of contributors/beneficiaries to the schemes, and aggregate revenues and expenditures.

The complement of the model is a microsimulation tool, called LAW (see below in detail). This reflects the modelling strategy of the administration, which is based on a cohort model for measures on long-term sustainability and an "add-on" model, which can answer questions on the distribution of economic resources.

LAW

Denmark's LAW model was developed and is operated by the Danish Ministry of Finance. It is currently in use, while it is also being revised and continuously updated. It is part of a larger model, which also include, among others, a tax model and a model for housing subsidies. LAW is a static microsimulation model, which run in SAS with a background of a complex panel dataset from Statistics Denmark, by the matching of 25-30 different administrative micro databases. The separate datasets are matched by the identification number of Danish residents. Although these data are individual they allow the reconstruction of households as household members (sometimes by assumption) can be matched.

Formal calibration for aggregation is from the Danish Pension Model (DPM; see above). The administration considers LAW a complementary model to the DPM, which can answer questions on the distribution of the economic resources.

Calculations are carried out on a random sample. The dataset contains retrospective information on employment and earnings back to 1979 at the maximum. Accruals in the funded scheme are also available: around 90 percent of funded schemes are covered by the sample. The remaining 10 percent has been 'individualised' by using a simplified matching technique.

Other types of available micro data include information on health conditions, social conditions, use of day-care centres, economic relationship to public sector, demographic conditions and education. All data inputs are on individuals, while households are treated separately in a typical agent fashion.

One notable feature of the model is that in the determination of labour supply, "dynamic" or second-order effects of tax changes with assumptions on gender-specific labour supply functions are used to derive behavioural responses.

The model produces a wide range of output indicators including first pension / last wage type of replacement rates, which are more telling than the standard average pension / average wage ratio. It is also capable of producing the distribution of pension wealth and future pension annuities payments.

The model is now being developed for long-term projections but it will still remain a static microsimulation model.

Germany

AVID

AVID (Altersvorsorge in Deutschland, Retirement Pensions Provision in Germany) is a repeated study based on large sample surveys of clients of the German social pension insurance. The survey was first undertaken in 1996 and repeated in 2002. The second round was extended in 2004. It was commissioned by the Federal Ministry of Labour and Social Affairs and the Federation of German Statutory Pension Insurance Institutes and it was conducted by an external contractor.

The 1996 round covered a sample of over 12,000 people of the German resident population between the ages of 40 and 60 (birth cohorts from 1936 to 1955) having a social security record and eligible for old-age pension at the age of 65. It was extended to the spouses of respondents as well, irrespective of the age and nationality of the former. The questionnaire design covered a whole range of potential income sources during old age, such as statutory pension insurance, private and public supplementary systems, civil servants‘ pension scheme, farmers‘ old-age pension scheme and schemes for the independent professions. It also included private provisions, such as life insurance and private pension insurance, property. The 2002/2004 round has a sample size of close to 14,000 people and their spouses.

The surveys collected rich sets of information on the family and household background, eligibilities to alternative future income sources upon retirement as well retrospective data affecting entitlements. This information was matched with the personal pension accounts held by the social security system including a detailed retrospective labour market and wage career.

This combined set was extrapolated by a dynamic microsimulation model. The model focuses on transitions across labour market stata but puts aside other socio-economic considerations such as e.g. changes in the marital status. The list of labour market stata is highly detailed including 14 different stata ((1) employed, subject to social insurance contributions, 2) child care, 3) housekeeping, 4) nursing relatives in need of care, 5) long-term sickness, 6) unemployment, 7) old-age pensioner, 8) unpaid work in family businesses, 9) low-paid employment, not subject to social insurance contributions, 10) civil servant, 11) self-employed, 12) limited earning capacity, 13) education, 14) other). Working hours and income position are also modelled for the relevant stata. Transitions between labour market states and working hours are modelled by hazard rate models; self-employment and working hours entries are modelled by logit/probit; the wage model is based on linear regression.

The reference period of extrapolation started by 1992, that is, it covered the years 1992-1996 in the first round and 1992-2002 in the second round.

The application of the model is the extension of the scope of standard models, that is, to go beyond aggregate cash flows and also identify risk groups and simulate the impact of various reform measures on the lower edge of the income distribution. It also serves in pension policy evaluation and planning and calculations on the link between work histories and old-age income. In addition, AVID also has the potential to enlarge the picture from the individual to the household and take into account alternative sources of income after retirement other than old-age pensions, such as other retirement provisions and withdrawal of private savings.

German Pension Model

The regular procedure of projecting future pension expenditures is managed by the Ministry of Health and Social Security in collaboration with the German Pension Insurance. The projection proper is made by an expert team including representatives of these two institutions and people from the German Federal (Social) Insurance Authority but the consultation process also involves experts of the Federal Ministry of Economics and Labour and the Finance Ministry.

The German Pension Model is a standard semi-aggregate model, which works with averages for cohorts and sexes separately for each of the three main provisions, old-age, disability and survivors. It quantifies the demographic impact on future pension expenditures and applies a partial equilibrium model in order to calculate the effects on contributions and pensions.

Estonia

Estonian Long-Term Pension Budget Model

The Estonian long-term pension budget model was developed and is operated by the Finance Policy Department of the Ministry of Finance. The model consists of Excel spreadsheets, with a partial equilibrium, "top down" structure. It is a deterministic macro simulation model based on cohorts, encompassing all pension schemes except the voluntary pillar. The unit of projection is the cohort, which means that the population is differentiated by age and gender. An important feature is that this is done not only in terms of labour market position (and retirement status) but an age and gender-specific relative wage structure is also incorporated into the model.

The model contains one important simplification, in that new pensioners are not projected separately from the existing pensioner stock in the disability scheme, but an evolution of the stock is assumed, calculated using initial (stock) data and an (arbitrary) change vector. In the old-age schemes, retirement is modelled by the adjustment of retirement age profile based on changes in participation rates of older cohorts, so retirement behaviour is exogenous and manually driven.

The assumptions on the future age and sex composition of the population (including mortality and fertility rates) are taken from Eurostat and are all exogenous, while the ethnic/racial composition is not explicitly included in the model. Macro variables (wage growth, real rate of return, employment, inflation) are all exogenous, coming from the commonly agreed Eurostat set of assumptions, and, like in other cases of the AWG projections, the wage share remains constant during the projection period so as to guarantee internal consistency of these variables.

The Estonian long-term pension budget model is a semi-aggregate model applied in projections of future revenues and expenditures.

Ireland

Irish Pension Model

The Irish pension model was developed and is operated by the Ministry of Finance and is regularly updated. The model is described as a partial equilibrium standard simulation deterministic model based on cohorts, encompassing public service pensions, social security pensions and assets of funds and reserves (the National Pensions Reserve Fund). New pensioners and their benefits are not projected separately from the existing pensioner stock, but an evolution of the stock is assumed. This differentiation between “stock” and “entry” pensioners and pension levels leaves some scope for possible development in the Irish model.

Assumptions regarding demography and macro variables are in line with the Eurostat and AWG projections.

