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and Economic Research

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Socio-demographic Forecast of Poland, 1997–2050, for Modelling Incomes and Social Security Retirement Pensions

Warsaw, 1999

This paper was prepared for the research project No. P 96-6089-R (ACE PHARE Programme 1996) on "The Medium and Long-term Perspectives of Fiscal Adjustment of Selected Central European Countries".
Financial support from the British Know-How Fund is also gratefully acknowledged.

Graphic Design: Agnieszka Natalia Bury

DTP: CeDeWu – Centrum Doradztwa i Wydawnictw "Multi-Press" sp. z o.o.

ISSN 1506-1701, ISBN 83-7178-139-3

Publisher:
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Abstract

The primary purpose of this paper is to report estimates of the size and the social and demographic composition of the population of Poland, in the years 1997–2050, which takes into account the variables needed for modelling the effects of the 1999 pension reform. The total population is forecast to increase from 38.5 mln to 40 mln, and then fall to around 37 mln in the year 2050.

The paper proposes specific assumptions concerning the rate and form of migration from the agricultural to the non-agricultural category, the rate of extension of post-elementary education, and the rate of increase in the number of self-employed and freelance workers. The agricultural community is forecast to decline from 23.8% in the year 2000 to about 20.4% in 2025 and 16.3% in 2050.

The education gap between Poland and the European Community, large in 1997, is forecast to decline gradually, but will almost disappear only towards the end of the 2000–2050 period. The paper traces the implications of these changes for the number and composition of the population of those who will receive benefits and those who will pay social security contributions.

The author wishes to note the contribution to this work by research assistant Andrzej Szarkowski. The English translation is by Vera Rich.

1. Introduction

The population forecast needed to estimate the effects of the reform of the workers retirement pension scheme introduced in Poland at the beginning of 1999 has to take into account changes in variables ignored by standard demographic forecasts. These forecasts define the population for successive years distinguished only by year of birth (age), sex and membership of the category ‘agricultural community’.

These criteria are insufficient to specified an individual’s place in the social security pensions system. For the latter purpose, one also requires to know if he/she has a source of earned income, and if so, what. On the answers to these two questions depends whether the said person pays social security contributions and if so, in what social security system he/she participates or can participate. On these answers depends, too, the type of social security pensions or benefits, and from which system these come or can come.

In order to analyse the operation of a pensions system, we must have at our disposal an estimate of the contributions paid and benefits received. In the system now being introduced in Poland, these sums are related to the wages received in successive years of life and the age at which a person begins to draw benefits.

We shall estimate the future sums of contributions and benefits for non-agricultural workers on the basis of education and the criteria specified in the demographic forecast: age, sex and membership of the agricultural ‘community’.

The socio-demographic forecast proposed in this paper to meet the requirements of an analysis of the functioning of the reformed non-agricultural pension system therefore defines for each year of the forecast up to 2050 the structure of Polish society from the standpoint of the following six variables:

– age,
– sex,
– membership of agricultural or non-agricultural community,
– education,
– kind of source of earned income,
– kind of benefits received.

2. Demographic Structure

As a first step, we make a forecast of the distribution of the population by age and sex. At this stage we have two extreme cases: *C* (conservative) and *P* (progressive). In case *C*, the life-expectancy of a person belonging to a given demographic category does not vary (increase) during the time-span of the forecast. In the simplest case, the life-expectancies are estimated separately for women and men.

In the progressive case, the life-expectancy of each individual is taken to be the probability of surviving successive years. The probability of surviving the $k+1$ th year for a person belonging to a chosen demographic category (e.g. for a woman) in the base year *s* of the forecast is given empirically; in the simplest case it equals the number of women aged $k+1$ at the end of year *s* divided by the number of women aged k at the beginning of year *s* (the difference being the number of women aged *k* at the beginning of year *s*, who died in the course of that year). The probabilities of such an event in years subsequent to s are constant in forecast *C*, but in forecast *P* increase in a pre-determined manner. This manner may be designated as a </Q>'continuation</R>' of trends observed in the past or as a gradual approach of these probabilities to the values characteristic of societies taken as standard, which the society which forms the subject of the forecast is assumed to resemble. It may also be assumed that these probabilities are known functions of other variables characterizing that society, e.g. the level of GDP per head, while the dynamics of the value of that variable form the subject of a separate forecast.

Like the mechanism of 'dying' (survival), the mechanism of birth may be treated either 'conservatively' or 'progressively'. Every year, the children born in that year enter the population. The expected number of them is linked to the number of women of child-bearing age. The expected number of children borne by a women of age *k* may be treated over the whole period of the forecast as an (empirically defined) constant in the case of a 'conservative' forecast, or a function which in successive years of the forecast $s+1$, $s+2$. $s+3$...., $s+k$ takes values which are not necessarily the same. This function may be determined using procedures analogous to those applicable for the case of life-expectancy.

As the basis of our social-demographic forecast, we adopted the forecast of the population of Poland prepared by Gunnar Tidner of Compu Marin AB for MPiPS. This covers the years 1995–2050, taking into account age, sex and the division of the population into agricultural and non-agricultural. This is a progressive forecast, applying gradual changes of the demographic parameters. The modifications which I found necessary to introduce to this forecast relate only to the fraction of the 'agricultural community' in the whole population at the starting point of the survey.

Tidner's survey takes the division of the population into farmers and non-farmers as given. Namely, it assumes that the fraction of the 'agricultural community' in every age group is the same for men and women. Moreover, for older farmers (aged 50 and above) this fraction increases linearly, and in the oldest year-cohorts reaches 60%. Both these assumptions seem to be very unrealistic.

For an analysis of the pensions system, the determination of potential beneficiaries of the agricultural social security system is of fundamental significance. It is necessary to adopt some unambiguous definition of the 'agricultural community' in order to link Tidner's demographic forecast with information from other sources, and in the same forecast to replace the unrealistic assumptions on the fraction of the agricultural community with information from the microsurvey.

We take the 'agricultural community' to mean persons living on private farms and small-holdings having at least one hectare of land under cultivation, and persons possessing at least 4 ares of land who state that their principal source of income is work on their own agricultural holding. The division of the agricultural population in each age-group into women and men was estimated for the demographic forecast on the basis of the results of the microsurvey. This did not produce any radical changes to the figure for the agricultural population in the initial year of Tidner's forecast. According to the microsurvey, however, the excess of older people in the agricultural community is less than in Tidner's forecast. As a consequence the rate of decrease of the agricultural community in the modified version of that forecast is less than in the original one.

3. Social Structure

Each category of persons classified by age, sex and membership (or not) of the agricultural community, the size of which for each year up to 2050 is defined by the demographic forecast, must be subdivided into categories with respect to educational level, possession (or not) of an earned income and receipt (or not) of social security benefits (in particular old age pension).

In view of the long period covered by the forecast, only three levels of education are considered: elementary, secondary and higher. Basic job training was considered as 'elementary' education, as also was incomplete secondary. Incomplete higher and tertiary education was considered as 'secondary'. However, incomplete elementary education was included with 'elementary'.

The classification of earned income did not require too much detail. Indeed, great detail would be impossible with the available data. In the microsurvey [1], earned income could come from work for an employer, work on one's own agricultural holding, self-employed work, and assisting in agricultural or other work. The last category meant, for persons belonging to the agricultural community, helping in agriculture, and for those not belonging to the agricultural community – assisting a family member in his/her non-agricultural self-employed economic activity.

The classification according to kind of social security benefit needed to consider if and what benefit was the principal source of unearned income. In the most developed version, we distinguished the following: old age pension, disability pensions of all three classes, family allowances, unemployment benefits and 'other benefits'. For recipients of old-age pension it was necessary to take into account whether these benefits came from the agricultural insurance system, or a workers' system.

In the reformed system of workers' retirement pensions, older persons, i.e. those over 50 years of age when the reform comes into force, will remain for the rest of their lives within the old system. Younger persons (under 30 years of age on that date) are automatically transferred to the new system, while the rest (between 30 and 50 years of age when the reform came into force) have to decide whether they wish to be transferred to the new system or remain within the old one.

For persons between 30 and 50 years of age, it is therefore necessary to introduce an additional binary division according to whether they come under the new or the old system. For the system to which they belong will affect what happens in the case of their having an earned income as an employee or from self-employed work outside of agriculture, i.e. will they pay contributions to the Social Security Fund (FUS) only or partly to the FUS and partly to the Open Pensions Fund (OFE), and will the pension of such a person be calculated according to the old formula of the Social Security Office (ZUS) or the new formula: partly from the FUS and partly from the OFE. In assigning a farmer supporting himself exclusively from self-employed agricultural work to the new system, we do not deprive him of his future agricultural retirement pension (from the Agricultural Social Security Fund – KRUS), but we do not expect him to pay contributions to FUS from his agricultural income. We would expect such contributions from him only in the eventuality that in the future he would work outside agriculture. Thus the division into 'new-system' and 'old system' persons applies to everyone, agricultural and non-agricultural communities alike. Younger people must be classified as 'new system', older people as 'old system', and those between 30 and 50 years of age at the start of the

[1] GUS, May 1995. 5% of households and the persons living in them.

reform are assumed to be divided into 'old' and 'new' system in proportions according to their age: the older they are, the more will belong to the 'old system' – 5% of 31-year-olds, 10% of 32-year-olds, and so on up to 100% of 50 year-olds. This division was carried out precisely in the same way in each category defined by the other variables, independent of sex, education, source of income. The only exception was for people who had taken early retirement. These we considered to be receiving pensions in the old system.

The problem of early retirement pensions still awaits a definitive systemic solution. It would be necessary to return to this question after adopting the more permanent solutions and verifying the other data used here including, *inter alia*, after the survey of how popular the new retirement pension system is among people in middle life, which will be carried out in the year 2000.

