AVID: Analysis of Old Age Income Structures in Germany

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ABSTRACT

We present the dynamic microsimulation project "Altersvorsorge in Deutschland" (AVID; "Retirement Pension Provision Schemes in Germany"), estimating the future old age income structures of the today middle aged German population. Ordered and used by the German Ministry of Labour and Social Affairs and the German Statutory Pension Insurance (DRV-Bund), AVID is designed to study the future distributional effects of the pension systems given an overall budget rather than analyzing the financial balance. Some research questions: Which households will get reasonable high incomes by accumulating several small pension entitlements, which households are the risk groups? How does the income level depend on the number of children respecting their (typical western German) biography distortion effect on the one hand and the increased children support of the statutory pension insurance on the other?

Often dynamic microsimulation studies process whole artificial biographies from birth to death. However, even though AVID is a microsimulation of the dynamic population type, it is (at parts) more of a complex data estimator for the missing sections of incomplete empirical data. Starting point is a representative sample of about 14.000 persons, of whom three kinds of data were collected: Their pension account data, survey data about their participation in various pension systems and a retrospective diary about their work biography (times of non-employment). The simulation starts at the end of the empirical biography and completes it until the 65th birthday. Subsequently, pension entitlements of seven systems including private schemes and net incomes of the households are calculated. Presuming an overall old age income defined completely at the 65th birthday the result is a cross sectional data set with the future old age incomes on individual and household level for structural analysis.

In this presentation we first give a short overview of the pension systems in Germany. The focus of AVID was minimizing systematic estimation errors. This was taken into account by a complex and customized-to-the-task data collection process which is reported in the second part. Equally important was the statistical methodology to model the different social employment states (SES), the type of self-employment, the working hours and the wage. Not included are models for education level, demographic effects, tax and social contributions, behavioural components, company change and retirement. This reflects the intention to distinguish between model core elements and model extensions on the one hand and – by having reduced the ingoing assumptions – to broaden the core acceptance on the other. Finally we present some exemplary results.

1. INTRODUCTION

The rise of education levels and birth control in the 20th century leads to a population ageing problem for most welfare states, In Europe, the ratio of those of retirement age (65+) to the working-age population (15-64) – the so called old-age dependency ratio – will probably double within the next fifty years. In the year 2000, the over-65s amounted to about one quarter (24%) of the working-age population in Germany; by 2050 it will be more than 50% (Frommert et al. 2009). For social policy planning a sound estimation of future old age income levels and old age income structures is needed. In the middle of the 1990s macro simulation instruments to forecast income levels (including demographic change and various economic scenarios) were well developed and established, whereas a tool to forecast the distribution of the total old age income was missing.

As in other countries the development of a dynamic microsimulation model was initiated, however suitable data sources were as scarce as everywhere else (Harding 1996). In Germany pension systems are usually dependent on employment status; the general component of pension insurance systems is weak. Thus the requirements for highly detailed longitudinal data of the employment situation, wage and pension systems participation to model old age incomes are particularly high. The German Ministry for Labour and Social Affairs had already established a sophisticated survey of older citizens (55+) to analyze the *current* old age income structures in Germany named "Alterssicherung in Deutschland (ASID)" (TNS Infratest Sozialforschung 2005, TNS Infratest Sozialforschung 2009). Now, together with the German Statutory Pension Insurance, they whished to create a dataset of a similar quality to analyze *future* old age income structures of people aged 40 to 59 years (and their spouses). This base line defined the frame of the dynamic microsimulation study AVID:

- a database providing sufficient and highly reliable data lowering the risk of biased results as much as possible,
- accounting for all important pension insurance systems including private schemes, projecting gross and net incomes on person and household level,
- emphasizing distribution effects, focussing on cross sectional results within 5-year-cohorts, and differentiating for sub groups,
- abstracting from macro economic conditions and demographic change as much as possible – while the ability of the instrument to reflect economic changes and financial contribution effects like taxes on the input side is limited, there is an extended ability to model social policy legislation effects on the output side under the same economic frame. (The study is not aimed to be used for analyzing financial balancing).
- distinguishing between the core model, providing the basic data of the biographies (social state, working hour, and wage), and optional models to be plugged in at later times, namely a retirement model. The core is designed to minimize the number of assumptions and to maximize the level of acceptance by a broad range of users, whereas partial models with more individual assumptions can find their place in the plug-ins.
- By its nature the outputs of microsimulations are in situ produced macro statistics and time series. The computer program is the persistent result of the project. On the other hand the goal of AVID is to look into population statistics which is usually done (not only in administrations) by analyzing empirical given static micro data (on person or household level) and large amounts of pivot tables on top. The set up of AVID meets this system and provides a kind of static and obliging micro data set, summarizing the distributional effects.

The simulation core of AVID, called SODSI ("SOcial Dynamic Simulation"), is of the population dynamic type (Harding 1996), aging a set of around 14.000 empirical biographies to their 65th birthday. All models are estimated on the same data sample of Germans aged 40 to 59 years (and their spouses irrespective of nationality and age), contrasting the approaches used e.g. in PENSIM2 (Holmer, Janney and Cohen 2008) and NEDYMAS (Nelissen 1996), but quite similar to SESIM (Flood et al. 2005) or DYNACAN (Gupta and Kapur 2000). In the case of SESIM (which examines the financial side of the pension question) there is a very rich administrative data source called LINDA providing almost all data to estimate a large set of models including real and financial wealth. In Germany administrative data are collected by different institutions without the possibility to link the data bases, which makes it difficult to get a comprehensive picture. Moreover, data of private schemes are usually not available for administrations. On the other hand the restrictions of longitudinal survey data like the "German Socio-Economic Panel" (GSOEP) don't fit the requirements for minimizing biases. Therefore a mixed approach was chosen and data from different sources combined: Data from the individual statutory pension insurance (SPI) accounts offered highly reliable information about the work biography and pension contributions. Additionally survey data was collected containing retrospective information about life courses and working hours as well as detailed information about the participation in other pension insurance schemes. Similar to PENSIM and SESIM the output of SODSI is postprocessed by two modules, one of them calculating the gross incomes from the different pension schemes at the time of retirement, the other computing taxes, social charges and the net income of households.

Following the above listed principles and according to what could be estimated from the data, SODSI does not include an explicit macro economic coupling, demographic effects, tax or social charge calculations during the working biography, a retirement model, a family status model (namely a marriage market model) and does not respect real or financial wealth.

2. OLD AGE INCOMES IN GERMANY

In Germany, old age provision schemes historically developed along different professions and status and are still very fragmented (Frerich and Frey 1993). This section will give a short overview and rough classification but cannot provide in depth descriptions of each system. The most commonly used classification in Germany – as in comparative welfare state research – is according to different pillars: The first pillar comprises obligatory pension systems such as the Statutory Pension Insurance (SPI), the Civil Servants Pension, different schemes for the professions (in German: "freie Berufe") and the Farmers Old Age Pension.[1]

Occupational pension schemes are regarded as the second pillar formed by collective security systems, which can be either compulsory or voluntary. In Germany these are namely the occupational (or company) pension schemes in the private sector and the supplementary insurance for public sector employees. Occupational pension schemes differ considerably – every company has its own and large holdings have several. In general, schemes can be organized in-house (company-based pension schemes, benefit funds) or externally (direct insurance, staff pension insurance, pension funds). In the past, employers had the main responsibility for their financing, but the 1999 Pension Reform Act ("Rentenreformgesetz") enabled employees to make contributions to pension schemes deducted from their gross pay (so called "deferred compensation"). The Public Sector Supplementary Pension (CSS) was introduced as additional pension to the SPI to shift the pension entitlements of public sector employees to a similar level of the one of civil servants.[2] In 2002, the CSS underwent a major redesign. The new version shares more characteristics with an occupational pension scheme, cutting the (formerly generous) entitlements, but offering interesting opportunities for private engagement (also by means of deferred compensation).[3] The major part of the population captured by AVID finds itself in between old and new CSS being affected by a complex transition arrangement.

All private, personal pension schemes are summarised in the term third pillar systems. They are intended to satisfy special pension preferences, but also to compensate for less generous indexing rules in the SPI. In Germany these are mainly private life and pension insurances, including the recently (2002) introduced "Riester" pensions (named due to the former German minister for Labour and Social Affairs, Walter Riester) which are stately promoted by subsidies or by tax-deductible special expense allowances. Other sources of (old age) income such as private or state transfers, rental income or interest from financial assets are not included in the AVID study.