The model is not built for producing micro level output but aggregate revenues and expenditure and the number of contributors / beneficiaries to the schemes. That said, an important feature of the model is that effects of pension reforms on the social welfare budget can be incorporated into the model.

Greece

Greek Pension Model

The National Actuarial Authority performs calculations on theoretical replacement rates in line with ISG methodology. Simulations incorporate cases where people have just entered employment or social insurance or will join the labor force in the near future or became insured for the first time only a few years earlier. The fund modeled (IKA-ETAM) covers all private sector employees (about 55 percent of the employed), therefore the modeled life-paths can be deemed as typical. Modelling work related to the AWG exercise is currently underway.

Spain

Spanish Pension Model (Modelo de proyección de pensiones del IEF)

The Spanish pension model was developed and is operated by the Ministry of Finance. This is a deterministic cohort-based projection model, covering old-age, early retirement, survivor and disability pensions for private employees and self-employed as well as minimum pension. A separate module covers public sector pensions, including disability, early, minimum and war pensions. The model is operated in Matlab and is updated on a yearly basis.

The unit of projection is the cohort, yet the simulated characteristics are not limited to age and gender, but the model also differentiates within cohorts by labour market position (making or not making contributions) and pension scheme but not by level of education. New pensioners and their benefits are projected separately from the existing pensioner stock, which helps to explicitly capture retirement and the dynamics of benefits over time. New disability pensioners are projected based on past experience. Minimum pensions are assumed to develop in line with the average pension.

France

DESTINIE

The French DESTINIE model was developed and is operated by the French Statistical Office, INSEE. It is updated on a regular basis: whenever changes to the legislation occur, or when a new version of the underlying dataset is available, the DESTINIE model is revised. A more complete rewriting is currently under way, under the name DESTINIE II. The new model essentially differs from the previous one in terms of programming language (Perl replacing Turbo Pascal), modularity, options of retirement behaviour, and consistency with macro-projections. But the main choices and functionalities of the first version have been kept. Even if Destinie II is not fully operational at this stage, it progressively replaces Destinie I and the details below refer to this new version.

DESTINIE is a dynamic microsimulation model based on a household survey, the Financial Assets Survey (Enquete Patrimoine, 2003) covering a 65,000-person representative sample of the population. The model covers the functioning of France’s entire pension system including widow pensions, family supplements, minimum pensions and a means tested minimum. But small specific schemes are not simulated in details. They are aggregated to the major schemes they are the closest to. For instance, wage earners in large public firms that often have specific schemes are aggregated to the group of State employees and are assumed to share the same pension rules.

Individuals in the model are characterised by their marital status, age and gender. Their career paths in terms of labour market status until 2003 are also included in the dataset. Wages are simulated through the model, thus also when creating the retrospective career histories, based on wage equations estimated on fiscal data matched with the LFS (the so-called Fiscal Income Survey). After the base year, the model simulates both demographic and economic trajectories from the initial year up to 2050, using a mix of deterministic rules, behavioural hypotheses and random drawings. Demographic developments are exogenous, but highly sophisticated, including the simulation of the school-leaving age, first "marriage", recoupling, rupture, and children born from all these unions. The model applies differentiated mortality rates depending on age on leaving school. It provides detailed information on household structure, including size and combined income. It also simulates kinship ties between non-core people, for instance the survival of parents or siblings. This is done through a closed population approach. Pseudo-kinship ties are reconstituted within the sample at the outset and then updated or generated by assuming that all unions take place within the sample, with a renewal of the sample ensured by births resulting from these unions.

As for the development of earnings and pension accruals, equations (transition probabilities) are estimated by gender and age on leaving school using data from the Labour Force Survey and other sources.

The predicted probabilities for demographic or labour market events are adjusted in order to fit every year the long-term demographic projections and the official labour force forecasts (labour force participation rates by gender and five-year ages) made by INSEE and to be consistent with the assumptions made within the macroeconomic environment. Conditional on labour market status, annual wages are finally imputed using the same wage equations as the ones used for the retrospective reconstitution of careers.

In projecting retirement decisions, the model incorporates five options to determine the choice of retirement age. The first one assumes that individuals retire as soon as they reach the so-called full rate (i.e. what is generally considered as the normal pension), access to the full rate depending both on age and the number of years of contribution through a rather complex non-linear formula. The two next options assume some form of utility maximization with an income-leisure trade-off, either instantaneous (people retire as soon as the value of leisure outweighs the immediate income loss) or prospective (the option value model of Stock and Wise). The two last options are based on measures of social-security wealth (SSW), i.e. the actualised expected flows of benefits from retirement age until death, with two sub-options: a myopic one under which people postpone retirement if a one year postponement increases their SSW and a more forward-looking one analogous to the Stock and Wise model where people delay if delaying leaves them with the option of getting a higher SSW level at a later age.

The model is able to produce pension distributions both in terms of retirement age and retirement income. It is also possible to extract poverty measures from it, such as the number of elderly falling below the 60 percent poverty line.

PRISME

The PRISME model of the French pension system is utilised by the Conseil d'Orientation des Retraites (Pensions Council) within the EU’s Ageing Working Group projections, among others. The model is a dynamic microsimulation model based on the administrative data from the General Scheme for Employees CNAV. Its time horizon is 2050, with the base year 2006 and is updated every 2 years. The tool covers the whole population of the entire pension system[1] registered for Social Security, contributing or not to the General Scheme.

The model reconstructs entire life paths, including school completion, household structure and kinship ties, the completion of the child-raising period and differentiates between seven labour market states 1) labour market participation CNAVTS, 2) labour market participation CNAVTS-analogous, 3) labour market participation non-CNAVTS, 4) unemployment 5) sick leave, 6) disability, 7) other. Thereafter, individuals end their working lives and die.

The main objective of the model is to forecast for the medium or long term the resources and the expenses of the General Scheme. In addition, PRISME allows forecasting at an individual level the accumulated entitlements to the Old Age Insurance Scheme, professional paths, wages of the private sector workers and the amount of pension (direct entitlement and widow pensions). Main published results concern general outcomes for the COR report 2006 and the update of 2007, detailing: the number of persons contributing (2003-2050), the number of pensioners (direct rights and widow pensions), the total amount of contributions and the balance of the General Scheme.

As for more micro level output, the model is able to produce the number of retirees at the average age of retirement, the number of early retirements (anticipated pensions) in the General Scheme, the share of pensioners concerned by the reduction in the case of early exit (decote) and by the supplement in case of deferment (surcote), the average pension benefit at retirement age by sex.

Italy

CAPP_DYN

CAPP_DYN is a dynamic, cross-sectional, population based, closed microsimulation model of the Italian population, developed by Centro di Analisi delle Politiche Publiche (CAPP), a research centre for the analysis of public policy, run jointly by the Universities of Modena and Bologna. CAPP_DYN is used for modelling various policy options in the field of social security (not just pensions).

The primary database of the model is the Bank of Italy Survey of Household Income and Wealth (SHIW_02), comprising 8001 households and 21,400 individuals. For the purpose of statistical adjustments, census data were used. Additional survey data have been taken from various sources to simulate educational choices, earning equations and labour market transitions. Special routines calibrate the model's endogenous results in a way to bring them in line with the exogenous basic economic hypotheses (per capita income growth, real earnings growth).