4. Postulated Changes in Socio-demographic Structure over the Period of the Forecast

Over the past half-century, there has been a great increase in Poland in the numbers of people of school age receiving secondary or higher education. The material basis of education is low (especially at the secondary level), and to increase it significantly would require a considerable investment. However, a fall in the school rolls is approaching and this will make it easier to maintain (attain) a higher proportion of educated people than formerly. We assumed that by the year 2021 Poland will attained the situation characteristic for the majority of countries in the European Union, in which 90% of 21 year olds will have a secondary education qualification, and that in the subsequent years of this forecast this level will be maintained. Likewise, as the standards of the European Union are approached by the year 2029, 30% of all 29-year-olds will have a higher education qualification, and this level will remain unchanged. As a consequence of these assumptions, in successive years of the forecast (after 2030) the educational level of the entire population will increase further. For the less educated year-cohorts will be lost from the population, so that the educational level of the latter will rise.

The category 'self-employed' comprises persons who at present are running their own businesses, employing others and also persons working as freelances. From the microsurvey carried out in 1995, it emerges that the fraction of self-employed persons is greatest among those aged (at that time) 41 years. This is equally so for men and for women. The possibility of working for oneself first arose for both sexes at the same time (around 1990), and those who took advantage of it were persons who were not too old to change their lifestyle. The older age-groups either ignored it completely or made little use of it.

We shall assume that up to the age of 41, the balance of those entering and leaving self-employed work is positive. As a result, in successive years up to 41 years of age the number of self-employed persons in the cohort will constantly increase. After 41 years of age, they will not leave self-employed work until they retire.

The increase in the number of persons with higher and secondary education will be achieved at the cost of the number of persons with only elementary education. In the case of self-employed persons, we did not accept that the increase in the number of self-employed will be compensated by a fall in the number of employed persons. We did, however, adopt the assumption that the increase in the number of self-employed will be partially compensated by a decrease in the number of persons without earned income, that is, persons whose livelihood comes from disability pensions of all three classes, or early retirement pensions.

This assumption has more significant consequences in the case of men, who at the age of 41 are twice as likely to be self-employed than women. Out of persons approaching pensionable age in 1995, only around 1% of men and women were self-employed. The self-employed 40-year-old in 1995 will still be self-employed in 2020. Among their contemporaries (of the same sex and educational level) there will therefore be a lower percentage of disabled and early-retired. In addition, we assume that self-employed women will retire at the same age as the men.

During the period covered by the forecast, the fraction of the agricultural community in the whole population will decrease. This assumption is incorporated into the demographic forecast. It is assumed there that in each year of the forecast, 30% of the cohort of 16-year-olds (both male and female) reckoned as belonging to the agricultural population will migrate to the non-agricultural category. The choice of 16 years of age suggests that the mechanism of migration applies in the course of secondary school. This assumption, which concentrates the whole migration of a given cohort into a single year of their life is certainly a crude approximation. If one analyses the current age-distribution of the rural and urban population, one can rather judge that migration to the towns has taken place in a somewhat different manner. Up to the age of 19, the proportion of the sexes in the rural population is equal. Over 19, males begin to be in the majority, which may be the result of the migration of young women who marry urban men.

The assumption of equal migration of both sexes appears however to be reasonable as far as the future is concerned. For it will take place to a large extent as a result of the disappearance of inefficient farms. All the children from such farms will migrate out of agriculture, whereas previously it was rather individuals who migrated.

5. Method of Making the Forecast

5.1. Creating the Initial Socio-demographic Structure

The initial structure of the population forming the basis of the forecast must be estimated with considerable precision. Any errors that arise will not only be repeated in successive years of the forecast, but may also have a snowball effect, leading to errors many times greater than the original ones.

The initial socio-demographic structure must determine, at the end of 1997, the joint distribution of the variables mentioned above (Table 1).

Table 1. The List of Variables

N	Variable		Possible values of the variable
1	Age	AGE	0 to 100 years
2	Sex	SEX	m, f
3	Work community	AG/non-AG	Agricultural, non-agricultural
4	Education	EDUC	Elementary, secondary, higher
5	Source of earned income	INC	None, employed work, farming, non-agricultural selfemployed work, assisting with any work
6	Kind of benefits	BENEF	None, retirement pension, disability pension of classes I, II, III, family allowance
7	Insurance system	INS	Workers', agricultural

We do not have available a joint and complete distribution of the population with respect to all the necessary variables for 1997 (or any other year). Such data have not been provided by any representative survey of an appropriately large scale.

In particular, we could not obtain from KRUS a distribution by age and sex of those receiving benefits from the agricultural insurance system nor similar information about persons insured under this scheme and paying contributions. As a result, we were obliged to estimate a joint distribution of the population according to our seven variables in the initial year of our forecast on the basis of the partial, more or less reliable, information available to us.

As a general principle, we assumed that we could put our greatest trust in the demographic forecast produced by the Main Statistical Bureau (GUS). With only a few simplifications, the preparation of the initial socio-economic structure (for 1997) may be presented as follows:

1. We take as our basis the results of the microsurvey, and for each year-cohort of men and women we find the percentage of persons belonging to the agricultural community. We count persons as belonging to the agricultural community if either they live on small-holdings with at least 1 hectare of land or else state that they support themselves by work in private agriculture and live on a holding possessing at least 4 ares of land. This definition excludes retired farmers or those drawing social security benefits from the agricultural system whose household does not possess a hectare of land.

2. We introduce the fraction of agricultural population in individual year-cohorts of men and women for 1995 into the initial structure of the demographic forecast. As a result we obtain a (forecast) structure by age and sex of the agricultural and non-agricultural communities for 1997, which is the initial year of our socio-demographic forecast.

3. We have at our disposal from GUS the annual averages for all pensioners and persons drawing benefits of different type who in 1997 come under workers social security systems [ZUS], Prison Service [CZZK], Ministry of Defence [MON], Ministry of Internal Affairs [MSW] and the railway [PKP]) and agricultural system (KRUS). We have at our disposal information on the distribution with respect to age and sex of old-age pensioners, disabled persons and recipients (the oldest member of the family) of ZUS family allowances for December 1997. We adjust these latter data to the annual averages provided by GUS.

4. We have at our disposal information obtained from the Ministry of Finance (MF) on the age and sex structure of persons drawing benefits from each of the workers' systems (ZUS, CZZK, MON, MSW, railways [PKP]) and from the agricultural system (KRUS). These data do not distinguish recipients according to the kind of benefit – old-age pensions, disability pensions, family allowances. The data relating to each of these systems (except ZUS, for which we have obtained data which require the adaptation of the end-of-year figures to the annual averages, as described below under point 4a) were then transformed for each pensions system (CZZK, MON, MSW and PKP, KRUS) as follows:

a) The numbers of all persons drawing benefit from a given pensions system (e.g. PKP) in the data of the Ministry of Finance (in which they are subdivided by age and sex) are totalled and compared with the annual average for that system given by GUS. The numbers for all groups (by age and sex) obtained from the Ministry of Finance data, are then multiplied by an appropriately chosen constant. This gives a description of the beneficiaries of that system, in which the percentage distribution by age and sex comes from the MF data and the information on their (annual average) total comes from GUS.

b) The persons drawing benefit from a given system have to be divided according to the kind of benefit into old-age pensioners, disabled and recipients of family allowances. They are not so divided in the MF data. Firstly, from each year-cohort of each sex we take the same percent of recipients of family allowances defined for all persons drawing benefit in the given system (derived from the GUS data). The remaining recipients are divided into old-age-pensioners and disabled. For this purpose, the age of retirement is taken somewhat arbitrarily (e.g., for PKP it is the same for men and women – 60 years). All those older than that retirement age (depending on sex) are considered to be old-age pensioners, and all those younger as disabled. It is known from the GUS data how many in a given group are disabled, and how many are pensioners. If the number of persons over retirement age drawing benefits is less than the GUS figure for the number of pensioners, then one has to class as 'pensioners' some who are below that retirement age. If the GUS figure for the disabled is greater than the number of recipients below retirement age, then one has to class as 'disabled' a proportion of those drawing benefit over retirement age. For simplicity, we assumed that the fraction of these 'age anomalies' in each year-cohort of each sex is the same. The age-distributions obtained on these assumptions for 'uniformed' persons (i.e. from the armed forces, police and prison service) drawing old-age pensions, disability benefits and family allowances are, without any doubt, false. However, these groups constitute only a small proportion of all the recipients of workers' pensions which we shall treat later. Those drawing benefits from KRUS, on the other hand, do not form the subject of this forecast at all.

Finally, the age- and sex distributions for all workers' systems, obtained separately for pensioners, disabled and recipients of family allowances, are added together and joint distributions obtained with respect to age, sex and kind of benefit in the workers' system and the agricultural system. The percentage distributions for the workers' system are similar to the percentage distribution describing those drawing benefits from ZUS itself. Adding to the ZUS recipients (e.g. pensioners) a relatively small number of (uniformed) pensioners would not produce any fundamental change of proportions. The percentage distributions for the agricultural system are a kind of fiction adjusted according to information on the sex and age compositions of all agricultural recipients of benefits (MF data) and information on the number of pensioners, disabled and recipients of family allowances (GUS data) and the arbitrary assumption that men begin to draw the agricultural pension at 70 years of age and women at 65 (Attempts to 'lower the retirement age' for farmers led to difficulties in the adjustment of the numbers of disabled and pensioners – namely, the result contained a very large number of disabled of pensionable age, which, perhaps, is really the case). The assumption of a high pensionable age does not change either the number of recipients of benefit in successive years, nor the total number of disabled, pensioners and recipients of family allowances. This assumption would have important consequences if one were forecasting, for the agricultural system, the level or the total amount of benefits and contributions, but we are not doing this.