The following table gives an overview of the different systems and their importance for today's pensioners' incomes according to the 2007 survey of the aforementioned study "Alterssicherung in Deutschland" (ASID):

Table 1: Share of different pension systems for gross income of people in Germany aged 65 and older in 2007 (in %)

		Old Länder		New Länder	
		Men	Women	Men	Women
1st Pillar	Statutory Pension System (SPI)	60%	69%	95%	96%
	Civil Service Pensions	16%	10%	1%	<1%
	Independent Professions Pension Schemes	1%	<1%	<1%	<1%
	Farmers Old Age Pension	1%	1%	<1%	<1%
2nd Pillar	Occupational Pensions in the Private Sector	9%	3%	<1%	<1%
	Public Sector Supplementary Pensions	3%	3%	1%	<1%
3rd Pillar	Private Provisions	11%	13%	3%	3%

Source: ASID 2007, authors' calculations

1 As the farmers profession as full time job is declining in Germany since many years, the pension system – in contrast to the other first pillar systems – takes only a small share of the overall old age income.

2 Therefore, Civil Servants Pensions occupy a special position as a combination of the first and second pillar (Frommert and Heien 2006a).

3 Next to this tax relief – taxes at the time people will actually receive the income are lower than during employment – occupational pension schemes in Germany are promoted by subsidies or by tax-deductible special expense allowances, although this kind of promotion is even more important for private pension schemes (see below).

3. DATA SOURCES

In a broader sense, not only the already mentioned pension account data and survey data (including the retrospective diary about work biographies) but also a) the editing of the matched data sets, b) the projection of individual (work) biographies by means of micro simulation, and c) the calculation of (gross and net) old age incomes can be seen as data sources of the AVID. Since the latter two steps are discussed in detail afterwards, in the following we will concentrate on the other steps which are presented in the chronological order of the data collection process.

3.1 Survey data

The first step consists of a detailed mail survey of a representative sample of approx. 14,000 persons. Respondents and their spouses are asked to give in depth information on their current work status, their different provisions for old age and their life courses. For the AVID 1996 a single survey was carried out in 1996, whereas for the AVID 2005 it seemed necessary, in addition to the main survey carried out in 2002, to include a shorter additional survey in 2004 focusing on the newly introduced subsidised occupational (deferred compensation) and private ("Riester") pensions.[4]

The universe of analysis of the AVID 2005 includes the entire population of Germany born in between 1942 and 1961 (and their spouses) irrespective of any entitlements to pensions from the SPI. The sample had thus to be derived from an external source and was in this instance taken from an access panel. As members of access panels can be expected to be experienced and skilled in answering self-administered questionnaires, the interviews were conducted with postal questionnaires in 2002 (n = 13,716) and 2004 (n = 10,132).[5]

Mail survey life course information in the AVID 2005 stems from two sources: Firstly, in the 2002 survey respondents were asked to list their complete (work) biography from the age of 15 to the present by means of a retrospective diary, i.e. by naming and locating chronologically the different episodes of their working life. To facilitate respondent's work (and enhance the validity of the answers), 23 possible answers indicating phases of employment and non-employment were specified. It should be mentioned that the life course information was only one part of a complex questionnaire and no specific life course instruments to reduce recall errors (like the life history calendar (Freedman et al. 1988), or the recently developed TrueTales instrument (Matthes, Reimer and Künster 2007) were used.

Secondly, many questions of the 2002 and the 2004 surveys contain information on special phases of the life course, e.g. times of part time employment or civil service employment. This information was used in the data editing process for consistency checks but also to fill gaps in the matched life course dataset if necessary.

3.2 Pension account data

In a second step – in cooperation with the central data management of the German SPI ("Datenstelle der Rentenversicherungsträger"; DSRV) – the individual pension insurance accounts of the AVID respondents were clarified by the (federal or regional) institutions which manage the accounts.[6] The clarification process overall took about 18 months since in some cases several gaps in the accounts had to be "filled". This usually involves the respondents delivering adequate documents, and it is the same process insured persons go through before the start of their pension payments. It is a procedure that results in very high data quality as mistakes which occurred during the standard data reporting process can be detected and corrected.

[4] For the survey questionnaires of the AVID 1996 and 2005 please refer to the website of the project: www.altersvorsorge-in-deutschland.de.

[5] For a description of the differences and innovations in the study design of the two AVID studies, please refer to (Frommert and Heien 2006b, Heien 2004a, Roth, Stegmann and Bieber 2002).

[6] In the AVID 2005, 12,728 of the 13,716 respondents have an SPI account. For details of the clarification process and the institutions involved see Heien (Heien 2004a, Heien forthcoming).

3.3 Data editing

These two datasets – the data from the two mail surveys and the pension account data – were then individually matched with the respondents' consent and checked extensively for consistency. Because of the high validity of the administrative data, the aim of the data editing process was mainly to fill possible gaps in the individual pension accounts.

This task was carried out by a specially trained editing group of ten persons and took about 20 months.[7] The data of each respondent was checked for more than 1,000 possible errors resulting in an average of 6 to 7 errors per respondent. If necessary, editing problems were solved by additional telephone interviews with the respondents. Telephone interviews were also used whenever possible to retrieve missing information (Heien 2004b, Heien forthcoming).

4. SODSI

Like for every dynamic microsimulation it can be looked from four different sides into the modelling question: a) the statistics side, b) the simulation side, c) the technical side, and d) the results side. In many articles (Falkingham and Harding 1996, Nelissen 1996, Werf, Sonsbeek and Gradus 2007) and documentations (SESIM (Flood et al. 2005), PENSIM (Holmer, Janney and Cohen 2008)) the focus is located on one or more points out of the last three, but statistics is treated less extensively, which may be justified by the particular focus on analysis more on the macro side. However to the developers of SODSI the major challenge of the AVID specific task seemed to be the statistical one. Working biographies are extremely (non linear) dynamic systems with many constraints to the whole compound of economic, social, psychical and rational structures human life is made of. How to get an estimator for the missing part good enough to find the overall working participation of some hundreds of population segments within an error range of 5% or less?

Following this orientation we give at first a short overview about the technical steps and scheme before coming to the central issue of parameter estimation, calibration and validation.

4.1 The microsimulation process

Technically, the biography data had to be fused from three different sources: from the SPI account data, from the data of diaries the interviewed persons filled out, and from the cross sectional survey data including some biographical information, e.g. working hours or marginal employment times (Fig. 1). These data are synchronized into a database containing all biography related information on the same scale of biography months (1 to 624, starting at January before the 14th birthday) and all time independent information. For several reasons no standard database management system (DBMS) software was used, instead a customized inline system was developed within the project.

There are three models within SODSI: a) The SES model for the social state, b) the model for working hours, and c) the wage model. The SES model was seen as the most important one. Hence we did several studies mainly to solve SES model estimation problems concerning left censuring, time dependent covariates and the possibility to combine a separate freelancer SES model with the general model. Further a calibration method, which can use macro time series as source to correct the model parameters of micro models was contrived.