[1] – Régimes des salariés: CNAV, régime des salariés agricoles, ARRCO, AGIRC, IRCANTEC. – Régimes des indépendants: ANCAVA (artisans), ORGANIC (commerçants), régime des exploitants agricoles, CNAVPL (professions libérales), régime élémentaire obligatoire de la CANCAVA, régime complémentaire obligatoire de l'ORGANIC, régime complémentaire obligatoire des exploitants agricoles, régimes complémentaires obligatoires de professions libérales (CARCD, CARMF, CARPIMKO, CAVP). – Régimes de fonctionnaires : régime de la fonction publique de l'État, CNRACL (collectivités locales), régime additionnel de la fonction publique. – Régimes spéciaux: Banque de France, CNIEG (industrie électrique et gazière), CRPCEN (clercs et employés de notaire), ENIM (marins), FSPOEIE (ouvriers de l'État), régime de retraite des mines, SNCF, RATP. http://lesrapports.ladocumentationfrancaise.fr/BRP/064000302/0000.pdf

The unit of simulation is the individual, but data on family structure and its changes are recorded, too. All individuals in the sample are involved in a considerable number of demographic and economic events, such as birth, education, marriage, work, retirement and death. Economic and demographic transitions among states are simulated by Monte Carlo processes. A set of matrices and econometric models are employed for generating transition probabilities. The CAPP_DYN model has a recursive structure consisting of a set of modules executed in a predetermined order (demographics, educational choices, job decisions and earnings estimation, retirement decisions).

The model covers most social security benefits of the Italian welfare system (old-age, survival, disability, minimum pension) and it is capable of producing a large number of indicators on intra-generational as well as intergenerational distributive effects (replacement rate, internal rate of returns etc). A comparison between labour and social security income is also possible. Since the model does not cover all income components (real and financial capital income are still missing), a complete analysis of income distribution and poverty in the long run is not possible. Recently a new module has been added in order to estimate the likely evolution of the frail part of the population in the medium to long term and the cost of the introduction of a long-term care public programme. At the same time, the research group is currently working on the substitution of the primary database, the SHIW, with the Italian EU-SILC 2005 survey, which would allow a better comparison with other European models.

CeRP models

The Centre for Research on Pensions and Welfare (CeRP) in Italy developed a family of pension models including a typical agent model a semi-aggregate model and a micro-simulation model. This short summary is based on the institute's annual report.

The typical agent model computes pension benefits and money's worth measures for a set of representative Italian workers according to the rules of the legislation in effect. By aggregating individual results, it evaluates the impact of alternative pension rules on pension expenditure.

The semi-aggregate model (CeRPSAM) was elaborated in cooperation with the Dutch Social and Cultural Planning Bureau The inputs of the model are country-specific demographic and household projections (mainly from Eurostat data), assumptions on future labour participation rates and labour productivity growth, and the current income/benefit positions of the population. The model produces estimates of future developments on a number of economic key variables, and of indicators for the future income/benefit positions of specific groups. The latter are subsequently implemented in European Community Household Panel Survey (ECHP)'s micro data through a weighting procedure. This makes it possible to calculate indicators of inequality, redistribution and poverty for the year 2025.

The microsimulation model (CeRPSIM) is able to simulate heterogeneous lives and earnings histories for individuals belonging to various cohorts, and to compute the resulting pension benefits. The simulated population evolves throughout a set of deterministic and stochastic elements. Discrete-state changes (marital status, labour status, etc.) are conditional on individual socioeconomic characteristics and are modelled throughout a Monte Carlo procedure. The process for the lifetime earnings paths is modelled, for each individual, as the sum of a group-specific deterministic component and of a group-specific stochastic component, estimated from a sample of administrative data.

RGS pension model

The pension model of the Ministry of Economic and Finance Department of General Accounts (Ragioneria Generale dello Stato) maintains a cohort-based standard simulation model based on administrative data. The model is used to assess the aggregate financial effects of reform proposals and serves as the underlying instrument of the AWG projections of public pensions. Sub-groups in the model are distinguished by age, sex, benefit type, source fund (private/public), contributor type (active/dormant/pensioner) and type of regime (earnings related, contribution based, mixed). Technically, changes status are handled by a transition matrix, in which probabilities have been derived from past data. Up to age 42, the number of new contributors is set equal to the increase of employed people within the cohort. The model is quite flexible to take on board exogenous macroeconomic projections except for exit from the labour market where probabilities have been estimated endogenously from past trends and eligibility criteria and only approximated to aggregate external forecasts. Projections on various sub-groups are aligned to macro level projections (e.g. in the case of wages) by using multipliers. Non-linearities of the pensions system (e.g. minimum pension or different rates of benefit indexation based on benefit amount) are also dealt with through an index of variability (variation coefficient) and a distribution function. The model makes use of historical data about workers with a contribution past, including dormant members who are no longer contributing but will be able to apply for a pension later.

Cyprus

ILO PENS (CY)

The ILO PENS is a sub-program of the ILO Social Budget Model developed and maintained by the ILO FACTS, the International Financial and Actuarial Service of the ILO. It is a standard deterministic cohort-based projection model. For each generation, the transition of an insured person (active, inactive and pensioner) is mapped into the next year's status by using actuarially assumed transition probabilities (mortality rates, incapacity rates, retirement rates, etc) and applying eligibility conditions and pension formula. The ILO PENS is written in Visual Basic with an Excel face. Its aim is to give short-term projections on key aggregate variables such as the number of beneficiaries and the overall expenditures, revenues and deficit of the system.

Cyprus uses the ILO PENS. The model has been customised in order to closely comply with local legislation. For further details on the model see the corresponding paragraph above.

The ILO PENS (CY) is operated by the Social Insurance Services of the Ministry of Labour and Social Insurance. It is updated in every three years, in order primarily to incorporate amendments to legislation and results from experience analyses. Its results are used in actuarial valuations, long-term budgetary planning, modelling pension reform options and in the cash-flow projections between the Consolidated Fund and the Social Insurance Fund.

Latvia

Latvian Pension Model

The Latvian pension model (LPM) is run under the auspices of the Ministry of Welfare. It is written in Visual Basic and has an Excel user face. It is applied to a variety of public cash programs such as the old-age pension, disability benefits, survivors' benefits as well as other functions such as short-term sickness, work injury, unemployment, maternity and funeral benefits.

The LPM is a standard semi-aggregate model. The level of disaggregation is the cohort (year-group) and sex. Projections are based on participation and wage profiles by age and sex provided by the State Social Security Agency (SSSA) and on data on current pensioners and pension profiles from CSB and SSSA. Assumptions regarding developments of major macroeconomic trends are in line with the assumption set of the AWG. Reweighing of the cohorts, that is, the imitation of future developments of the retirement process, more specifically, the average number of new retirees and the pensioner career of cohorts, is based on assumptions.