5. After carrying out the previous step we have, for 1997, an estimate of the number of persons of each age and sex receiving each kind of benefit from the workers system and, separately, the agricultural system. The demographic forecast provides information on the numbers of men and women in each separate year-cohort of the agricultural and non-agricultural population for the same year. We propose to treat the numerical values obtained from the demographic forecast as trustworthy. Consequently, the number of persons not receiving any social security benefit in each group, defined by age and sex, will be determined by subtracting from the total size of this group (from the demographic forecast) the number of recipients of benefits of the various pensions and benefits systems previously estimated according to the MF, ZUS and GUS data. Quite often it turned out that the number of recipients of benefits according to MF, ZUS and GUS was somewhat higher than the total number of all persons according to the demographic forecast, and was so for a number of successive years. We have not been able to explain this fact. We have put our faith in the demographic forecast and have assumed that the total number of persons receiving benefits is somewhat less, or we have adjusted the number of pensioners and recipients to the total numbers of individual year-cohorts of men and women separately. When linking the recipients of benefits in the population described by the demographic forecast, we were careful, moreover, to put the recipients of workers' benefits into the non-agricultural community and the recipients of agricultural benefit into the agricultural community.

6. We treated the microsurvey as a source of conditional distributions with respect to education, source of earned income and kind of benefit in groups defined by age, sex and membership of the agricultural or non-agricultural community. The size of these groups was taken from the demographic forecast. We recall that the structure of the population in the initial year of this forecast (1995) was confirmed earlier by the date from the microsurvey on the proportion of the agricultural community in each group defined by age and sex. For that point of time, we had available two competing but incomplete sets of information on the participation of recipients of benefits in each group defined by age and sex. There are 404 such groups, since age can take 101 values, sex can take 2 and membership or not of the agricultural community – two. The size of each year-cohort of men and women and their division between the agricultural and non-agricultural communities was taken from the demographic forecast.

The number of persons receiving benefits of different kinds from both types of system (workers' and agricultural) was taken from a compilation of the MF, ZUS and GUS data. Care was taken to enter the recipients of benefits under a workers’ scheme in the subset of the ‘non-agricultural community’, and those receiving agricultural benefits in the subset of the ‘agricultural community’.

The MF, ZUS and GUS data relate only to persons receiving some kind of retirement pension. They lack information about persons not receiving retirement benefit. The microsurvey data relates to all persons belonging to groups defined by age, sex and membership (or not) of the agricultural community. The size of the (whole) group estimated on the basis of the microsurvey is generally different from that given for that group by the demographic forecast. We combine all this information in the following manner.

The size of the group is defined by the demographic forecast. The MF, ZUS and GUS data allow one to extract from it persons receiving benefits and to subdivide the recipients of different kinds of benefits (retirement, disability and family allowances) into participants of the workers ‘</R> and agricultural systems. The rest are those receiving no form of social security benefits whatsoever, or receiving unemployment benefit or other (unspecified) allowances.

The microsurvey provides other data. It does not differentiate between recipients of benefits from the agricultural and workers ‘</R> schemes, but each group of pensioners, disabled and recipients of family allowances is further subdivided according to education and membership of the agricultural or non-agricultural community. The microsurvey data are also a source of information on the boundary (unconditional joint) distribution of education type of earned income in the whole group. This is shown in Table 2.

Table 2. Source of Data

Variables	MF ZUS GUS	Microsurvey
Education	missing	+
Source of earned income	missing	+
Kind of benefit	+	+
Type of benefit scheme (workers’ or agricultural)	+	missing

All four sources provide information on the fraction of pensioners, disabled, and recipients of family allowances. The MF, ZUS and GUS data allow us to divide the recipients of benefits of each kind into participants of the workers’ and agricultural schemes. On the other hand, the data from the microsurvey allow us to divide the recipients of each kind of benefit according to age and whether or not they simultaneously possess a source of earned income.

Obviously, the MF/ZUS/GUS data sets are not always completely consistent with microsurvey set as regards the fractions of recipients of different kinds of benefit. If the microsurvey distribution of the kind of benefit received differs from that obtained from the compilation of the MF, ZUS and GUS data, then the conditional distributions by education and type of earned income derived from the microsurvey in conjunction with the distribution by kind of benefit received according to the MF, ZUS and GUS data will give an unconditional distribution by education and type of earned income different from that derived from the microsurvey. We have, however, more trust in the boundary distribution by education and type of earned income than in its conditional analogues in the subsets defined by type of benefit. We therefore settle for (at the least) a modification of these conditional distributions, so as to preserve unchanged the boundary distribution of all variables: education, source of earned income (from the microsurvey), kind of benefit and type of benefit system (according to MF, ZUS, GUS). We obtain this result, using an iteration method of 'raking' (Deming 1943 and Deming and Stephan 1940).

As we observed above, the number of subsets in which we make these adjustments of the information from the various sources equals 404. We hope that possible errors in individual groups will be to a considerable extent evened out in the analysis of the whole, and that the initial socio-demographic structure thus obtained will in a rough approximation represent the real situation of 1997. In reality, it is not the structure itself which is the object of our interest, but the consequences of its changes for the functioning of the reformed workers </R> pensions system over the next 50 years.

5.2. Forecast of Population Figures and Socio-demographic Structure

Each year-cohort of the population is divided into four 'demographic groups': men and women, farmer and non-farmer. The demographic forecast defines the size of each of these groups in successive years up to 2050. These values are defined taking into account the initial structure of the population in 1997, the postulate dynamics of the birth rate and life-expectancy and an annual migration to the non-agricultural community of 30% of members of the agricultural community aged 16 in that year.

For 1997 we also know the </Q>'social'</R> structure of each of the four 'demographic' groups with respect to education, source of earned income and kind of benefits.

These structures vary with time. Regarding education, we assume:

(i) the percentage of 22-year-olds having secondary education in successive years of the forecast will increase linearly until 2020 up to a level of 90%,

(ii) the percentage of 29-year-olds having higher education will increase linearly until 2029 up to a level of 30%,

(iii) no one over 22 years of age having only elementary education and no one over 29 years of age having only secondary education will raise his/her educational level.

These assumptions were implemented in the forecast in two stages. In the first stage we initially modified the educational structure of individual year-cohorts in successive years of the forecast, in accordance with these assumptions. The educational structure of the year-cohort of 29-year-olds after 2029 grew increasingly richer in persons with higher education. Beginning from 2029, in each successive year of the forecast, 30% had higher education, 60% secondary and 10% elementary. However, the educational structure of the year-cohort of persons aged $29+k$ in year p of the forecast is identical with the educational structure of the 29 year old age-set in the $(p - k)$-th year of the forecast.

It cannot be assumed that the socio-demographic structure of each group distinguished by age and education will be the same in the future as in 1997, when, for example, there were practically no farmers among persons with higher education. There would be no justification for assuming that the conditional distributions of persons with respect to the variables in the groups distinguished by education. Hence in constructing the forecast we employed the method of "raking". This is an iteration method of adjusting the joint distribution of two variables to their limiting distributions.

The purpose of raking is to find a joint distribution of all 'socio-demographic' criteria which would be at the same time consistent with the forecast distribution of education and also with the joint distribution of all the other criteria (excluding education) characterising the given age group in 1997, and which in addition would be similar to the joint distribution of all the criteria (including education) in the year 1997. After 'raking' education from the other variables for all age-groups in successive years of the forecast, one may proceed to the second step, in which the assumptions relating to self-employed persons are implemented.

For successive years of the forecast, we assumed that the percentage of self-employed persons in the year-cohort of persons aged k years is for $41 < k \leq 65$ the same as in 1997, or equal to the fraction of self-employed persons in the year-cohort of persons aged $k-1$ in the preceding year of the forecast. This is equivalent to assuming that persons over 41 years do not abandon self-employed work. As a consequence, for the age-sets from 41 to 65 in successive years of the forecast the fraction of self-employed persons is not less than the value for those year-cohorts in 1997.

If in some year-cohort the fraction of the self-employed increases, then the corresponding fractions of other categories must decrease. In the forecast, the increase of the self-employed is compensated by a decrease in the fraction of persons without a source of earned income. Among such persons aged from 41 to 65, there is a significant fraction drawing retirement pensions. The increased fraction of self-employed is compensated by a decrease in the fraction of persons receiving disability benefit (specifically, class III, or if this is too small, class II as well) or early retirement.

Modification of the fraction of the self-employed in the forecast year-cohorts (for persons aged from 42 to 65) is thus in essence a modification of the joint distribution of two variables 'source of paid income; and 'kind of benefit received'. In the next part, we shall present the consequences of our postulates with the aid of diagrams representing the forecast changes in the size and structure of the Polish population for the years 1997–2050.

6. Results of the Forecast

6.1. Population with Respect to the Principal Descriptive Characteristics

The size of the Polish population over the first 20 years of the forecast will gradually increase from 38.5 millions to 40 millions, and then fall to around 37 millions in the year 2050. In step with this there will be a gradual decrease in the agricultural community, both in absolute numbers and as a percentage of the whole. While the fraction of the non-agricultural community will increase throughout this period, in the last 15 years of the forecast, its absolute value will decrease. The excess of women over men will decrease. All these figures are shown in Fig. 1.

A relatively small change in the size of the whole population will be accompanied by large changes in its age-structure (see Figs 2 – 7). In Fig. 2, for 2000, we observe the well-known sine curve of demographic peaks and troughs reflecting the effects of the two World Wars of the twentieth century. Subsequent graphs show the expected damping and decrease of amplitude of this sine curve. The peak of 10-year-olds in 2050 is difficult to explain. The only significant peak in this distribution is that of persons of around 65 years of age in 2050. The consequences of this age structure will be a decrease in the size of the population persisting beyond 2050 caused by the disappearance of this peak.

Figs 8 and 9 also represent the age distribution, but for men and women separately. In the these distributions we observe the same two regularities and the successive demographic peaks approximately 25 years apart gradually disappear.

Special attention should be paid to the age distribution of the farming community (Fig.10). This distribution shows the consequences of the assumption that in each year of the forecast there will be a 30% migration of 16-year-olds from the agricultural to the non-agricultural category. Already in the distribution for the year 2000 we see a 'break' in the size of the year-cohorts of 16–20 year old, from which 30% have emigrated to the non-agricultural category. In the age distribution for 2010 and beyond this gap gradually becomes wider. In subsequent distributions we observe a decrease in the number of children. This is the effect of a decrease of the number of women in the agricultural community. As a consequence, the agricultural community will grow older in successive years of the forecast. The number of persons aged over 55 years in 2050 will be greater than today, while the number of younger people will be notably less.