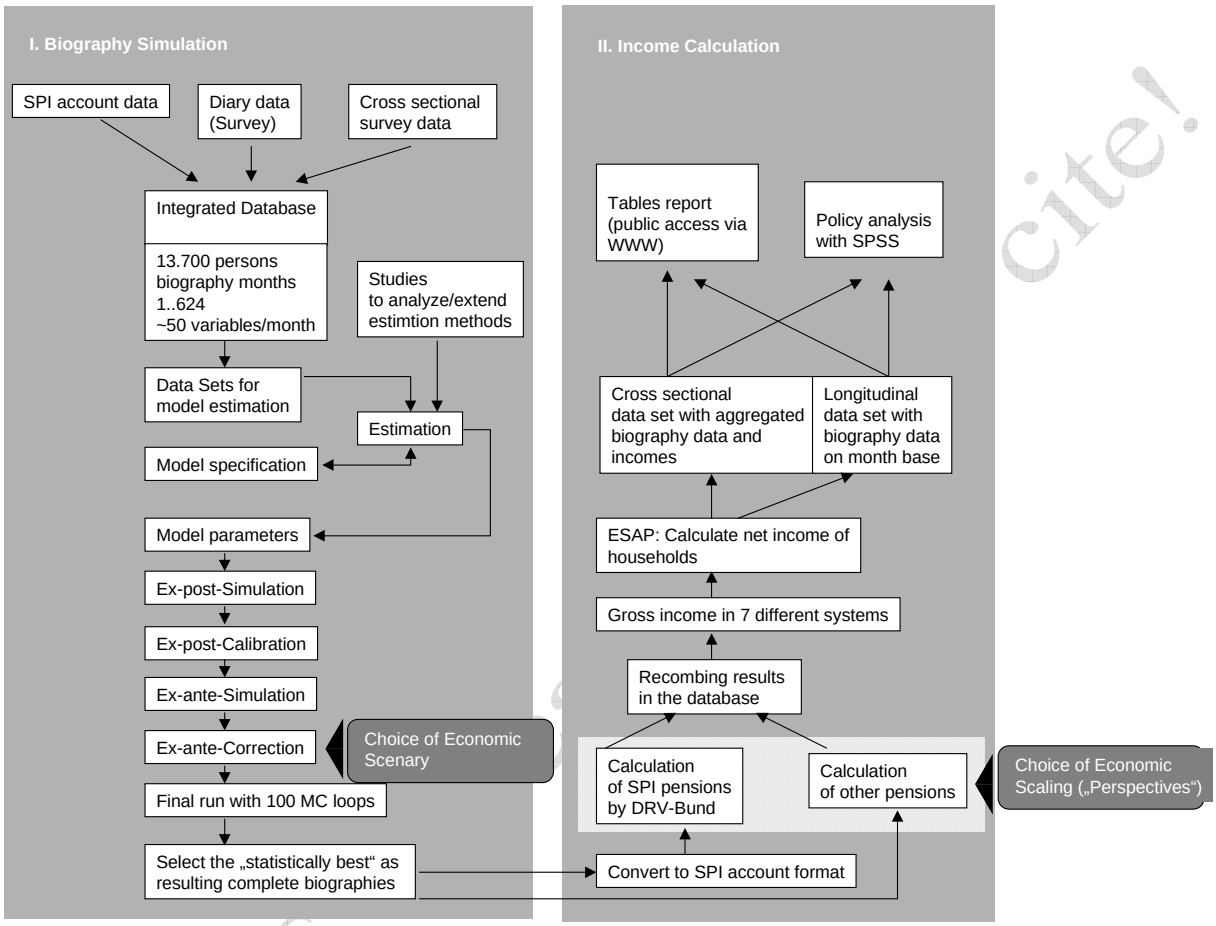
With the new methods the covariate structure of all models were specified. The base interval for the parameter estimation of most models was the interval from 1992 to 2001. In the ex-post-simulation the biography data of this interval were reproduced, starting with January 1992. The calibration method was applied to the differences.

Though intended, AVID could not be fully shielded from macro economic issues. The model parameters reflect the macro economic situation of the base interval. SODSI projects the economic tendencies of the 1990ies to the 21st century. Whereas for western Germany this may be the maximal neutral default scenario, it is clear, that the newly-formed states were in a transition phase. The economic conditions of the next 20 years to be the same as today this assumption is not considered a neutral one for eastern Germany. This point was taken into account by requiring certain similarities between *future* and *present* biographies assuming the economy of eastern Germany not to go further straight in the direction of the past.

[7] Since many pension insurance accounts could be clarified quickly, the work of the data editing group could already start when the clarification process hadn't finished completely.

Several articles (SESIM, PENSIM) mention the problem of Monte Carlo variance within simulation tests of policy parameters. It is solved if the policy test is done with the *same* simulated biographies. However it is a kind of contradiction in se to gain single data sets out of a Monte Carlo study trying to minimize its variance by increasing the number of its loops. This contradiction cannot be solved, but with appropriate methods it is possible to choose a biography out of the Monte Carlo swarm, which lowers the overall variance fairly below the no-loop-at-all level.

Fig. 1: Biography simulation and income calculation



Source: Authors' description

In the first AVID (1996) the accurate calculation of the SPI incomes turned out to be a difficult task. Therefore, in the 2005 version this was done by the SPI administration (Deutsche Rentenversicherung Bund) itself. The returning results were integrated in the database, together with the calculations of the other pension systems.

The module ESAP, the long term established net income calculation tool of TNS Infratest, was applied to the gross incomes computing taxes, social charges and net incomes. For AVID ESAP had to be modified in order to account for the different scaling of tax and social charge parameters in future years.

All results are collected in order to enrich the biographies and personal data in the database. Subsequently the researcher is able to analyze the relations between old age income patterns, biography pattern and provision contribution patterns. Technically this can be done by several ways:

- Writing the analysis programs in C++ natively accessing the database.
- Extracting data on the way of a simple BASIC-program.
- Using a longitudinal SPSS extract of the database, which contains the most important biography variables.
- Using the cross sectional SPSS dataset with aggregated biography data (e.g. number of months spent in the different social states), most of the answers from the survey and all income data.
- Gathering information from the table report (~10.000 tables, public access over World Wide Web.)

The two parts of the process – simulation (SODSI) and income calculation (ESAP) – are used separately. Simulations can be done without including income calculations and different income calculations can be processed on base of the same simulated biographies.

4.2 Scenarios and perspectives

Base line and positive labour market scenario

As previously mentioned, there is no single correct economic projection into the future if economic systems in the near past are not in equilibrium – even putting aside certain macroeconomic parameters like interest rates and all irregular events and impacts. Therefore, some assumptions have to be made about the future of the labour market, working participation, the weekly working time (of western German women), and the earning levels. Two sets of such assumptions were bundled in two scenarios, affecting foremost the economic development of the New Länder. The biography consistence (How much time was spent in average in which social state? How much was earned in average?) was used as correction criterion. In the first ("base line") scenario the parameter corrections were chosen along the base line, that average personal employment durations, unemployment durations, illness durations, etc. in the future have to be roughly the same proportions as between 1992 and 2001. In the second scenario the future average unemployment part of the biography is decisively shorter than during the base interval 1992 to 2001. Similar corrections were done to the income model. Therefore the latter scenario is called "positive labour market".

Later retirement scenario

A third scenario aims on estimating effects of a later retirement at 67th birthday according to the SPI Age Adjustment Act ("RV-Altersgrenzenanpassungsgesetz") from 2007. Technically that would be easily done by just running the simulation two years longer. However this was considered to produce misleading results since the models would exaggerate age effects when applied to ages above 65. Hence a copy procedure was preferred: just double a 2-year-interval within the biography.

"Riester" participation scenario

Finally, the fourth scenario varies the participation quote to the newly introduced subsidised "Riester" pensions. At sampling time (2002/2004) the participation was still low but growing fast. The scenario assumes fixed participation quotes (50%, 100%) and makes simple assumptions about the corresponding fictive contracts.

Perspectives

Another set of open parameters controls the calculation part of AVID (Fig. 1). Since SODSI runs only statistical micro models without any macro coupling and does not include any behavioural component, general economic indicators like growth, interest rates or inflation can initially stay aside. Only when calculating the old age incomes from the different provision systems, all with their individual financial setup, economic indicators were introduced as scaling factors applied to each resulting amount. All scaling factors were gauged along the SPI. (Factor 2 would mean: Nominally doubled growth compared with SPI incomes). Firstly the incomes are upscaled with the system specific factor to the nominal income at the 65th birthday (set AVID retirement age). Secondly all incomes are downscaled with the same factor to the year 2005 to enable the comparison of values anchored nominally at different points in time.

Two different downscaling factors were applied to meet two different aims of the study. The first one uses the SPI growth ("standard perspective"). Thus you can see the proportions among the different systems in terms of 2005 values. The second uses an assumed gross wage growth. Thus you can see the proportions between the old age income components on one side and the future gross wage levels on the other side supporting the consideration of inequality and relative poverty tendencies ("participation perspective").