Although the LPM is a cohort model, it is also used to draw typical age-earnings careers in order to calculate theoretical replacement rates. Nevertheless, the main application of the model seems to be the projection of financial developments, aggregate spending on old age, disability, short-term sickness, work injury, unemployment, maternity, survivors, funeral benefit and even administration costs. A special section of the LPM is modelling the consequences of the switch of the system from a defined benefit pension formula to a non-financially defined contribution (NDC) system.

Lithuania

PRISM (LT)

PRISM (Pension Reform Illustration and Simulation Model) is a general-purpose pension model developed by Patrick Wiese. In Lithuania it is maintained by the Ministry of Social Security and Labour and it contains state social insurance pensions covering old-age pensions (including mandatory private funds), disability benefits and survivors' pensions.

PRISM is a semi-aggregate model. It can operate as an "average person parameter" model or as a distributional model. In this case new retirees are assigned a bivariate normal distribution of lifetime wages and of pension service. The sub-groups are created by age and sex. Demographic projections are made by the model or, alternatively, an exogenous population projection can be imported into the model; the assumptions are in line with those of the AWG. The model has the capacity to endogenise the calculation of GDP, that is to say, to derive it from inflation, wage growth and employment growth, thereby ensuring internal consistency.

The model calculates the usual aggregate measures, such as the cash-flow of the system, asset accumulation in the pre-funded pillar, and the number of contributors and beneficiaries. In addition, it produces entry replacement rates for men and women with 35 years of service assuming various wage levels (50 percent, 100 percent and 200 percent). In addition to these, PRISM is able to generate measures for lifetime internal rates of return for the various sub-groups as well as cumulative measures such as the implicit debt of the system.

Luxemburg

LuxMod

LuxMod is a Computable General Equilibrium Model (CGE) for the Luxembourg economy and social protection, managed by the Inspection générale de la sécurité sociale (IGSS). The instrument has been programmed in GAMS and updated on an annual basis. The model disaggregates the economy into four sectors: households, enterprises, government and rest of the world. The instrument covers all social security schemes but does not simulate the acquisition of pension rights. The model is based on aggregate administrative data. It has been used in the annual budgeting process and during the preparation of social security reforms and from 2008, LuxMod will be used for updating the Luxembourg Stability and Convergence Programme. According to plans, it might be linked to a microsimulation model in the future.

REDIS project

The *REDIS project* started in 2007 and aims at assessing the coherence of social transfer policies with the help of poverty and redistribution indicators, focusing on individuals and households. The project is carried out by CEPS/INSTEAD Luxembourg (Centre d'Etudes de Populations, de Pauvreté et de Politiques Socio-Economiques) in partnership with IGSS (Inspection Générale de la Sécurité Sociale) and financed by the National Research Fund. As a starting point, the redistributional effects of the Luxembourg tax reforms of 2001/2002 have been analysed by using the static microsimulation model EUROMOD. The analysis of the tax reform was based, on one hand, on administrative data drawn from the Luxemburg Social Security Data Warehouse and the EU-SILC survey. The model was run with these two different types of datasets and outputs (inequality indicators and poverty rates) compared. The unit of analysis was in both cases the fiscal household.

The REDIS project foresees some important developments to EUROMOD. Among others, a new module enabling explicit modelling of pension calculation rules is planned. Another planned extension will serve the evaluation of effects of co-payments for health care services on net income. In certain areas (such as the labour supply of women or co-payments in health care services) EUROMOD calculations are going to be extended by behavioural equations. The project will also propose a gradual strategy for developing dynamic microsimulation models with enhanced capabilities in the area of social policy analysis, to be completed by 2010. Current plans include a cohort microsimulation model for the modelling of lifetime income distribution and a pilot dynamic population model.

SOBULUX

SOBULUX (Social budget simulating software for Luxembourg) is a cohort-based standard simulation model set up by the Inspection générale de la sécurité sociale (IGSS), based on previous ILO-type macro-projections. The regularly (most recently in 2005) updated tool is based on administrative datasets of the IGSS. In order to take account of peculiarities of the Luxembourg labour market (high proportion of migrant workers), the instrument was designed to include dimensions such as country of origin or employment status (beyond the general breakdown by age, sex and benefit type). The model thus makes a difference between total labour force and 'national' labour force. Labour force participation rates are computed by applying entry probabilities to inactive population or exit probabilities to active population. The administration also applies SOBULUX to model the acquisition of pension accruals by a separate module. The tool has been used for long-term planning, the assessment of pension reform options and in political debates. EPC-AWG pension projections are also produced by SOBULUX.

Hungary

Hungarian Pension Models

The National Bank of Hungary and the Ministry of Finance both have their own cohort-based standard pension models developed and maintained internally by the respective institutions.

Both models rely on administrative datasets provided primarily by the National Pensions Authority and carry out deterministic calculations along the dimensions of age, sex and benefit-type. Both models (programmed in Excel VBA/Excel) draw on exogenous demographic and labour supply assumptions but are able to adjust the latter in order to ensure consistency with rules on pension entitlement. The instrument of the MoF is also able to take account of mortality differences between disability and other pensioners. The initial development of the model of the MoF (which will now serve as a basis for the 2008 round of AWG projections) took approximately 2.5 man-months (including data collection and calibration). Both models have been used to calculate various fiscal indicators in a number of policy and parameter scenarios. Their main weakness lies in the way exogenous (past and projected) changes in the labour supply are reflected in the future evolution of average pension accruals. This work could not be carried properly due to the lack of a retrospective data series on benefit accruals. This shortcoming might be redressed following the involvement of the National Pensions Authority in the new cycle of the labour market survey carried out in 2008.

NYIKA

The NYIKA model is a recent development born from the cooperation of the Pensions and Ageing Roundtable (NYIKA by its Hungarian acronym), an independent expert body invited by the Prime Minister, and Deloitte Touche Tohmatsu, a multinational consultancy. The Roundtable, jointly with similar expert groups on education and taxation, is a chapter in the budget of the Prime Minister's Office.

The model was developed with the aim of testing the effects of various pension reform scenarios on financial sustainability and poverty in old age. It is a dynamic microsimulation model with dynamic ageing. The life events modelled are entry to the labour market (with transition from school to labour), marital stata, labour market positions (full time employed, part time employed, unemployed, inactive below retirement age), and retirement. Models of life event are mostly based on past and current patterns and require further refinement.

The model is based on administrative data on contributors to the pay-as-you-go pillar (KELEN with over 6 million records), which is matched with contributory records of the mandatory private funds of the second pillar (KPN). The model also gains further information on current pensioners (from the NYUFUR dataset of the pension administration) and contributors (from Labour Force Survey).

The first results of the model have recently been released but its current position in the administration and its future developments are still uncertain.

Malta

PROST (MT)

PROST (Pension Reform Options Simulation Toolkit) is a general-purpose model of the World Bank. It is a combined semi-aggregate and typical agent model, in that it derives conclusions regarding macro expenditure and revenue flows by reweighing cohorts and genders based on a demographic projection, but it is also capable of tackling as many as six typical careers defined by the user. Consequently, it overcomes the usual problem of typical agent models of producing aggregate results and at the same time it avoids some deficiencies of cohort models such as remaining silent about replacement rates and similar life-cycle measures.