In the age distribution of the non-agricultural community (Fig. 11), it is difficult to observe the consequences of the migration of young people from the agricultural to the non-agricultural community.

Fig. 12 shows the number of children aged under one year at the end of the year in successive years of the forecast. The birth-rate of the whole population will rise from the present level of around 420 thousand to around 500 thousand in 2015, and will then fall fairly sharply and after 2023 will oscillate around 400 thousand a year. In the agricultural community the number of births will begin to fall from around 100 thousand annually to around 50 thousand annually.

There will be considerable oscillations too in the size of the year-cohorts of persons retiring at the statutory age, women at 60 and men at 65. Fig.13 shows the size of these two categories in successive years of the forecast, divided according to (potential) entitlement to pensions under the old and new systems.

6.2. Forecast of Extension of Post-elementary Education

We have adopted an assumption on the extension of post-elementary education is completed among persons aged up to 21 for secondary education, and aged up to 29 for higher education. We have assumed that the numbers of people of 'educational' age completing post-elementary education will increase to a certain level. After this the fraction of persons with a given level of education will become stabilized.

The next group of diagrams show distributions with respect to education, for the whole set (Fig.14), for people aged from 18 to 65 (Fig. 15) and for people aged over 25 (Fig. 16). 25 years may be taken at the age at which full time study normally ends. In the diagrams relating to adults with respect to education – elementary, secondary and higher – we record only those persons who have received it. We assume, however, that every adult has received at least primary education. In preparing the distribution of education for the whole population, including children, everyone was assumed to have received at least elementary education, even those who had still not started school.

According to these graphs, the percentage index of education of the whole population will increase throughout the period of the forecast, but in 2050 will still not have reached the level characteristic of the age-sets of people finishing their education after 2029 (30% higher education, 60% secondary, 100% elementary).

We consider the most important (relative) changes in the level of education to be that relating to the agricultural community aged over 25 year (Fig. 16). The corresponding distribution for the non-agricultural community is shown in Fig. 1.

The following diagrams (Figs 18,19, 20) represent the dynamics of the extension of education for men and women separately. According to the forecast, the further expansion of higher and secondary education will be somewhat greater among men than among women.

6.3. Sources of Earned Income of Persons of Working Age

The changes in the structure of the population of persons of working age (18 to 60 for women and 18 to 65 for men) with respect to the kind of source of earned income are a consequence of the decreasing fraction of the agricultural community, increase in the level of education, and our assumption that self-employed and freelance workers do not abandon this type of work. These indices are mutually connected. For self-employed persons generally have post-elementary education and belong to the non-agricultural community.

In the whole population (Fig. 21) we observe a gradual growth in the fraction of employed workers and a rapid growth in the fraction of self-employed, accompanied by a decrease in the fraction of farmers and non-working persons.

The next two diagrams (Figs 22 and 23) provide information on the agricultural and non-agricultural communities respectively. It is worth noting the fact that the fraction of farmers in the agricultural community will rise at the cost of the ‘assistants’. It turned out that the rise in the fraction of employed workers in the final years of the forecast was a consequence of our assumptions.

6.4 Sources of Unearned Income of Persons of Working Age

The next three diagrams (Figs 24, 25, 26) present the structure of the whole population of persons of working age with respect to unearned sources of income, and also separately for the agricultural and non-agricultural communities. The dominant category ‘no source of unearned income’ is omitted from the graphs.

From the graph of the whole population (Fig. 24), it is seen that the fraction of persons who have taken early retirement among the population of working age has a tendency to rise. This is due to the ageing of the population. The increase of the fraction of persons on early retirement is not systematic. We first observe a rapid growth from 4 to 6%, then a decrease, and then after a few decades a new increase from 6 to 8%. This is caused by the demographic peaks reaching 'early retirement' age; so that there will consequently be a larger pool of persons taking early retirement.

A characteristic phenomenon is the absence of persons taking early retirement among the agricultural population. This, however, is a result of the assumptions we have adopted. All persons below retirement age receiving benefits from KRUS were counted as members of the agricultural population and considered to be disabled (not pensioners).

6.5 Sources of Uunearned Income of the Population of Retirement Age

The final series of diagrams (27, 28, 29) represent the fractions of persons drawing benefits of different kinds in the whole set of persons of retirement age and subdivided into the agricultural and non-agricultural communities. Almost all persons of retirement age receive benefits. According to our forecast, the fraction of disability benefits will decrease and that of old-age pensions will increase. The fraction of family allowances will remain constant.

It is worth noting the low level of family allowances among the agricultural community. For farmers' widows receive retirement benefit and not family allowances. The forecast indicates that this situation will continue.

According to our forecast, in the future the structure of benefits received by persons of retirement age will be similar to the present. The numbers receiving different benefits will vary and will depend on the size of the corresponding year-cohorts. The sizes of these 'retired' year-cohorts, as we have shown above, will at the same time oscillate and their fraction of the whole population will increase.

The final diagram (30) represents once again the forecast of the size of the population, including two additional figures: the number of persons of pensionable age, and the number of persons of working age (18 – 60/65). The number of persons of pensionable age will increase and will double in the course of 50 years. The number of persons of working age will rise for the first 10 years and then begin to decrease, so that in 2050 for one person of pensionable age there will be less than two persons of working age.

A long-term forecast such as ours is only a projection from the trends observable today. For this reason we decided not to give numerical tables. For figures in tables would suggest to the reader an accuracy which should not be attributed to our forecast. Even an approximate readout of the figures from the table will give an accuracy greater than we should wish to suggest. For let us remember, a mere 50 years, likewise, elapsed between 1910 and 1960.

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Deming, W.E. (1943). 'Statistical Adjustment of Data'. NY: John Wiley.

Deming, W.E. and Stephan, F.F. (1940). 'On a Least Squares Adjustment of a Sampled Frequence Table when the Expected Marginal Totals are Known'. The Annals of Mathematical Statistics, 11, pp. 427–444.