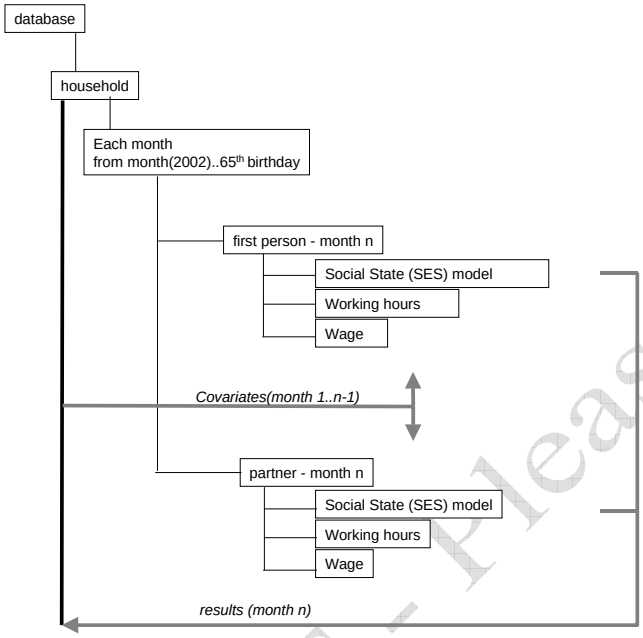
4.3 Biography simulation setup

The simulation setup is a longitudinal one. All models refer to a common covariate database, which provides three types of covariates for month *n* (*n* to be chosen out of the time interval 2002 up to 65th birthday):

- time independent covariates
- aggregated time dependent covariates related to the whole biography in the past (or to parts of it).
- time dependent covariates related to the preceding month.

No access was given to the data of the current month to avoid problems with the sequence of the single modules. To refer to the current situation of the partner means referring to month *n-1*of the partner. The process is illustrated in Fig. 2:

Fig. 2: Biography simulation



Source: Authors' description

4.4 Social state model

Each person in each month with empirical data has one of 13 social employment states (SES states): Education, Caring (for elderly family members), Household, Illness, Unemployed, Employed, Pension before 65, Self-employed, Civil Servant, Marginally employed, Regularly Employed, Disability and Miscellaneous state. We call this the state i of the SES $s_k(t)$ for person *k* in time *t*. In each *t* a transition to another state j may happen. The transition probability $q_{ij}(t)$ of the 13 x 12 transitions is described by a parametric multi-state multi-spell hazard rate model estimated on the data from 1992 to 2001. In AVID almost all persons simulated are at least 40 years at start hence spells covering education times are not required for the estimation. Since the estimation of all model in AVID are done separately for four groups (separation by gender and old/new Länder) the number of spells for many transitions is very low. On the other hand these transitions are not the important one. Hence the model is only equipped with covariates for the important transitions. As an example here the models with covariates for the women of the new Länder:[8]

[8] In the example you see no "self-employment" since this state was modelled additionally in a separate model.

Table 2: Social state model for the women of the new Länder (transitions, which were modelled with covariates)

Source state (t_n)	**Target state** (t_{n+1})
Household	Regularly employed
Ill	Regularly employed
Ill	Pension Disable
Unemployed	Marginally employed
Unemployed	Regularly employed
Unemployed	Pension Disable
Marginally employed	Unemployed
Regularly employed	Household
Regularly employed	Ill
Regularly employed	Unemployed
Regularly employed	Pension Disable

Source: Authors' description

The first estimations were done with a preselected set of covariates out of the common pool of around 100 covariates. From these around 30 covariates the significant one (level 10%) were taken and the estimation were done a second time. The significant covariate set for a transition from Regular Employment to Unemployment looks like (covariates like "salary of the partner" or "preceding lifetime in household of the partner" didn't show up significant):

- Education level
- Job position
- Age
- Has child
- Number of children
- Preceding lifetime in unemployment
- Preceding lifetime in regular employment
- Salary of the last 12 months
- Has partner
- Education level of the partner

Generally, we encountered four challenges:

1) Usually for hazard rate models only time independent covariates may be used. For the biography dynamics this restriction does not allow a powerful model.

2) Data may not be complete. Gaps result in left censured spells. But methodology to deal with left censuring is sparse (in general we follow Rohwer 1999).

3) In the AVID sample the age distribution at sampling time is flat. Hence the higher the age the lower the number of transitions we have in the sample. Foremost this affects transitions to incapacity, which happen frequently above age of 55, but seldom below.

4) "Self-employment" in Germany may happen in very different forms concerning the age provision systems. There are occasionally freelancers without any regular provision, there are farmers with a state-run pension system (ADL) but quite low pension level, there are lawyers and pharmacists with a compulsory high level pension system, there are craftsmen with a mixed insurance state between self-employed and employee. One of the aims of AVID 2005 was to find an adequate representation of these differences.

Point 1) was solved by spell splitting: Each spell was split in pieces of two months. This allows for time dependent covariates whereas the increase of right censuring does not affect the estimation. Secondly as optimization procedure we used the downhill simplex method, which improved greatly the convergence stability. However both measurements increased computation time heavily. On a 2-CPU-workstation estimation of all base SES models needed 20 hours.

For point 2) we did some Monte Carlo simulations, which showed, that an iterated estimation procedure with gaps filled by model simulations estimated in the previous loop reduces left censor errors by a factor of ½.

Point 3) could not be compensated by methodology. Unfortunately for higher ages the transitions are more important for the simulation, but there are fewer transitions in the sample. All we could do was to reduce the covariates of the disability models to age and age square. (Gender and New Länder are anyway respected by separate estimations).

Point 4) requires some considerations. Out of question was a case consuming extension of the SES model by three additional states, splitting the 4 x 24 possible self-employment transitions into more than 4 x 100. Instead the question was divided in several parts:

- four self-employment categories (SEC) were defined.
- if the SEC is known, the question of transitions between self-employment and non-self-employment is answered by the SEC-transition model before the general SES model is applied. Otherwise transitions in self-employment are non-specific element of the general model.
- if the SEC is empirically unknown and the person enters self-employment the first time, a SEC state model is applied.
- if somebody leaves self-employment a SES-entering model determines the following SES.

In this way only 40 additional models had to be estimated, not 300.

4.5 Working time model

In Germany part time working is a strong component of female working behaviour. Whereas in the former GDR and shortly after the reunion most mothers in the new Länder continued to work full time after a one year baby break, the share of female part time workers in the eastern parts grows continuously. Overall the number of part time employees in Germany has increased by 40% since 1994 (Bundesagentur für Arbeit 2009).

For modelling weekly working time there are some issues to consider:

- The distribution of weekly working time in Germany is naturally quite heterogeneous: The biggest share shows full-time employment which was set to 39 hours. There are other peaks at multiples of 5 hours: 15, 20, 25, and 30 hours. Thus a simple metric regression approach does not seem promising.
- The weekly working time data originated from the survey and were asked only for times of employment. Hence the model does not include times of self-employment.
- For the estimation of pension entitlements it is generally sufficient to know the sum of months spent in a certain working time category (and the corresponding income effects). However the aim of the project was to get a reasonable working time history including plausible spell lengths for each person.

Since the most robust models to represent spell structures are models of the survival class, we decided to use again hazard rate models (taking the advantage to use the same simulation module as for the SES base model). They can show the working time history during an employment period. But they can't at start of the employment. There would have been the option to ignore all non-employment times taking the employment spells as one uninterrupted continuous process and employment interruptions just as covariate influences. That would mean to relate the *duration* of a partial time period within the preceding employment to the partial time decision of the present employment even if there were 10 years of non-employment in between – not acceptable to our opinion. Therefore we took a compound model on partial time category. The first part describes the partial time decision at employment start (entrance model), the second part (hazard model) the transitions during the employment.