Accordingly, PROST produces the average entry pension over average gross wage type of replacement rate. Indeed, this version of the replacement rate is not without problems of interpretation but its changes over time or across various reform scenarios can still be informative. It also produces indicators for expected returns of typical life careers. In addition, PROST can be used to get to aggregate measures such as number of future contributors and pensions (but not that of pensioners), revenues and expenditures of the system, financial balance of the system and the pension funds, and a special measure of sustainability, the balancing level of contributions or replacement rates. A further application of the model is to produce cumulative measures such as the implicit pension debt.

The model can assess both parametric and structural reforms, such as the introduction of individual, funded retirement savings accounts. A shift from a defined benefit pay-as-you-go scheme to one based on notional accounts can also be modelled including measurements of transition costs.

In Malta, PROST has been catered for by the Ministry of Finance, Economy and Investments and it has been updated in approximately every 3-4 years. It is mainly used in long-term budgetary planning and the evaluation of pension reform options.

Netherlands

GAMMA

GAMMA (acronym for General Accounting Model with Maximizing Agents) is a dynamic deterministic open-economy overlapping generations general equilibrium model of the Netherlands, developed by the CPB (Netherlands Bureau for Economic Policy Analysis). The model distinguishes markets for goods, capital, labour and a ‘market’ for income transfers from the government to households. GAMMA identifies the following agents: households, pension funds, the government, firms and the foreign sector. Households are divided up into 99 cohorts. GAMMA incorporates the economic behaviour of households, firms and pension funds. Households decide on labour supply and private saving, firms decide on demand for labour and capital, and pension funds decide on pension contributions and benefit levels. Agents are rational and forward looking, and optimise in a consistent microeconomic framework. GAMMA thus allows for welfare analysis of policy reforms. However, since perfect labour and capital markets are assumed, the model is not equipped to describe short- and medium-term dynamics.

GAMMA includes three separate sub-models: one for social security schemes (MOSI), one for occupational pensions (EXPLOT) and one for occupational early retirement pensions (PVK). As regards the system of public pensions, GAMMA relates the development of first pillar pension expenditure to two factors: the productivity in the economy and the number of people over the age of 65. Some age-specificity within this group is introduced to take account of the positive correlation between age and the proportion of single persons. For the projection of the occupational pension pillar, the 700-plus pension funds in the Netherlands have been assembled in a model of a single ’average’ pension fund. This average pension fund offers a pre-funded average pay scheme, aiming at a replacement rate of 70 percent of average pay and investing in a mixed portfolio of bonds and equity (50-50 percent). The pension model includes economic behaviour inasmuch as contribution rates and indexation factors are functions of the coverage ratio of pension funds, i.e. the amount of financial wealth in terms of pension rights. The hypothetical model fund charges actuarial cost-effective contribution rates (cost effectiveness being related to the entire pension fund) and indexes accrued rights at combination of wage and price increase (full indexation above a funding ratio of 135 percent of the nominal liabilities). GAMMA has been used for the purposes of the AWG projections.

MICROS

The microsimulation model MICROS has been in use at the Ministry of Social Affairs and Employment for several years. The model consists of a large micro database, a set of calculation rules (written in Fortran) and a large database with input variables.

The micro database consists of more than 60,000 households of whom data are available on household composition, income and housing costs. The calculation rules represent, among other things, the tax- and social security system. In this way, the income effects of a wide range of policy measures in the field of income policy, including pension reforms, can be calculated.

The model can simulate ageing in a static, as well as a dynamic way. In static ageing, the situation of individual cases remains unchanged (only income levels change). The structure of the population is revised by changing the weights of the cases. Dynamic simulation is the simulation of events like birth, leaving school, finding a job or (early) retirement. Here, a probability of each event is calculated for each case and subsequently is determined whether the event occurs or not.

The dynamic ageing part models life events such as entering the labour market (with transition from education to work), marital status (marriage, divorce), childbirth, labour market position (getting a job, changing working hours, losing job, losing working ability), leaving the labour market (early retirement, retirement). The model also has a housing market module and a migration module.

In practice, the Ministry of Social Affairs and Employment primarily focuses on the static ageing version of the model. Important applications of dynamic microsimulations with static ageing are developments in purchasing power, income inequality, poverty, and financial returns on participation. The model adjusts its poverty and inequality measures to household size and composition, and calculates various replacement rates, poverty measures (Leiden poverty line, median poverty lines), and inequality indicators (Gini, Theil, decile ratios).

SADNAP

The SADNAP model (Social Affairs Department of the Netherlands Ageing and Pensions Model) is a dynamic microsimulation model developed by the Department of Social Affairs and Employment. The model is still under development. Currently, it is capable of projecting state pension (AOW – Algemene Ouderdoms Wet) expenditures, but there are plans to upgrade it to cover private pensions and allow for the analysis of income distribution (inequality indicators, distribution of wealth among generations). The construction of a proper marriage market module is also envisaged.

The model is based on two administrative datasets. Statistics Netherlands (CBS) supplied a micro data file containing information on the number of acquired AOW entitlement years for the population aged 15-64, along with the following individual characteristics: age, origin (native, western non-native, non-western non-native), gender, marital status. The authority responsible for the payment of state pensions, the Social Insurance Bank (SVB) supplied a comprehensive dataset on all 2.6 million people receiving AOW in 2006, including data on AOW entitlements, age, gender, country of residence, marital status, age of the partner and the existence of a partner allowance. (This file also contains data on people receiving state pension abroad.) The demographic assumptions for the projection were also provided by the CBS. With regard to household structure, the tool can only distinguish between singles and non-singles (through the use of a simple random procedure). Transitions between statuses are simulated by the Monte-Carlo method.

The model is currently used for budgetary projections and for the assessment of various policy alternatives (e.g. removal of the partner allowance, increase of retirement age).

Austria

Austrian Applied Projection Models

Pension projections used to be made by the main consultative forum of policy discussions, the Pension Advising Council (PAC). The PAC, composed of external experts and representatives of the government and social stakeholders, presents an annual opinion paper to the government. However, since the introduction of the sustainability factor in 2005, a calculation signalling unexpected changes, such as an unanticipated growth in life expectancy, a permanent monitoring mechanism was launched in 2007. The mechanism does not automatically trigger adjustment of contributions and benefits but mobilises an expert team to propose corrections to such effect. The organisational background of the expert team is still to be clarified, in particular under the auspices of which government agency they work, or alternatively if they work in isolation from the government.

The projection is based on two separate models reflecting the structure of the pension system, which consists of separate schemes for the private sector and the civil service (as well as smaller schemes for farmers and the self-employed, which are modelled according to the private sector model). The two models are consolidated and cover the old age, disability, survivors and early retirement functions.

The models calculate the number of new pensioners, the number of exits as well as future expenditures.

Austrian microsimulation model (under construction)

The Austrian microsimulation model is under construction by an external contractor of the Federal Ministry of Social Affairs and Consumer Protection. The aim of the Ministry is to build the model to simulate the aggregate financial consequences of alternative policy proposals, and to be able to respond to *ad hoc* inquiries by various departments, political parties or other stakeholders. The first module, the demography module, is expected to be completed by 2008.