List of Diagrams

Figure 1. Size of Population

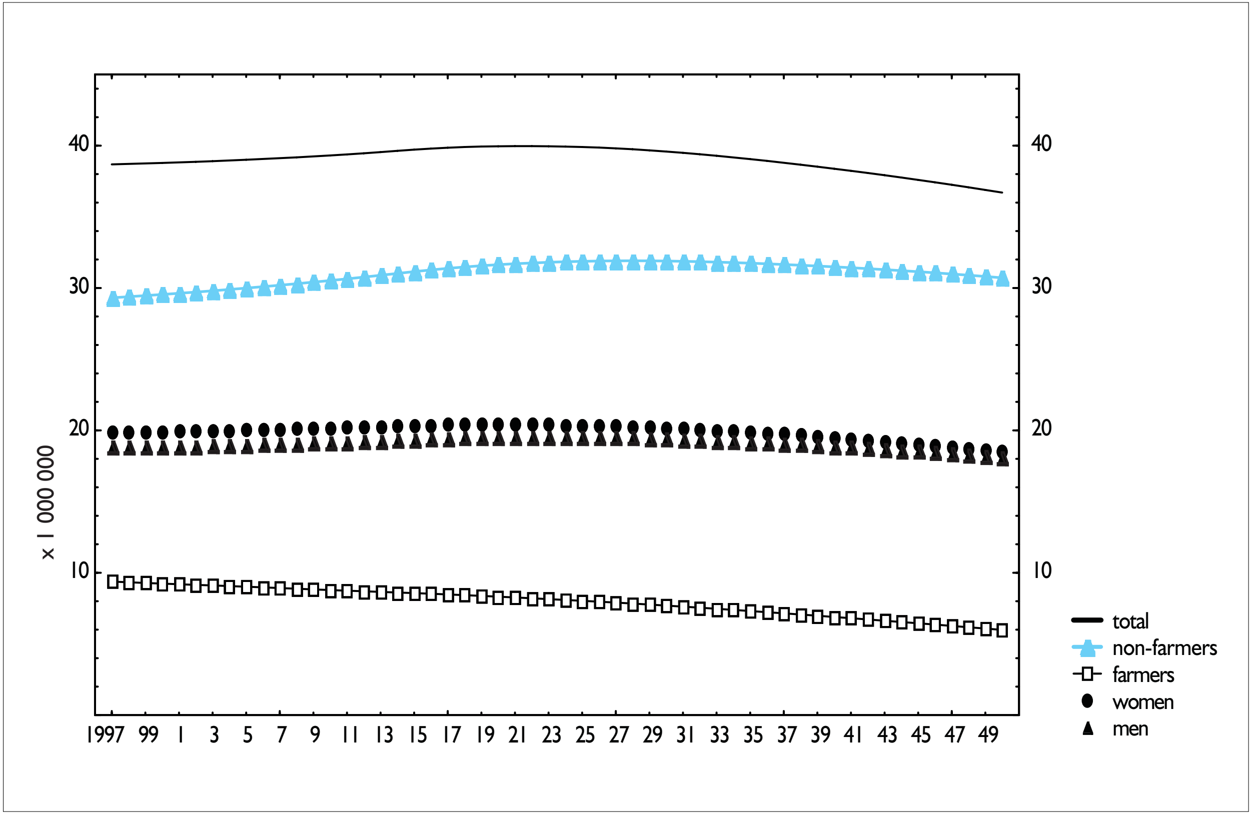


Figure 2. Age Structure of the Population in the Year 2000

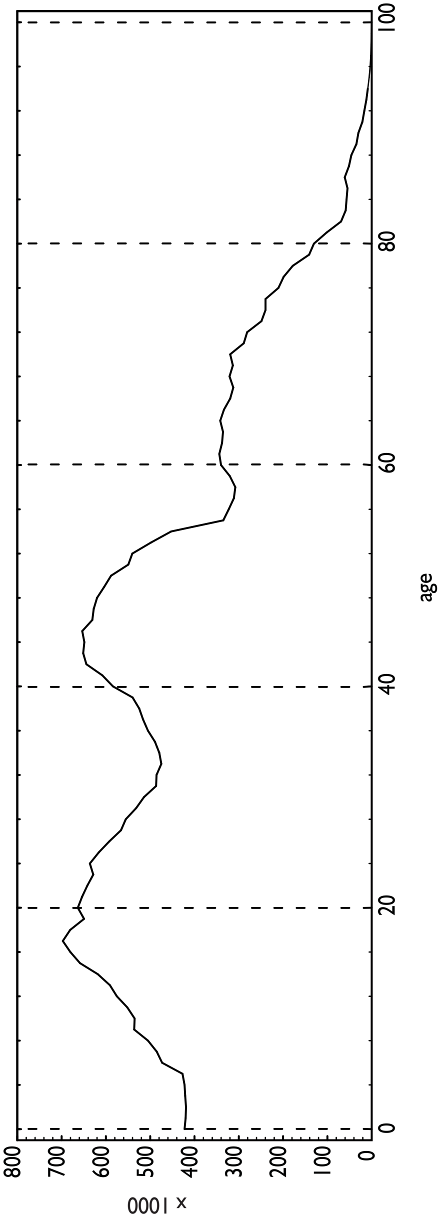


Figure 3. Age Structure of the Population in the Year 2010

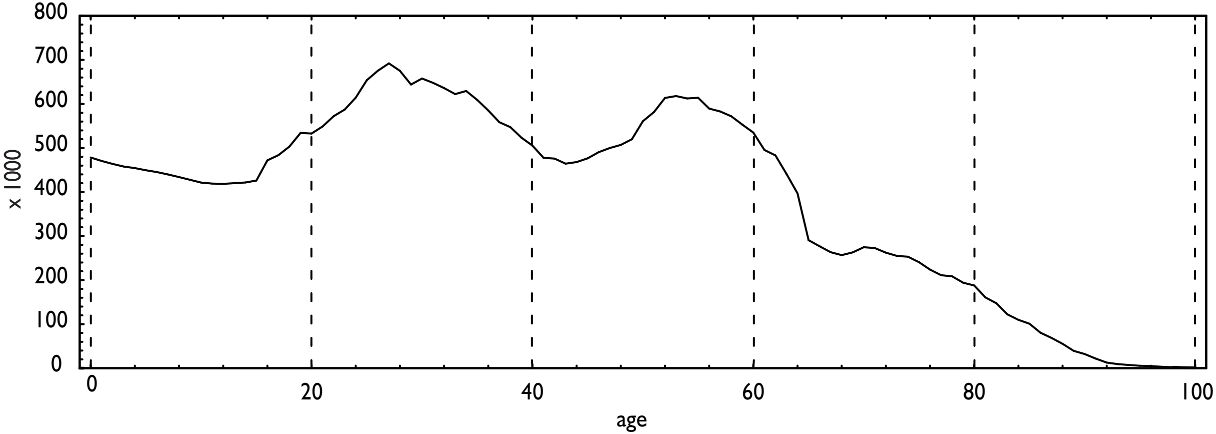


Figure 4. Age Structure of the Population in the Year 2020

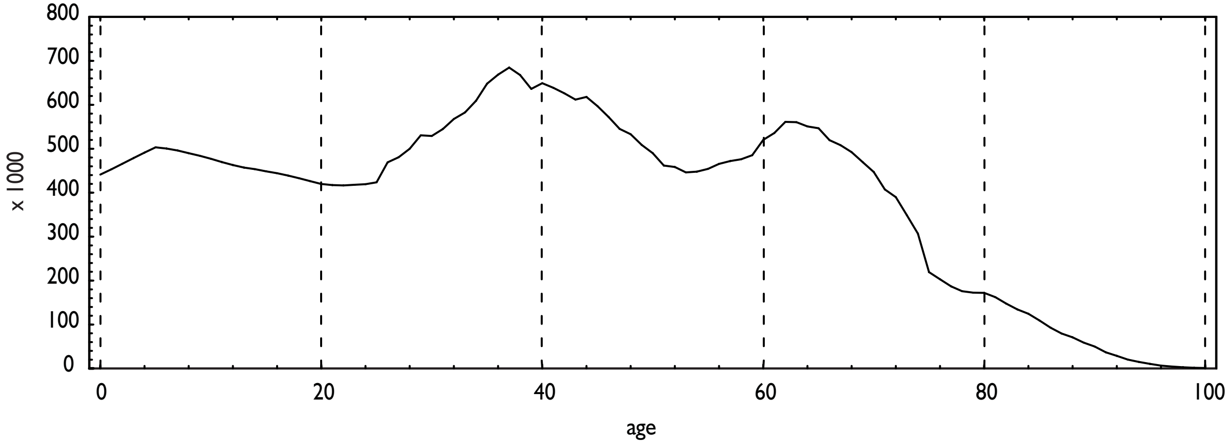


Figure 5. Age Structure of the Population in the Year 2030

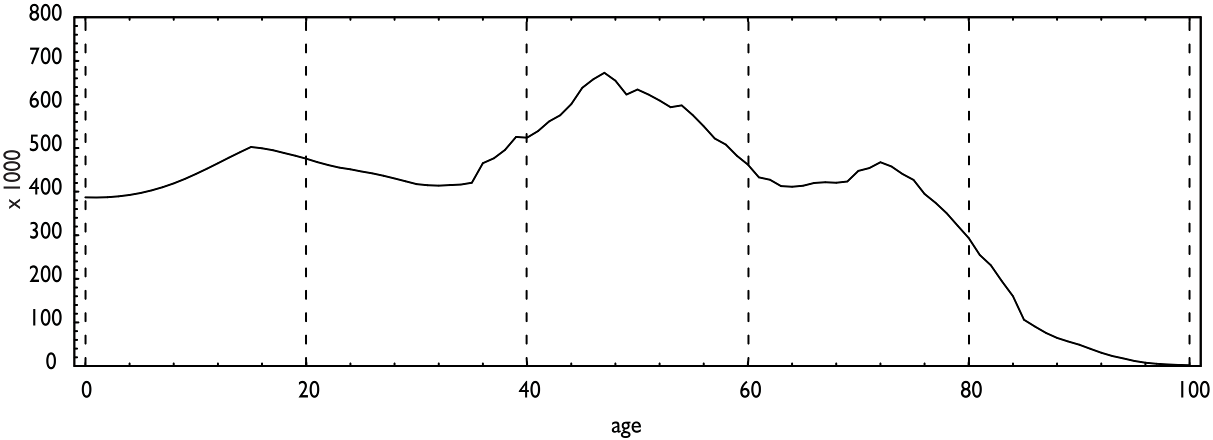


Figure 6. Age Structure of the Population in the Year 2040