Table 3: Working time entrance model, example of estimation with all covariates
(Multinomial logit model with target "Partial time 15 to 20 hours a week")

	Women Old Länder			**Women New Länder**		
Number of observations (employment entrance events):	18,793			11,039		
	Coeff	Err	Sig	Coeff	Err	Sig
Constant	**-10,0578**	0,3491	0	**-12,6637**	1,4692	0
Birth year	**0,0660**	0,0050	0	**0,0643**	0,0185	0,0005
Age	**7,6255**	0,9218	0	**9,4559**	2,8362	0,00086
Before employment start: household	**0,3712**	0,1050	0,00041	**1,3442**	0,2780	0
Length of preceding unemployment period in months	**4,6025**	0,5751	0	2,1159	3,7201	0,5695
Has child	**2,3928**	0,1565	0	-0,2253	0,5421	0,67769
Number of children	**-0,2133**	0,0436	0	0,0393	0,1212	0,74553
Age youngest child	**-10,0598**	0,7768	0	-1,4128	2,1709	0,5152
High school degree	0,1329	0,1913	0,48722	-0,4153	1,8631	0,82361
Job position "Basic Blue or White Collar position"	**0,5027**	0,0760	0	-0,1403	0,2542	0,58098
Job position "Basic Blue or White Collar position"	**0,4336**	0,1112	0,0001	0,0944	0,4028	0,81477
Job position "In education"	**0,2125**	0,0735	0,00384	-0,1483	0,3131	0,63586
Job position "Technician"	0,1399	0,2456	0,56905	-9,7063	148,9000	0,94802
University degree	0,2496	0,2803	0,37331	-0,0180	1,8795	0,99235
Months spent in employment until now	-0,1620	0,8909	0,85571	-3,1746	2,2006	0,14913
Months spent in household until now	**5,8056**	0,9550	0	5,3332	3,6868	0,14802
Months spent in employment until now	**-6,8729**	2,4125	0,00439	-1,2989	7,5397	0,86322
Has partner	0,0711	0,1326	0,59175	**1,1796**	0,6303	0,06129
Partner has high school degree	-0,0654	0,2170	0,76323	0,1333	1,8890	0,94372
Partner "Basic Blue or White Collar position"	0,0844	0,0930	0,36445	0,2496	0,2940	0,39593
Partner "Higher Blue or White Collar position"	**0,2741**	0,1052	0,0092	0,5782	0,3533	0,10177
Partner "Technician"	-0,1737	0,2795	0,53436	10,0569	148,9000	0,94615
Partner University degree	-0,0763	0,3102	0,80559	0,5028	1,8863	0,78981
Months partner employment until now	**-1,2064**	0,4384	0,00593	-1,4898	1,4250	0,29582
Months partner household until now	-4,9395	10,4800	0,63741	-218,7049	234,1200	0,35023
Months partner employment until now	**-5,6941**	2,8008	0,04205	-15,7908	12,3060	0,19944
Current wage	**-0,5965**	0,0985	0	**-2,5366**	0,4372	0
Average wage of the partner last 5 years	**0,2078**	0,0636	0,00108	0,2116	0,2381	0,3742
Partner: preceding SES was "unemployed"	**0,4563**	0,1119	0,00005	0,3971	0,3763	0,29127
Partner: Preceding SES was "marginal"	**0,4577**	0,1281	0,00035	**1,9068**	0,4682	0,00005
Was employed	**0,5191**	0,1811	0,00414	**2,9817**	0,7949	0,00018
Partial time duration life time until now	**17,8925**	0,9703	0	**9,4375**	2,0998	0,00001

Source: AVID 2005, authors' calculations

Altogether the statistically profound estimation of the whole compound model would require controlling selection effects as well as covering both models in a simultaneous estimation. To do that would have exceeded time resources leaving the area of standard estimation procedures. Instead we preferred to control the results carefully by ex-post simulations (see later chapters).

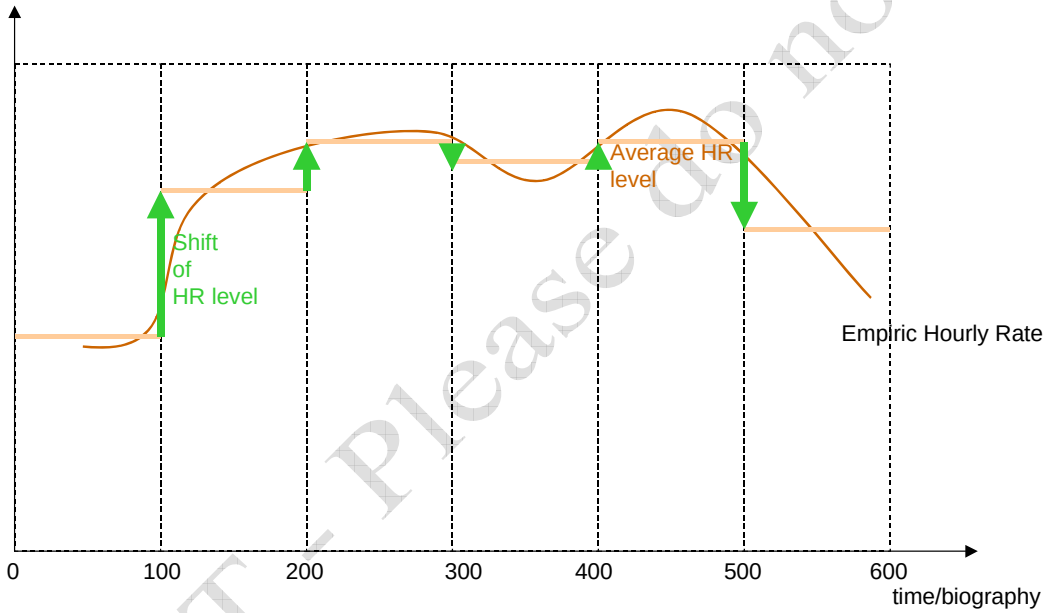
4.6 Wage model

Wage modelling has a long and broad history in econometrics. However AVID required a particular solution. Whereas in most cases the wage model is developed stand-alone and target wage is measured on a monthly or yearly base, in AVID the wage model has to connect to the SES and working time model as well as to the empirical wage at sampling time. Thus the task was reduced to model the earnings level of employments times in terms of the hourly rate.

The greatest challenge was to extract the empirical hourly rate from the data. In a first step the income from the SPI accounts was transferred to a daily base. However in some professions the job is more or less only formally registered as employment and the registered days of work are distributed quite unsteadily, hence huge hourly rates are created. Only after applying an algorithm which corrects the dates reported in the survey and by implementing a time series filter to smooth artificial peaks a clear definition of the hourly rate could be pinned down.

Hourly rate (HR) is not a quick changing value. The biography was divided into six parts providing six average hourly rates for these periods (Fig. 3). Since most of these values for most of the biographies are given empirically we decided to model the HR shifts in between these periods. With the shift between the values as target variable, 4 x 5 wage models were estimated.

Fig. 3: Setup of the wage model



Source: Authors' description

As the HR shifts show normal shaped unimodal distributions, a linear regression was regarded to be sufficient. Resulting coefficients show strong influences of school education level and professional status – the higher the status the greater the expectation to uplift his hourly rate.

4.7 Calibration and validation

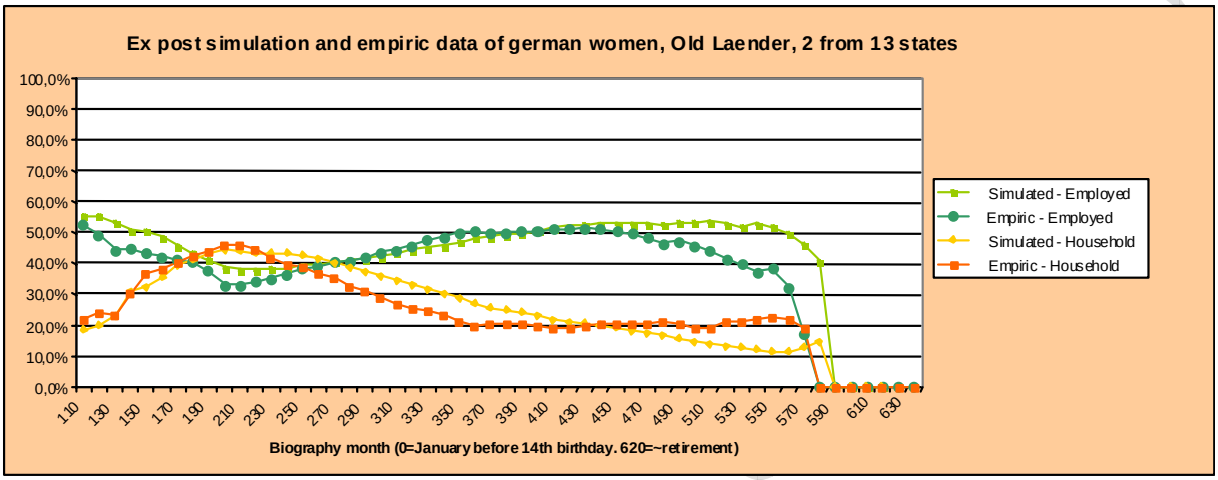
Validation is always a delicate chapter for simulation studies. In theory these are the potential methods:

- Comparison of empirical and simulated data within the training interval ("Ex-post-validation"). The simulation should be able to reproduce the data it was estimated against.
- Splitting up the data set in two parts, one using as training set and one as test set as used to do in data mining if the sample size is large enough. ("Test set validation")
- Splitting up empirical time ranges using the first as training set and the last one as test set. ("Ex ante validation")
- Comparison of ex-ante-simulations between different simulation projects

Ex-post-validation

Usually the first method has an ambiguous character as it is the only way to fit the open parameters. In case of SODSI the parameters of the partial models are estimated statistically. Thus a true ex-post-comparison makes sense even though the correlation will not be perfect due to the fact that all partial models were estimated separately and many statistical effects (e.g. Heckman like corrections) could not be respected. Fig. 4 shows the social state quotes on the vertical and age ("biography month") on the horizontal axes. Dark colours are empirical data, light colours simulated data. Women of the old Länder have the most difficult dynamics of all four segments.