Poland

FUS07

FUS07 model is a cohort based standard simulation model of the Social Insurance Institution, performing deterministic actuarial calculations with an Excel – VB background. The model is updated on an annual basis. It covers four social insurance schemes: old-age, disability, sickness and accident insurance, however, it does not take into account the farmers’ scheme, which is projected by Polmodel, a simulation model of the social policy budget. The tool distinguishes between different mortality rates of certain types of benefit recipients. Main outputs of the model include the standard fiscal indicators (expenditures, revenues, surplus/debt of the Social Insurance Fund) and various standard ratios (e.g. benefit ratio). FUS07 (and earlier versions) have served as a tool for the AWG pension projections.

Portugal

ModPensPor

ModpensPor, a cohort-based standard simulation model has been adapted by the Cabinet for Strategy and Planning (GEP) of the Portuguese Ministry of Labour and Social Solidarity from Spain's Modpens model (developed by Fundación de Estudios de Economía Aplicada) with the help of an external contractor in 1996. Besides pensions, the model can also project contributions, unemployment, sick leave, and maternity benefits based on administrative data. The model is programmed in Gauss Matrix Programming Language and updated on an annual basis. ModPensPor is used for the assessment of financial sustainability of the social security system, as well as for the AWG exercise. An area of further development could be the method of determining the new flow of retirees. At present, it is performed in a simplified way, without incorporating projected changes in the labour market. The proportion of a cohort becoming eligible for pension is assumed to stay constant from the base year onwards, as is the case with the average length of contributions (32 years). The wage history of new retirees is derived from data on average wage growth since the 1960s.

Romania

No information was available for the research team on Romanian pension modelling.

Slovenia

SIOLG 1.0

The model *SIOLG 1.0* is a dynamic overlapping-generations general equilibrium model of the Slovenian economy, based on social accounting matrix (SAM) for the year 2000. The tool is programmed in GAMS (general algebraic modelling system). The model has been developed with the intention of analysing the sustainability of the Slovenian public finances as a whole, though it can be used to analyse any sector of the economy (eg. pension, health care, long-term care). The pension block enables the modelling of the first pillar of the Slovenian pension system, based on administrative data (Institute of Pension and Disability Insurance of Slovenia). SIOLG 1.0 has been used in the AWG pension exercise.

Slovakia

MAJA

MAJA is a cohort model of the Ministry of Labour, Social Affairs and Family developed and maintained in-house in cooperation with the ILO and the World Bank.

PROST (SK)

PROST (Pension Reform Options Simulation Toolkit) is a general-purpose model of the World Bank. It is a combined semi-aggregate and typical agent model, in that it derives conclusions regarding macro expenditure and revenue flows by reweighing cohorts and genders based on a demographic projection, but it is also capable of tackling as many as six typical careers defined by the user. Consequently, it overcomes the usual problem of typical agent models of producing aggregate results and at the same time it avoids some deficiencies of cohort models such as remaining silent about replacement rates and similar life-cycle measures.

Accordingly, PROST produces the average entry pension over average gross wage type of replacement rate. Indeed, this version of the replacement rate is not without problems of interpretation but its changes over time or across various reform scenarios can still be informative. It also produces indicators for expected returns of typical life careers. In addition, PROST can be used to get to aggregate measures such as number of future contributors and pensions (but not that of pensioners), revenues and expenditures of the system, financial balance of the system and the pension funds, and a special measure of sustainability, the balancing level of contributions or replacement rates. A further application of the model is to produce cumulative measures such as the implicit pension debt.

The model can assess both parametric and structural reforms, such as the introduction of individual, funded retirement savings accounts. A shift from a defined benefit pay-as-you-go scheme to one based on notional accounts can also be modelled including measurements of transition costs.

Slovakia has also used the PROST package to model pension contributions and expenditures. Here it is operated by the Financial Policy Institute, a background institute of the Ministry of Finance. For further details on the model see the above description.

Finland

Finnish Centre for Pensions Models

In Finland the primary centre of pension modelling is the Finnish Centre for Pensions.

The Centre's standard model builds on the PTS standard simulation model for long-term planning. The PTS is an actuarial valuation model, based on the standard cohort-based approach, which covers the entire earnings-related pension system. A separate model was created for national pensions (minimum pensions), in which the number of eligible people is estimated using past information as a ratio of new pensioners to all non-pensioners.

The assumptions regarding the future age and sex composition of the population (including mortality and fertility rates) are exogenous, however, the model is sophisticated relative to its peers because for persons drawing an old-age pension a high pension is connected with a low mortality risk when age and gender are standardised, and the mortality risk for disabled persons is higher than the corresponding risk for the general population.

The model is not suited to produce micro level output, and results are annual pension expenditures, contributions and accumulation of funds. Generation and gender-specific results are also possible.

Standard modelling is occasionally extended by special purpose analyses, such as the ELPA-analysis, the AK-analysis and the stochastic lifecycle model.

The ELPA-analysis aimed at calculating the effect of the pension reform on the pensions of the 1998 retiree-cohort (about 40,000 people) based on administrative records of the Statistics Finland.

The purpose of the AK-analysis is to project the future development of Finland's earnings-related scheme by extrapolating an administrative micro dataset, called the "lifetime wage database" (AK). The AK is a 5000-person sample consisting of 400 to 1000 people from every fifth birth-cohorts between 1905 and 1970. Data on earnings and detailed career information are drawn from administrative records. The dataset covers the period of 1963 to 2005. The time horizon of the model is 2045. The calculation concerns the development of new old-age pensions, explicitly modelling the acquisition of pension accruals. While demography is fully exogenous, an element of sophistication compared to other models is that the AK applies different mortality rates depending on age at leaving school. Careers have been extrapolated taking two distinct approaches: 1) historical data on how people's earnings develop with age; 2) in a way consistent with the assumptions of the standard calculations. Distribution of pension wealth and future pension annuities payments are available, presented in the form of median, quartiles etc. Aggregate measures are under consideration; no formal calibration for aggregation has yet been designed.

The stochastic life-cycle model was developed in 2005-2006. We received conflicting descriptions whether or not this is a dynamic microsimulation model. The purpose of the development is to evaluate the effect of the 2005 pension reform on retirement, employment and pensions on the basis of financial incentives. The programming language was Gauss and Stata. The underlying dataset consists of pension data from the Finnish Centre for Pensions and data on employment from Statistics Finland. Data include wages and service years throughout individuals' employment histories. Age and gender are known for each individual. The model describes labour supply decisions at the individual level. It includes detailed rules of the Finnish statutory private-sector pension scheme and takes into account income taxation and unemployment insurance. The parameters for the utility function are chosen so that as with the pre-reform pension rules in force, individuals in the model behave similarly to the way people behave in actual statistical data. The behavioural parameters are then fixed, but the pension rules are changed and it is then observed how the individual's behaviour changes. The main outputs are standard replacement rates and tentative individual and aggregate return measures.