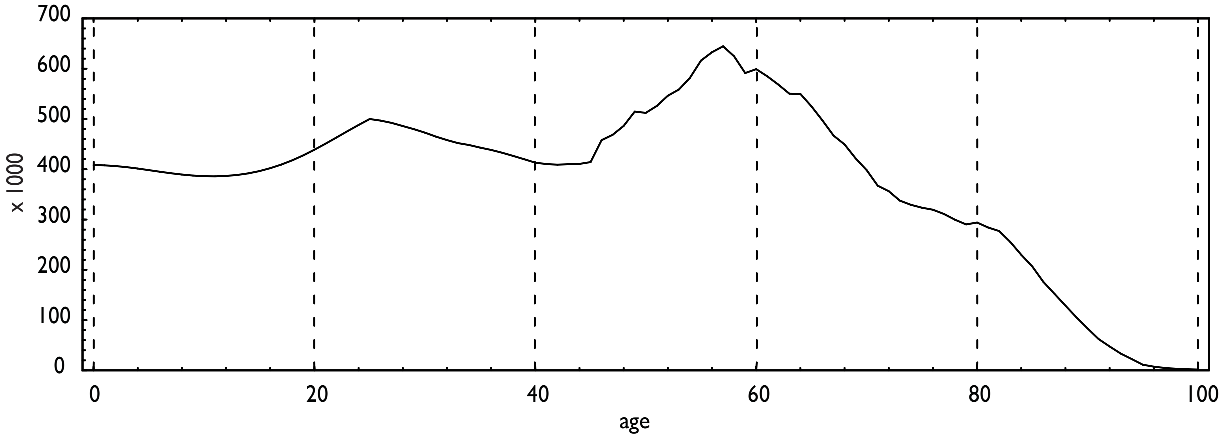


Figure 7. Age Structure of the Population in the Year 2050

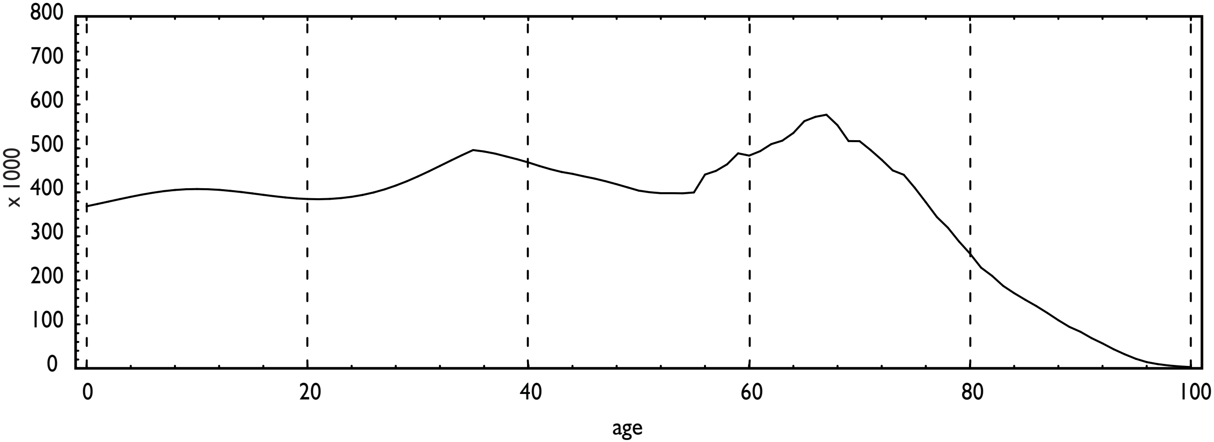


Figure 8. Age Distribution of Women in Selected Years of the Forecast

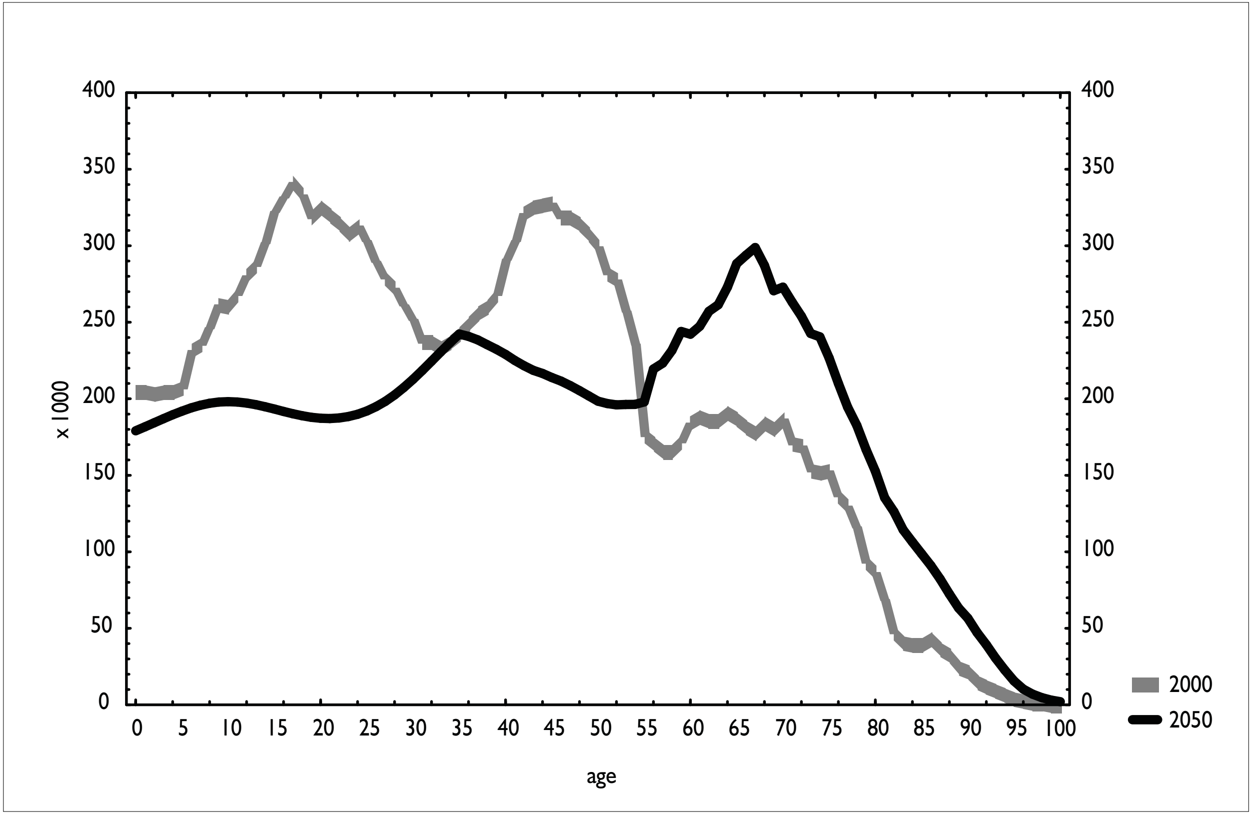


Figure 9. Age Distribution of Men in Selected Years of the Forecast

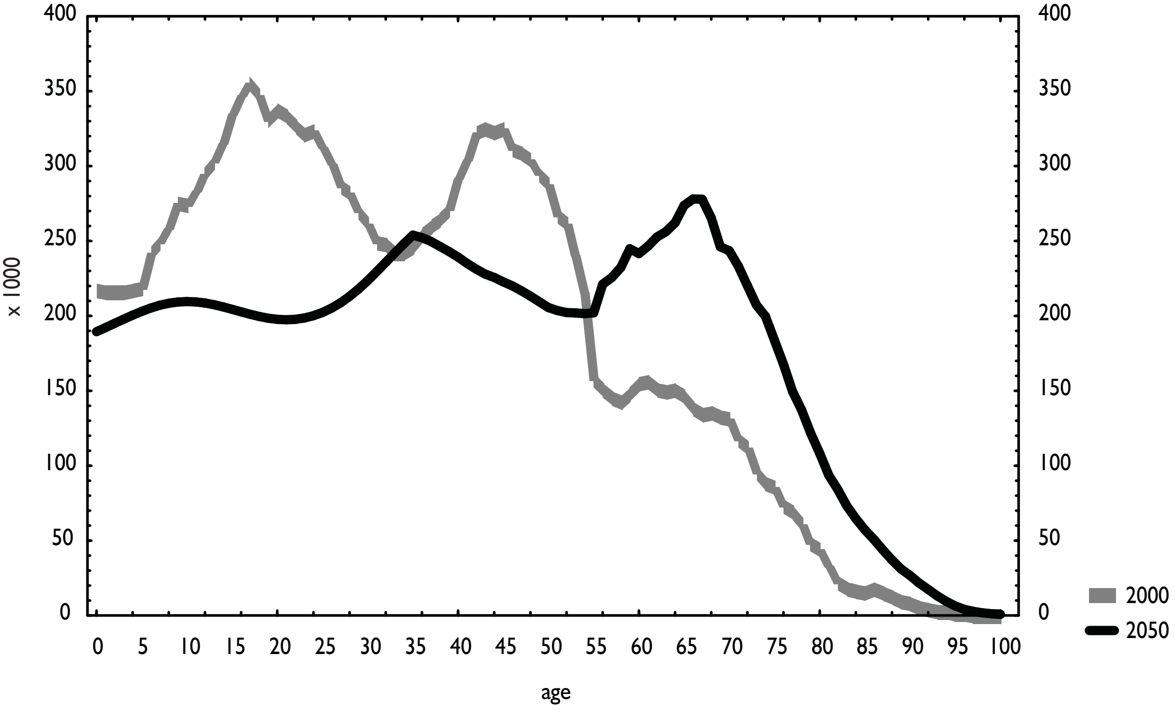


Figure 10. Distribution of the Agricultural Community in Selected Years of the Forecast

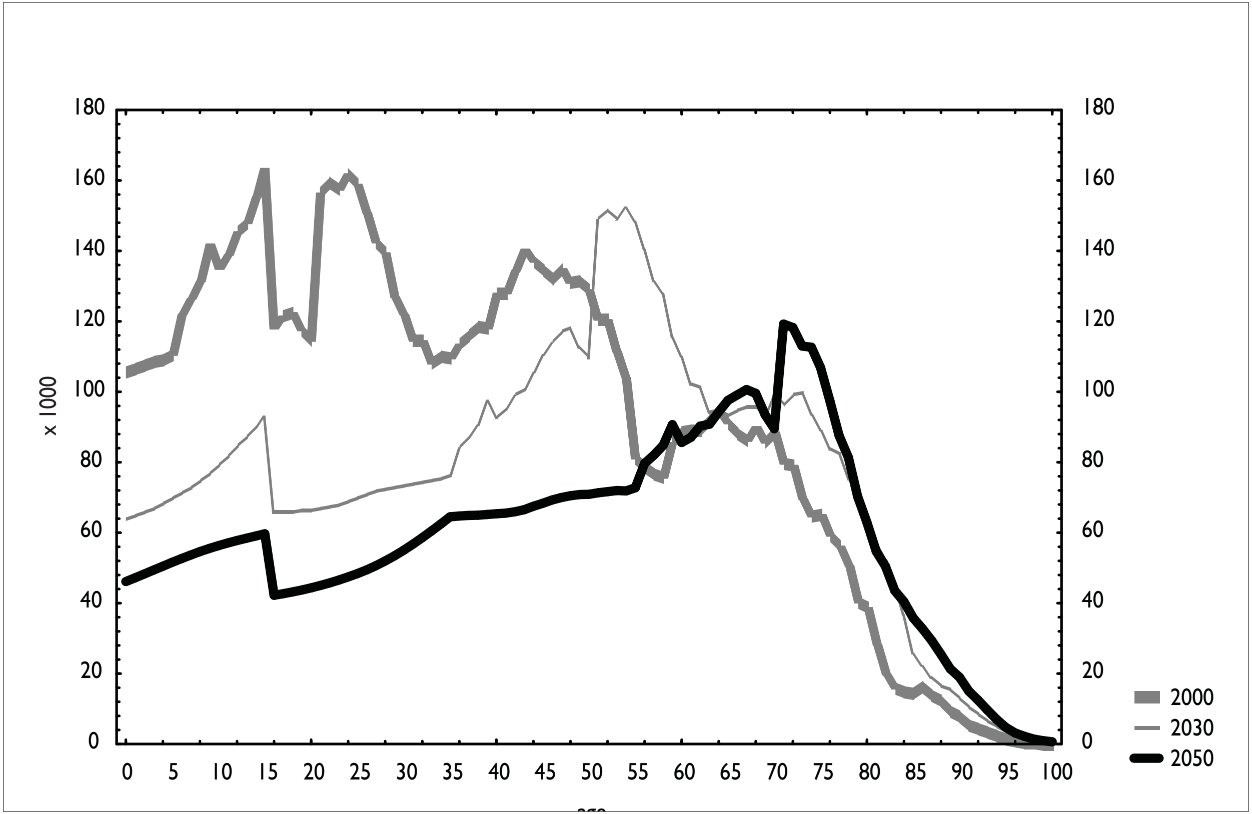


Figure 11. Distribution of the Non-agricultural Community in Selected Years of the Forecast