Fig. 4: Not calibrated ex-post-simulation for German women, Old Länder (each biography was simulated 30 times)



Source: AVID 2005, authors' calculations

Even though the simulation system is highly non-linear the agreement between empiric and simulated data without any fit was not too bad. However at higher ages the simulation numbers tend to diverge in particular for unemployment and marginal employment and for cases of the New Länder. This is caused by overlays of economic unemployment and retirement regulations for unemployed, which are not easily disentangled into socioeconomic effects and pure retirement effects. One way was to alter the unemployment state operationalization, the other way to adapt the simulation to some movements in the empiric data which are not reflected by the statistic models. This latter step called "calibration" was adopted and applied not only to unemployment, but to the whole social state model and to the wage model as well. The goal was to fit the relationship between the target variables and age to the empiric data (and therefore to the situation 1992 to 2001) without changing much in the relations to all other variables.

Muzuqu

Fits of microsimulations to macro time series have their own sensibilities, even more so if such an overall fit interferes with statistical estimations: How to avert the fit algorithm running into non-realistic states destroying all carefully estimated structures? The social state (SES) model was a particular challenge in this regard. At least the central characteristics of the system, the period lengths, are to stay invariant. Further there are computing costs: One good run of SODSI needed around 10 hours on a dual opteron machine in 2005 . Each method with repeated iterations then demands days and weeks of computation for one calibration - a death sentence to flexible scenario computations.

The basic idea of the fitting method "Muzuqu"[9] developed for AVID 2005 is to remodel the whole system under simplified conditions (no covariates at all), but with a time (age) dependent correction function and the constrain to fit the empiric macro quotes (or averages) at each point in time. The Master Equation (Haken 1977) connects hazard rates and macro quotes together:

[9] A German abbreviation, translated in English as "**Mu**lti **St**ate estimators under constraints of empiric **Quo**tes".

$$\frac{\Delta Q_i(t)}{\Delta t} = \sum_{i \neq j} \left[r_{ji}^0(t) + k_{ji}(t) \right] Q_j(t) - \sum_{i \neq j} \left[r_{ij}^0(t) + k_{ij}(t) \right] Q_i(t).$$

$r_{ji}^0(t) = \text{ML - Estimator of the transition } j \text{ to } i \text{ at } t \text{ without covariates.}$

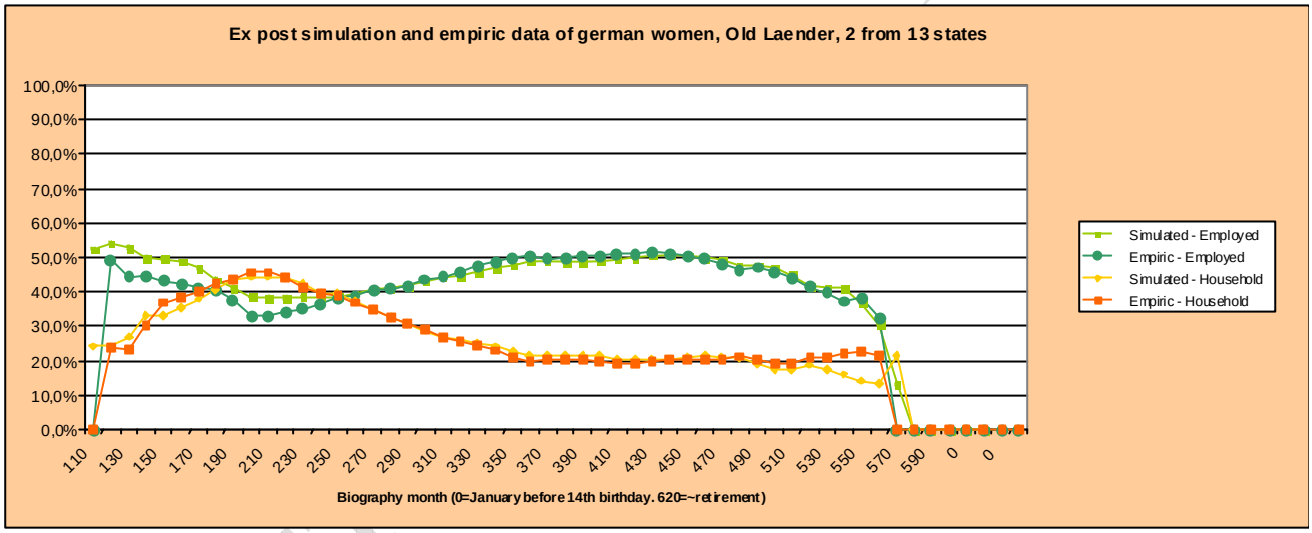
$k_{ji}(t) = \text{Correction of the transition to fit } Q_i(t)$

$Q_i(t) = \text{Macro quotes of social state } i \text{ in } t$

$t = \text{Age (in months : 0..623)}$

The approximation task of the $k_{ji}(t)$ can be transformed to a linear equation system for each t so that the whole approximation of all states, transitions and segments is solved within minutes. A second equation system cares for the period lengths. So far the theory. In practice the SES model is much more complicated in respect of the model structure and in respect of the deterministic constraints. For the sub models for self-employment states there is no point to pin down the effective transition rate - and therefore no point to apply the correction. Deterministic corrections are done by preventing transitions, which may happen statistically, but are known to be impossible in future by legislation. Even only small corrections have a worse effect by misleading the approximation into the wrong direction. With some modifications of the Muzuqu method, of the application procedure and the simulation procedure these difficulties could not be eliminated, but reduced to an acceptable size.

Fig. 5: Muzuqu-calibrated ex-post-simulation for German women, Old Länder (Parameters chosen as in the uncalibrated case)



Source: AVID 2005, authors' calculations

5. OLD AGE INCOMES

One of the most important tasks of AVID was to capture not only the SPI incomes, but all important pension systems in Germany to study accumulation effects on person and household level. Although the most important employment biography data and many participation parameters of all systems were available from the survey, the feasibility to calculate pension entitlements on a personal level varied considerably from system to system. Where such a calculation was not possible on the basis of the survey data, the income was obtained by a statistical estimation based on the results of the survey "Alterssicherung in Deutschland 2003".

The following Table 4 gives an overview of the different methods used for each system:

Table 4: Calculation of entitlements for different pension systems

Pension system	Method applied
1st Pillar	
Statutory Pension System (SPI)	The SPI account data were complemented with the simulated biography data and the pension entitlements were calculated by the SPI administration itself.
Civil Service Pensions	All regulations were implemented rule based, the most challenging part was the reconstruction of the position and salary level career from the survey data.
Independent Professions Pension Schemes	Since the system is split into many different bodies and regulations the entitlements were estimated based on the membership duration (biography data), the survey data and data of ASID 2003.
Farmers Old Age Pension	The regulations of the system – taking only a small share of the overall old age income – are relatively simple and could be implemented easily.
2nd Pillar	
Occupational Pensions in the Private Sector	To estimate the conventional pension types a statistical model was built. It relates several covariates like sex, professional status, educational level, industrial sector and the expected magnitude of income based on ASID 2003 data to the pension entitlement. The new types could be calculated rule based along the constraints given by the biography and the survey data. For three types existing modules of other pension schemes were used whereas the deferred compensation required a new module on its own.
Civil Service / Public Sector Supplementary Pensions (CSS)	All regulations were implemented rule based: The old CSS, the new CSS and the transition regulations including the controversially debated "Startgutschrift", an approximation method for the SPI entitlements.
3rd Pillar	
Private Insurance Schemes	It is generally assumed that the participation in the different pension schemes will not change during the simulation, only the contributions may be interrupted. That is plausible for all schemes apart from the third pillar ones. Private insurances can be started fully independent of the employment status and they can also be sold. This is most relevant for the self-employed who are not included in the SPI and then might lack the financial resources to buy a private insurance. With the AVID survey data for self-employed a private insurance (life insurances[10] and private pension insurances) participation model called PRIVES was implemented, estimating the inclines or declines of entitlements when a change in self-employment status occurs. In the survey information about the insurance contracts was gathered, however, rather than using all these variables only two were used: time and size of payout. Since most private insurance contracts are a creative mix-up of various insurance services, estimation from contributions is nearly impossible. In case the payout was given as a single payment they were converted to a monthly (life-long pension) payment. Two questions are central for the new "Riester" pensions: Who participates and to which extent? The second wave of the survey in 2004 was specially designed to gather information on these newly introduced products. For the contract data of 2004 and on the base of the employment biography the Riester entitlements could be calculated along the corresponding laws and regulations[11] As the survey in 2004 could only capture the beginnings of a trend, some additional scenarios were calculated: • participation remains the same as in 2004, • 50% of all qualified for benefits participate in 2005, • 100% of all qualified for benefits participate in 2005.

Source: Authors' description

[10] In Germany life insurances happen quite often to be coupled with savings and capital investments components. Hence we distinguish between "risk life insurances" (only insurance) and "capital life insurance". In this article we address only the latter.

[11] Altersvermögensgesetz (AVMG) and Einkommenssteuergesetz (EStG)

6. TECHNICAL ISSUES

The AVID software runs under Windows and Linux. It is written in C++. Under Windows there is a DLL application interface to allow access from other programming languages, e.g. from MS Visual Basic or Visual Basic for Application (VBA). There is already a simple interface to read data from the database and to run the income calculation with a few BASIC-commands (VBA compatible).

Runtimes (for Dual processor Opteron 1,8 GHz, 2 GB RAM):

1) Estimations for all models: Around 20 hours, with left truncation iteration several days.
2) Calibration: Around 30 minutes.
3) SODSI (Biography Simulation): Around 10 hours with 100 biographies per person.
4) Income Calculation: Around 40 minutes.

Simulation and income calculation can be run for any subset and runtime is reduced proportional to the subset size.

7. SOME RESULTS

The standard reporting of the AVID results includes a detailed report and an extensive number of summary tables which can be accessed via the website of the project (www.altersvorsorge-in-deutschland.de). In this paper we only describe a few examples of how results might be presented and used in the policy discussion. Results are usually presented for four different groups: Men living in the old Länder, women living in the old Länder, men living in the new Länder and women living in the new Länder.[12] This is due to the fact that the circumstances and work histories – at least for the AVID cohorts – are still substantially different according to gender and region and result in different situations concerning old age incomes.

7.1 Entitlement to benefits and gross/net incomes

Table 5 shows the percentage of people entitled to certain pension benefits for the above mentioned groups. The coverage of the SPI in these cohorts is near universal in the old Länder (95 % for men and 98 % for women), and even reaches 100 % for both, men and women, in the new Länder. The only group to reach a reasonable coverage regarding other first pillar systems are men in the old Länder (14 %). The reason for this pattern can be found in the labour structure of the two regions in Germany: Whereas in the new Länder all entitlements were transferred to the SPI in the unification process and women were to a large extent participating in the labour force, the different historically developed other systems are still in place in the old Länder. These included mainly male labour force participants while women generally stayed at home more often (so called “male-breadwinner-model”; Lewis 1992). Also with second pillar systems, the percentage of respondents with entitlements is highest for men in the old Länder (46 %). Almost a third of the women in the old Länder do also have entitlements in an occupational pension system, and roughly a fifth of the Germans in the new Länder. The occupational pension systems were introduced in the new Länder from the 1990ies only, so that widespread coverage as in the old Länder could not be expected for these generations yet. Over 60 % of the population can expect old age incomes from private third pillar provisions, the only exception being women in the old Länder where the coverage only reaches 51 %. Also, around two thirds of the people in the old Länder own their homes and will not be burdened by paying rent. This is only true for a lesser number, around one half, of the people in the new Länder.[13]

Looking at the gross and net old age incomes in Table 5, it should mainly be noted that men (old Länder: 1,628 €; new Länder: 1,142 €) generally have higher old age incomes than women (old Länder: 882 €; new Länder: 996 €), with this pattern being a lot more pronounced in the old Länder (185%) than in the new ones (115%).

[12] The distinction of old and new Länder refers to the part of Germany the respondent lived in at the time of the first survey in 2002.

[13] Note that the information about home owners was additionally collected in the survey but no imputed rent was included in the calculation of the old age incomes.

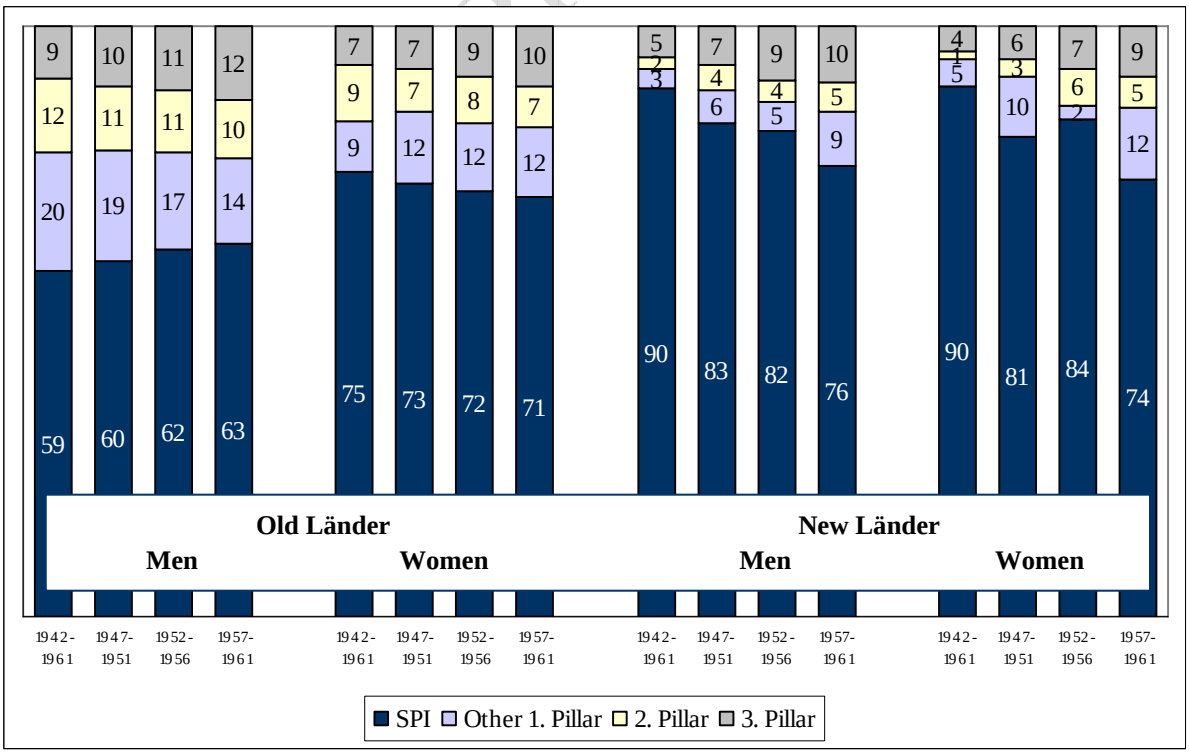
Table 5: Future pension entitlements of Germans, birth cohorts 1942-1961 (in % and in €/month)

	Old Länder		New Länder	
	Men	Women	Men	Women
SPI	95%	98%	100%	100%
Other 1. Pillar	14%	5%	3%	4%
2. Pillar	46%	31%	18%	22%
3. Pillar	64%	51%	61%	64%
House Owner	68%	66%	50%	52%
Gross old age income	1,820 €	882 €	1,142 €	996 €
Net old age income	1,628 €	816 €	1,036 €	909 €

Source: AVID 2005, authors' calculations (n = 12,218)

Fig. 6 presents the contribution of the different pension schemes to the total volume of old age income as a trend over 5-year-cohorts. The importance of the SPI only increases, however slightly, for men in the old Länder. In all other groups its importance declines, in the new Länder substantially from 90 % for men and women to 76 % and 74 % respectively. In the new Länder the other systems – other first pillar systems, as well as occupational and private schemes – generally gain in importance over the cohorts. In the old Länder this is only true for the private third pillar schemes, the second pillar schemes rather loose importance slightly (2 %-points from the oldest to the youngest cohort). Other first pillar schemes loose importance for men in the old Länder and gain importance for the women. This is mainly due to a high proportion and high old age incomes of (male) civil servants in the older cohorts. On the whole the trends for the different groups seem to converge: for the younger cohorts the patterns of men and women and the two different regions are strikingly similar accounting for the different starting points and life circumstances.