Sweden

MiMESIS

MiMESIS has been used since 1973. It was built and maintained in-house by the social security administration. It is frequently referred to in public discussions. The Swedish pension reform was based on this model. The annual report of the Swedish pension system, the Orange Report, was also built on it, aw were many governmental inquiries.

MiMESIS is a microsimulation model based on administrative individual data, which are not matched with household figures or other surveys. It produces aggregate results on contributions and benefits for cohorts, gender and some other pre-defined groups. It explicitly models labour income, old-age pensions, disability benefits and sickness benefits, but the main focus is old-age pensions.

The model is mainly used to assess financial stability of the pension system under various policy scenarios or demographic and macroeconomic conditions. It can also be used to calculate replacement rates.

SESIM

SESIM (www.sesim.org) is a dynamic microsimulation model with dynamic ageing. It was developed and has been maintained in-house by the Ministry of Finance. Program development did not require specialised programming expertise; the developers had finance, economics and similar backgrounds. Accordingly, the program is written in Visual Basic, a well-known software, and generates Excel and Access outputs. SESIM was built in 1997 as a tool to calculate budgetary and distributional effects of student loans and grants. After 2000 it was transformed to a pension model and since 2003 it has been used on a regular basis for that purpose.

SESIM is based on the longitudinal panel of Statistics Sweden, called LINDA, which was created from administrative registers, such as registers of the tax office and the social security administration, with the start year of 1999. It contains about 380, 000 people, which is about 3.5 percent of the population. Combined with household members the sample grows to as much as 786,000 people. LINDA is matched with the income distribution survey of Statistics Sweden, named HEK, the GEOSWEDE spatial dataset (for data on regional mobility and tenure), the household expenditure survey (for information on indirect taxes) and even the emigrants data of the National Social Insurance Board on people who do not reside in Sweden but collected pension accruals there. Altogether, the input data of SESIM include information on gender, age, marital status, household composition, education, income, wealth, taxes paid and housing. Income data are derived from a wide range of income sources, such as labour income, old-age pension, other pension benefits and even the value of in-kind public services (education, health care). Data on households are also rather extensive. The modellers can count on household size, household composition, age of members and household income.

United Kingdom

Pensim2

Pensim2 models demographic, education, and labour market processes such as, labour market status and earnings, partnership and fertility, and mortality. For the elderly population savings, taxes, housing, institutional care, disability benefits and income related benefits are also simulated. The lifetime accumulation of state pension contributions and private pension membership are also modelled. Transition equations are estimated from either the LLMDB or the BHPS. The model does not simulate behavioural responses.

Pensim2 output was one of sources used for policy formation by the UK Pensions Commission in its second report: *A New Pension Settlement for the 21st Century*. It is now established as one of the major tools used by analysts in the Department for the development of State and Private pension policies.

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Annex: The PENMICRO questionnaire

The PENMICRO questionnaire consists of questions regarding

- general information on the model
- micro datasets
- core model properties
- other model properties and
- output indicators.

Depending on the type of model (standard typical agent, standard cohort, static microsimulation / dynamic microsimulation with static ageing and dynamic microsimulation with dynamic ageing) we circulated different combinations of questions. From the question sets below the following combinations were asked about

1. standard typical agent models:
   G1-G9: General information on the model
   A1-A5: Availability of micro data
   TA1-TA7: Properties of models modelling careers of fictitious typical agents
   R1-R11: Other questions on modelling
   O1-012: Output indicators

2. standard cohort models:
   G1-G9: General information on the model
   A1-A5: Availability of micro data
   C1-C6: Properties of standard cohort models
   R1-R11: Other questions on modelling
   O1-012: Output indicators

3. static microsimulation models / dynamic microsimulation models with static ageing
   G1-G9: General information on the model
   DP1-DP9: Micro dataset of the pension authorities (administrative data only)
   DM1-DM8: Other datasets matched with pension data
   MSA1-MSA6: Simulation properties of static microsimulation models or dynamic microsimulation models with static ageing
   R1-R10: Other questions on modelling
   O1-012: Output indicators

4. dynamic microsimulation models with dynamic ageing
   G1-G9: General information on the model
   DP1-DP9: Micro dataset of the pension authorities (administrative data only)
   DM1-DM8: Other datasets matched with pension data
   MDA1-MDA8: Simulation properties of dynamic microsimulation models with dynamic ageing
   R1-R10: Other questions on modelling
   O1-012: Output indicators

The sets of questions are listed below.

General information

General information on the model

G1	responsible agency	
G2	developer 1. imported from international agency, namely … 2. developed and maintained by external contractor for agency 3. developed by external contractor, maintained in-house 4. developed and maintained in-house Is the external contractor academic or commercial?	
G3	stage of development	
G4	resources devoted to initial development	
		amount paid to external developer
		did initial development include buying specific software? If yes, which one?
		man-months devoted to data collection/preparation
		man-months devoted to initial development (including debugging, calibration)
		if own development: which kind of expertise was hired?
G5	maintenance	
		frequency and scope of updating
		amount paid to external contractor for maintenance
		man-months devoted to maintenance/updating
		which kind of expertise was hired/employed?
	further development	
		amount paid to external contractor for upgrading
		man-months devoted to further development
G6	programming language	
G7	application in policy formation or governance	
G8	type of model - macro - standard (typical agent) - standard (cohort, aggregate) - dynamic MS with static ageing - dynamic MS with dynamic ageing	
G9	Which schemes / benefits are considered in the model?	

Micro datasets

Availability of micro data

A1	Are there micro datasets available containing information on	
		education history
		employment history
		wage history
		contribution history
		accumulated accruals
		health conditions, public health expenses by individual
		household panel (income, consumption)
A2	Are some of these datasets matched? If yes, which of them?	
A3	Are there technical or legal constraints of matching micro datasets?	
		technical
		legal
A4	Would there be possible to match entries of a survey dataset with administrative data? If yes, which ones?	
A5	Would there be possible to match entries of an administrative dataset with other administrative data? If yes, which ones?	

Micro dataset of the pension authorities (administrative data only)

DP1	name of the dataset(s) proceeded by the model; size of samples	
DP2	Demography Which of the listed characteristics are recorded? - ethnic/racial origin - migrant status - gender - age - education - marital status - mortality by scheme (old-age, disability, etc) - region	
DP3	employment	
		what kind of observed data can be gained on the employment history of the individual?
		How far do data go back with retrospective information on employment?
DP4	wages, income	
		What kind of observed data on current and retrospective wages does the dataset contain?
		How far do data go back with retrospective information on wages?
		What kind of observed data is available on other sources of income?
DP5	separate scheme information	
		Is there information available on accruals in other mandatory schemes such as insurance schemes or second- and third-pillar retirement schemes? Can these datasets be matched with data on the first-pillar?
DP6	matching data	
		Can the benefit of observed pensioners be matched with previous data on contributions?
		What other administrative datasets (such as health conditions, employment, tax declaration, wealth/property register) can administrative pension data be matched with?
		- if none: • are such datasets nonexistent? • are they not matchable? • are there legal constraints to match them?
DP7	individual vsersus household data	
		Matching strategy: does it start with pension authority data and match it with survey data, or the other way around?
		Can the individual dataset be matched with administrative data on other household members?
		Can the individual dataset be matched with household survey?
DP8	Are data on past pension accruals available (for which period / scheme)?	
DP9	Does the set contain accumulated accrual / pension wealth data?	