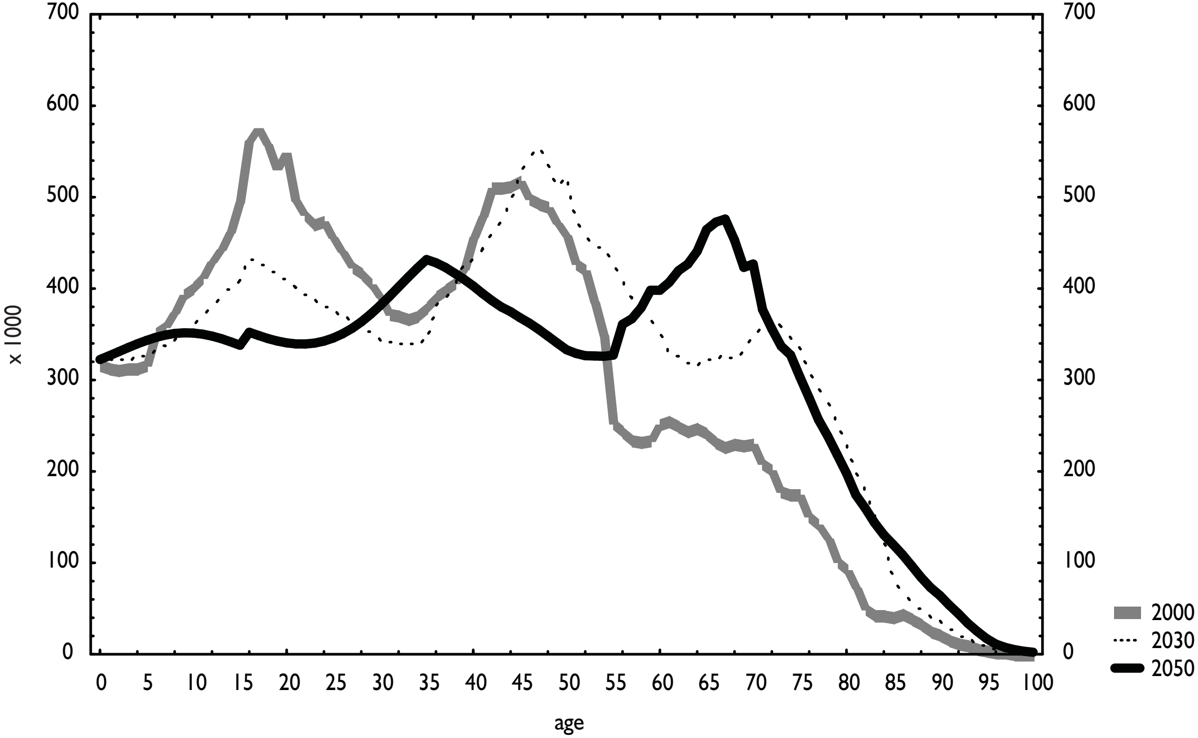
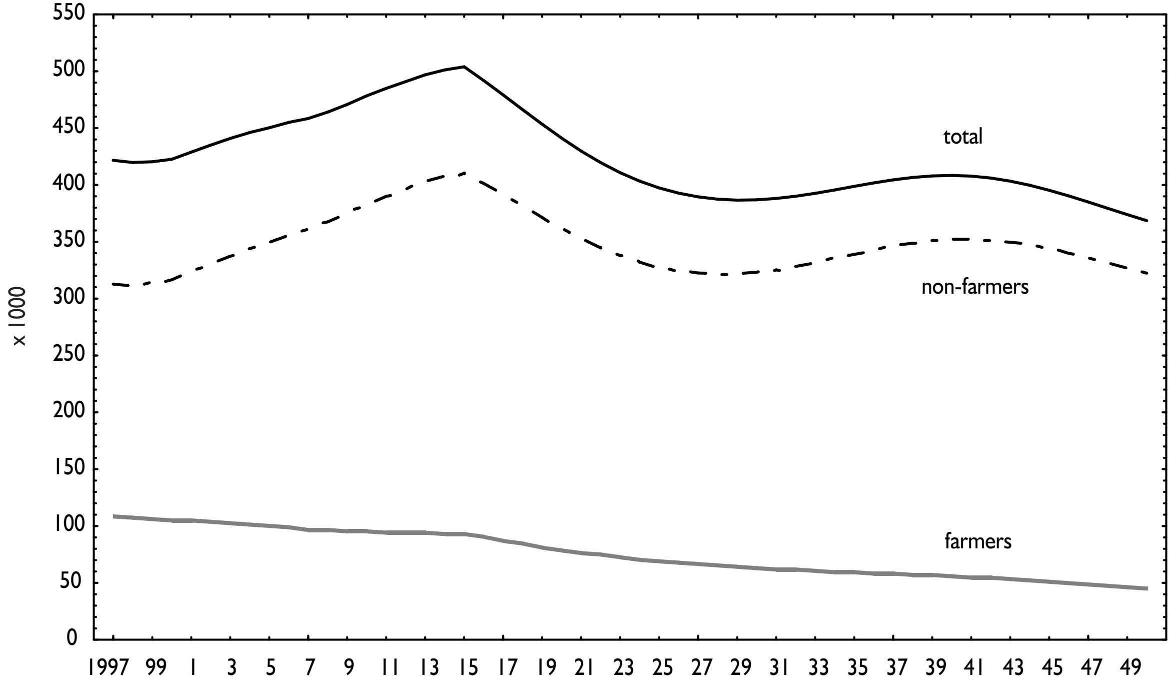


Figure 12. Numbers of Persons of Age 0 Years



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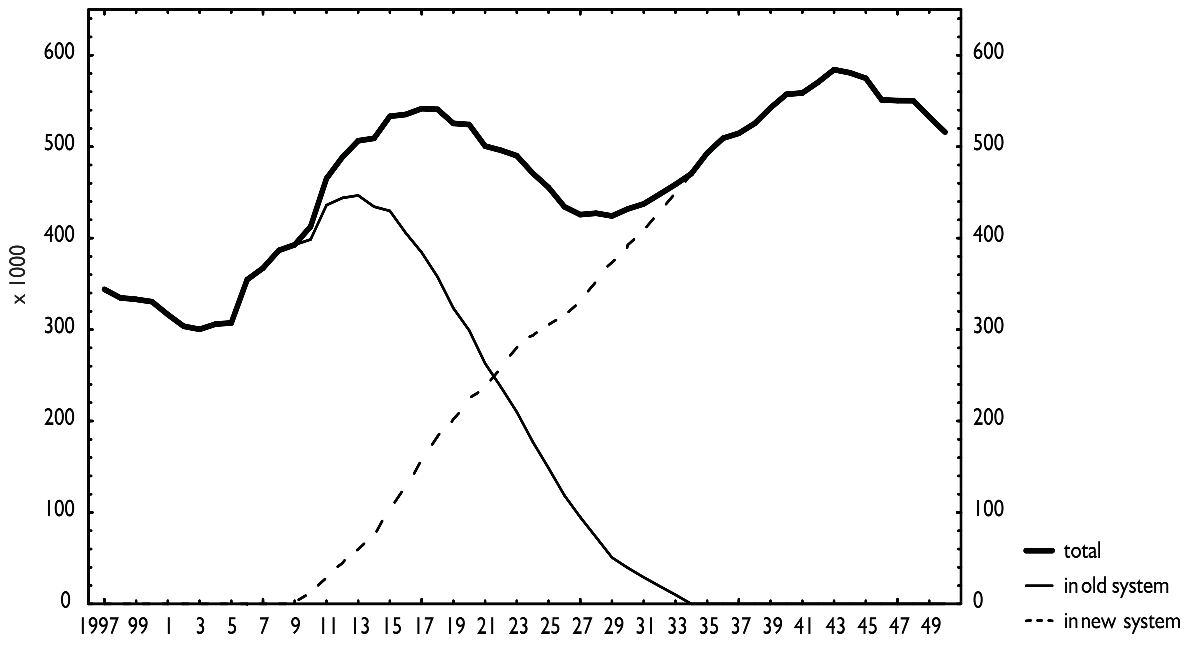