Fig. 6: Overall share of different old age provisions (in %)



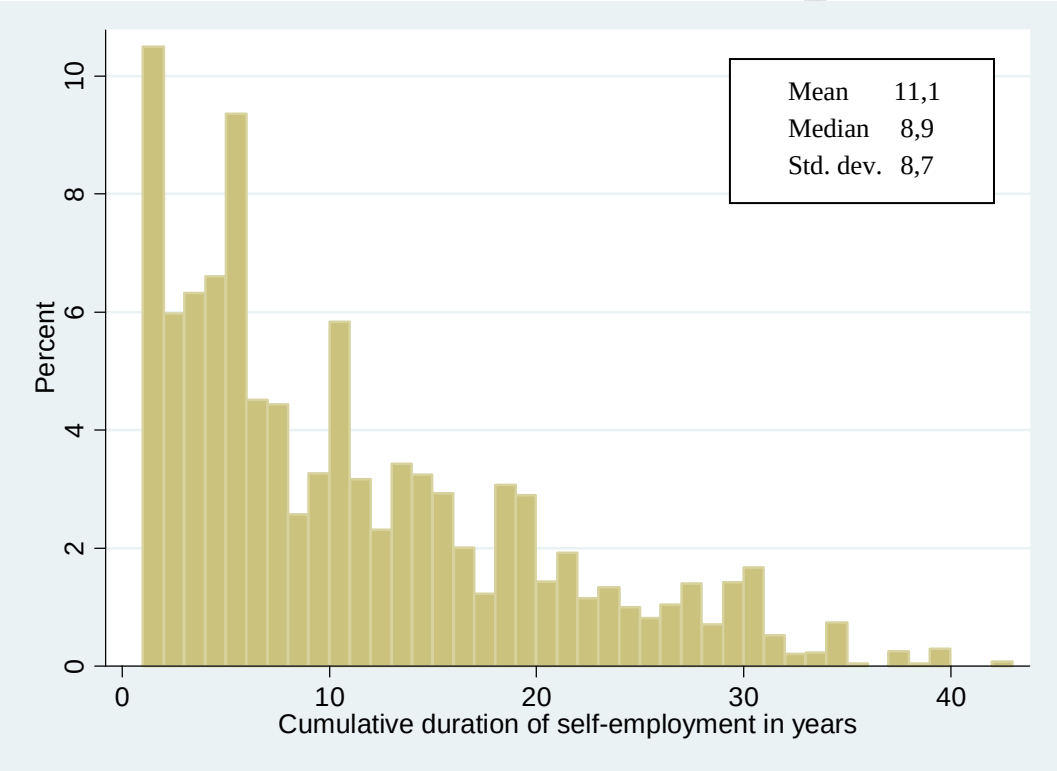
Source: AVID 2005, authors' calculations (n= 12,218)

7.2 Self-employment

In Germany – as opposed to other European countries – self-employed people are not necessarily included in an obligatory pension system (Schnell 2008). Some groups of the self-employed are included in the SPI, others like i.e. physicians, dentists, lawyers or architects pay into their own obligatory first pillar systems. The group of self-employed who are not included in any obligatory pension system has been under scrutiny for a while (e.g. Fachinger, Oelschläger and Schmähl 2004). With increasingly discontinuous work histories and a rising number of people who have episodes of not insured self-employment, unemployment or low paid employment there is a growing concern that the German old age insurance system in its current form will not be able to provide adequate protection from old age poverty for this growing group (Frommert and Loose forthcoming, Palier and Martin 2008). One of the aims of AVID was to examine the causes of and possible measures against low future old age incomes.

With the AVID 2005 data it was possible to identify people who during their work history had been self-employed without being included in an obligatory pension system at the time. The following figure and table refer to this group: People were included in the analyses if they had been self-employed without inclusion in an obligatory pension system for at least 12 months of their working life. Fig. 7 shows that for most people the cumulative duration of this sort of self-employment is rather short. Half of the people with episodes of "unprotected self-employment" accumulate roughly nine years. The highest percentage can even be observed for durations of only one to two years.

Fig. 7: Cumulative duration of self-employment



Source: AVID 2005, authors' calculations (n=855)

A closer look at this group of self-employed reveals other differences (Table 6): The longer the cumulative duration of self-employment, the lower the projected old age incomes. While people with a duration of up to five years of self-employment still reach over 1,000 €, the projected gross incomes for the next categories are substantially lower. As a reference point, the projected gross old age income of the rest of the AVID population with SPI entitlements amounts to 1,293 € (additional calculations not included in Table 6). Looking again at the importance of the different pension schemes there seems to be another dividing line. For all except the people with more than 15 years of self-employment, the SPI still accounts for over 70 % of the old age income. For people with less than 15 years of self-employment even occupational second pillar schemes play a (however small) role. For people with over 15 years of self-employment private provisions (46 %) play a role almost as important as the SPI (52 %). The importance of private provisions is

otherwise surprisingly low, even for people with a duration of over ten to 15 years of self-employment (20 %), bearing in mind that the phases of self-employment are not covered by any other (obligatory) pension provision scheme (see also Frommert and Loose forthcoming).

Table 6: Self-employment: Old age income and biographical indicators

Duration of self-employment	Gross old age income	SPI	Other 1. Pillar	2. Pillar	3.Pillar	Duration SPI cover	Duration unemployment
		%	%	%	%	Years	Years
1 to 2 years	1,158 €	77	3	10	10	27	7
Over 2 to 5 years	1,032 €	75	5	6	14	25	6
Over 5 to 10 years	847 €	79	0	8	13	23	6
Over 10 to 15 years	818 €	73	0	7	20	21	4
Over 15 years	819 €	52	-	2	46	16	3
Total	903 €	70	1	6	22	21	5

Source: AVID 2005, authors' calculations (n=855)

As far as the biographical indicators are concerned, the emerging pattern is quite similar: People with up to 15 years of self-employment also spent a reasonable time in (dependent) employment subject to social insurance contributions (between 21 and 27 years) while the number is lower for people with 15 years or more. People with a shorter duration of self-employment (up to ten years, which is a good half of the group) also have longer durations of unemployment than people with a longer duration of self-employment. This might be a hint that there are actually two different groups being investigated here: A group of people who should not be considered as people with self-employment but as people with discontinuous work histories, with comparably longer times of SPI contributions and unemployment; and another group of people where self-employment is more of a career choice, not necessarily in terms of high incomes (which should show in higher private pension provisions too) but in terms of self-employment being the main characteristic of the work histories (perhaps even in the sense of a selectively chosen "way of life").

At the moment the policy discussion only considers "self-employed people who are not included in any obligatory pension provision scheme", but there might be a point in considering both groups separately. People with discontinuous work biographies might consider self-employment only to avoid unemployment (Sternberg, Brixy and Hundt 2006). This should lead to different (labour market) solutions than for people who consider self-employment as their career choice. On the other hand, if self-employment is just a phase, albeit but one where one looses out on prospective pension points, people might look differently upon an obligatory inclusion into a pension scheme than when they actively choose self-employment and thus independence as their life paths (see also Ehler and Frommert 2009) .

8. CONCLUSION

While AVID has a methodological focus on income distribution analysis rather than providing an overall instrument for pension forecasts and planning, it has definitely proved very applicable to pension policy questions in the past. The key benefits of the study were its very detailed treatment and simulation of the respondents' life courses and the in-depth implementation of SPI regulations. Another point leading to widespread publicity and acceptance was the availability of and easy access to extended tabulated results.

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