Other datasets matched with pension data

DM1	Administrative or survey or both; size of samples? Name of the datasets proceeded by the model.
DM2	are individual data matched with household data; if yes, what is the method of matching?
DM3	Are separate micro datasets matched; if yes, what is the method of matching?
DM4	Which of the listed individual characteristics are recorded in matched data? - ethnic/racial origin - migrant status - gender - age - education - marital status
DM5	What are the income components covered? - labour income - old-age benefit - survivor benefit - disability benefit - social assistance - value of in-kind services - other: ...
DM6	Which of the listed household characteristics are recorded? - size - age of members - combined income (including income definition)
DM7	Time in data - cross section - repeated cross sections - retrospective data from cross section set - panel
DM8	What kind of problems did you face and solutions did you find in the matching procedure that could be relevant for modellers in other countries?

Core model and simulation properties

Properties of models modelling careers of fictitious typical agents

TA1	What are the characteristics of typical agents whose life path is modelled?
TA2	How are typical agents selected and how are their life-path characteristics established?
TA3	Do data allow extending the characterisation of typical agents with other features? examples: - ethnic/racial origin - migrant status - education - occupation - marital status - health conditions
TA4	What do life-paths of typical agents look like?
TA5	What are the core scenarios or assumptions of demographic, labour market and other relevant developments in drawing the life-paths of typical agents?
TA6	How is consistency between core scenarios and/or assumptions established or maintained?
TA7	What is the procedure, if any, applied to derive aggregate results from the life-paths of typical agents?

Properties of cohort models

C1	What are the characteristics/subgroups considered in projecting the career of a cohort? examples: - age - gender - level of education - labour market position - occupation - wage - migrant status - ethnic/racial origin	
C2	What are the classes of the classification among the dimensions reported in C1?	
		age
		level of education
		labour market position
		wage
		ethnic/racial origin
		others: …
C3	What are the assumptions regarding future developments of the following characteristics/subgroups?	
		population, age composition
		mortality, fertility
		ethnic/racial composition
		migration
		family composition, marital status
		occupation
		health status
C4	What does the reweighting of subgroups, if any, as an imitation of future developments looks like?	
C5	What are the assumptions regarding the following macroeconomic variables?	
		inflation
		interest rate (short and long term)
		GDP
		wage
		real rate of return
		employment
		real income growth
C6	What does the mechanism ensuring consistency among the assumptions regarding various characteristics / macroeconomic variables look like?	

Simulation properties of static microsimulation models or dynamic microsimulation models with static ageing

MSA1	What are the dimensions in the multidimensional re-weighting matrix	
MSA2	What are the classes of each dimension? (including the option 'continuous')	
		ethnic/racial origin
		migrant status
		education
		marital status
		labour market status
		occupation
		health conditions
		other
MSA3	What are the other components of the re-weighting matrix?	
MSA4	What is the data source of the various dimensions of the re-weighting matrix (possibly specified to gender) and of the projected aggregate controls in the updating process?	
		population, age composition
		gender
		ethnic/racial origin
		migration
		family composition, marital status
		wage
		real rate of return
		employment
		occupation
		inflation
		interest rate (short and long term)
		GDP
		real income growth
MSA5	If re-weighting is carried forward serially in various dimensions: what mechanism (if any) keeps the separate re-weighting processes consistent? examples: - education and employment - education and occupation - education and wages/contributions - marital status and fertility - disability/health and employment	
MSA6	What kind of problems did you face and solutions did you find in the modelling procedure that could be relevant for modellers in other countries?	

Simulation properties of dynamic microsimulation models with dynamic ageing

MDA1	cross-sectional vs cohort/longitudinal	
MDA2	What are the life events modelled: what are the stata in these processes?	
		education
		marital status
		birth, adoption
		labour market position
		occupation
		retirement
		health
		other: …
MDA3	Which processes are simulated via endogenous transition probabilities, produced by logits or probits?	
MDA4	What is the source of the exogenous transition probabilities in these processes?	
		survival
		education
		marital status
		birth, adoption
		labour market position
		occupation
		retirement
		migration
		health
		other: …
MDA5	What kinds of empirical models are used to simulate the values attached to the individual in these processes?	
		survival
		education
		marital status
		birth, adoption
		labour market position
		occupation
		wages
		retirement
		migration
		health
		other: …
MDA6	What is the order of modules in the recursive calculation?	
MDA7	If transition probabilities are calculated separately: what mechanisms keep consistency among them? examples: - education and employment - education and occupation - education and wages/contributions - marital status and fertility - disability/health and employment - other: ...	
MDA8	What kind of problems did you face and solutions did you find in the modelling procedure that could be relevant for modellers in other countries?	

Other questions on modelling

Other questions on modelling

R1	Does the model apply mortality rates differentiated across various stata (disability, marital status, ethnic origin, migrants, type of pension scheme)?
R2	Are migrant workers treated separately?
R3	Can the model address the level of informality in the economy (including measuring the covered wage bill)?
R4	Is the acquisition of pension accruals explicitly modelled?
R5	How are minimum pension arrangements modelled? Are there any necessary simplifying assumptions made? If so, what?
R6	How does the model deal with portability of accruals across national pension schemes?
R7[1]	Is the share of part-time work projected?
R7[2]	How does the model simulate taxes (other than social security contributions)?
R8	Can effects of pension reforms on the social assistance budget modelled?
R9	Does the model allow for parallel work and retirement?
R10	What kinds of empirical models are used to derive behavioural responses in these areas:
	fertility
	labour supply
	savings
R11[1]	What kind of retrospective data regarding contributory history or accumulated accruals does the model use?

[1]*Only standard models.*
[2]*Only microsimulation models.*

Output indicators

Output indicators

O1	What kind of replacement rates can the model produce?
O2[2]	If the model contains household income data: what is the equivalence scale applied?
O3	What kind of poverty measures can the model produce?
O4	What kind of income inequality measures can the model produce?
O5	What kind of non-pecuniary measures of poverty and inequality can the model produce? such as measures of non-monetary deprivation, in particular, in housing
O6	Does the model produce cumulative values such as pension wealth or related measures?
O7	What kind of individual return measures does the model produce? implicit rate of return implicit tax rate payback period other: ...
O8	What kind of aggregate return measures does the model produce? implicit rate of return implicit tax rate other: ...
O9	What kind of sustainability measures does the model produce? - number of future contributors and beneficiaries - number of future minimum pension recipients - future revenues and expenditures - implicit pension debt, net present value - other: ...
O10	What kind of intra- or intergenerational redistribution measures are produced by the model?
O11	Can the model decompose tendencies in aggregate expenditures/ revenues and if yes into what components?
O12	What kind of output or indicators other than mentioned in the previous questions can the model produce?

[2]*Only microsimulation models.*