Figure 14. Education in the Whole Population

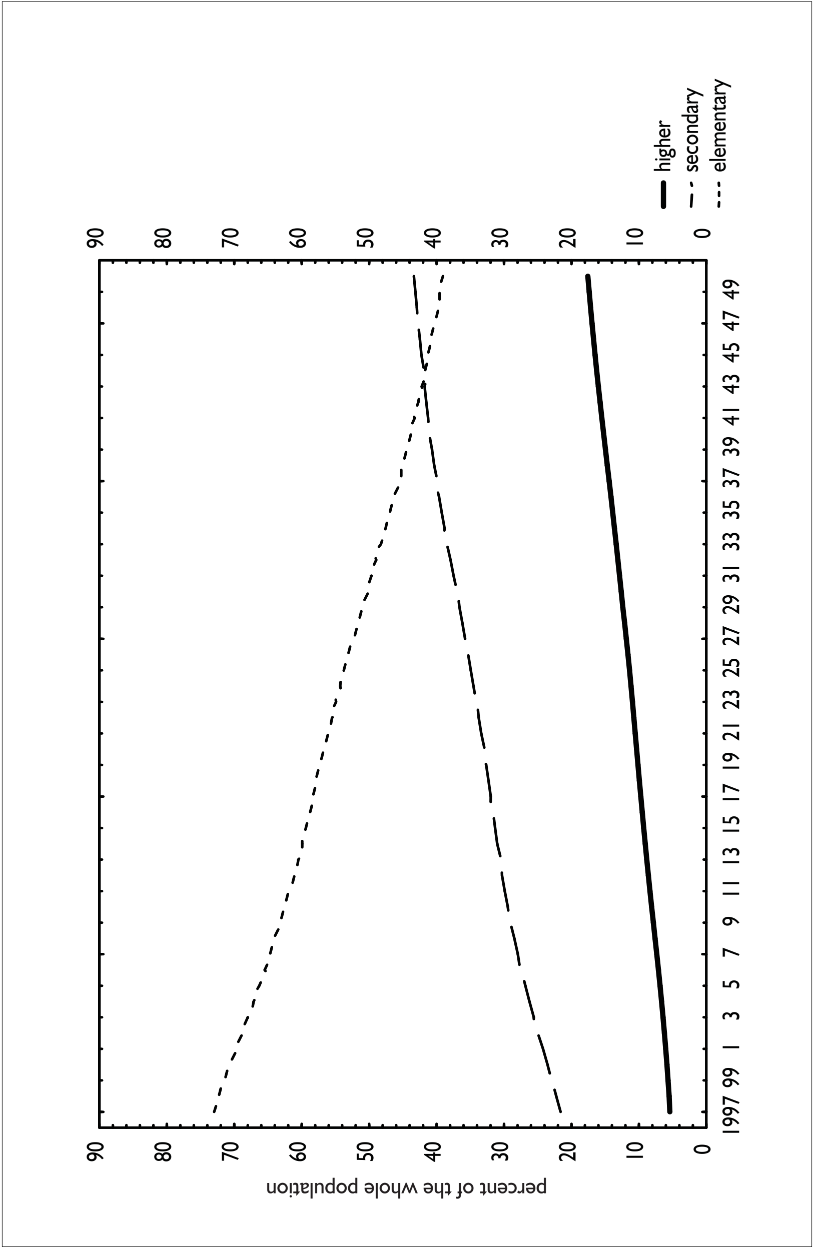


Figure 15. Education of Persons Aged 18 –64 Years

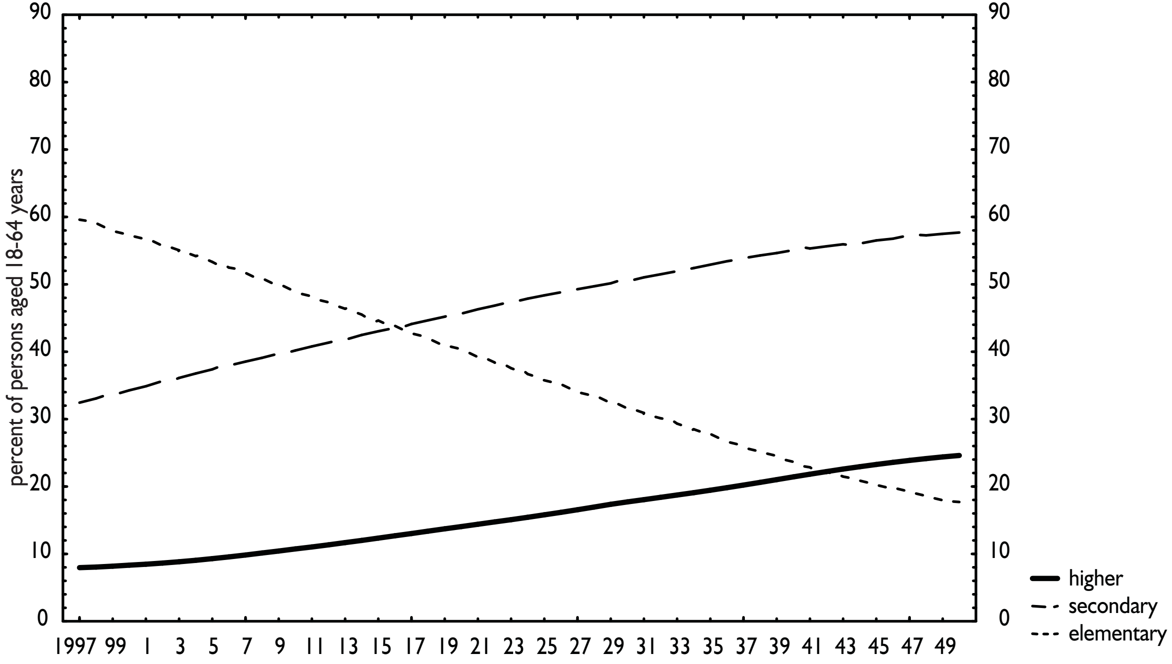
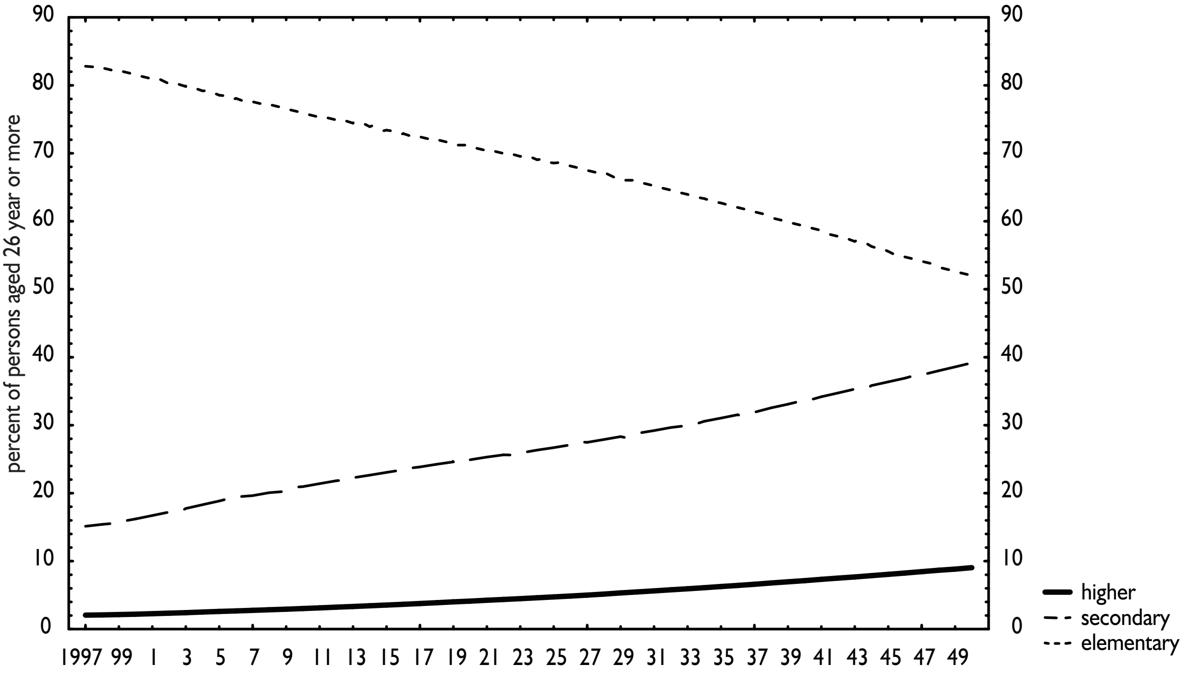


Figure 16. Education of the Agricultural Community



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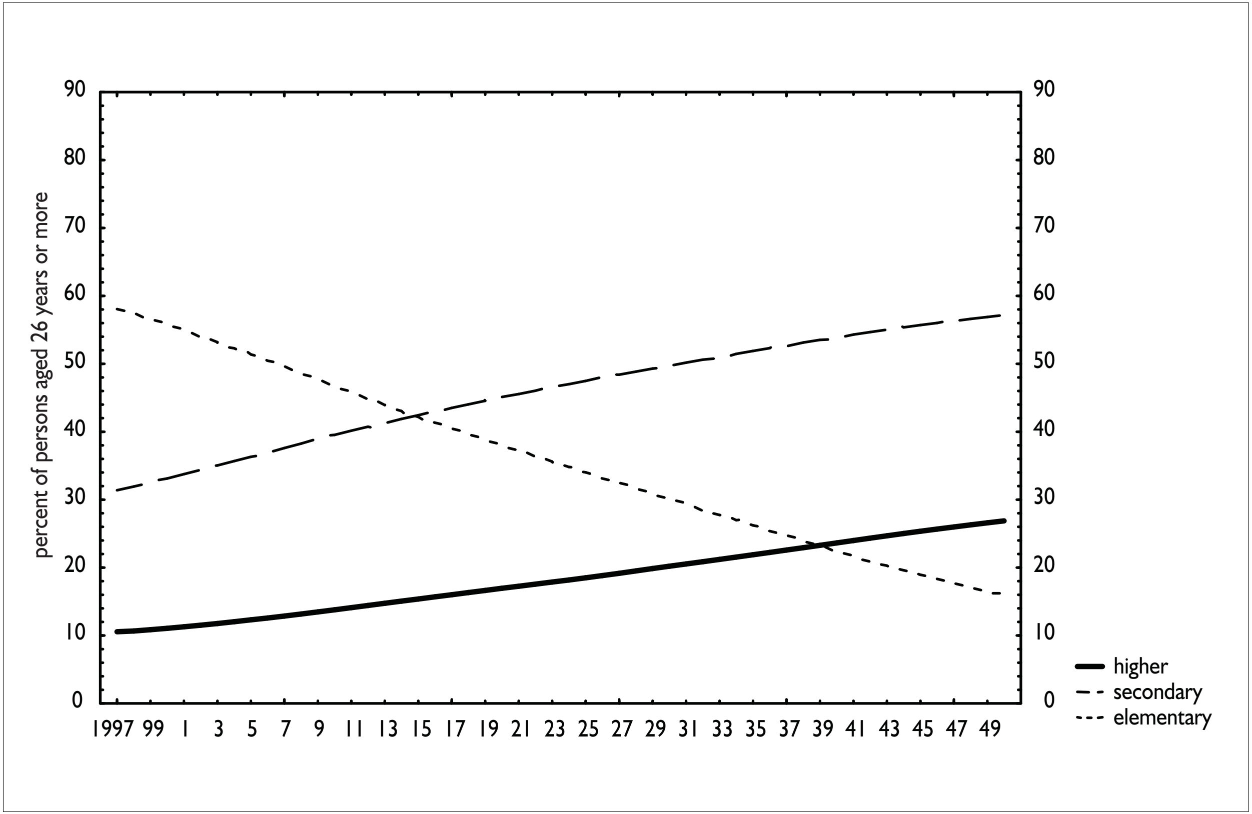


Figure 18. Education of Men

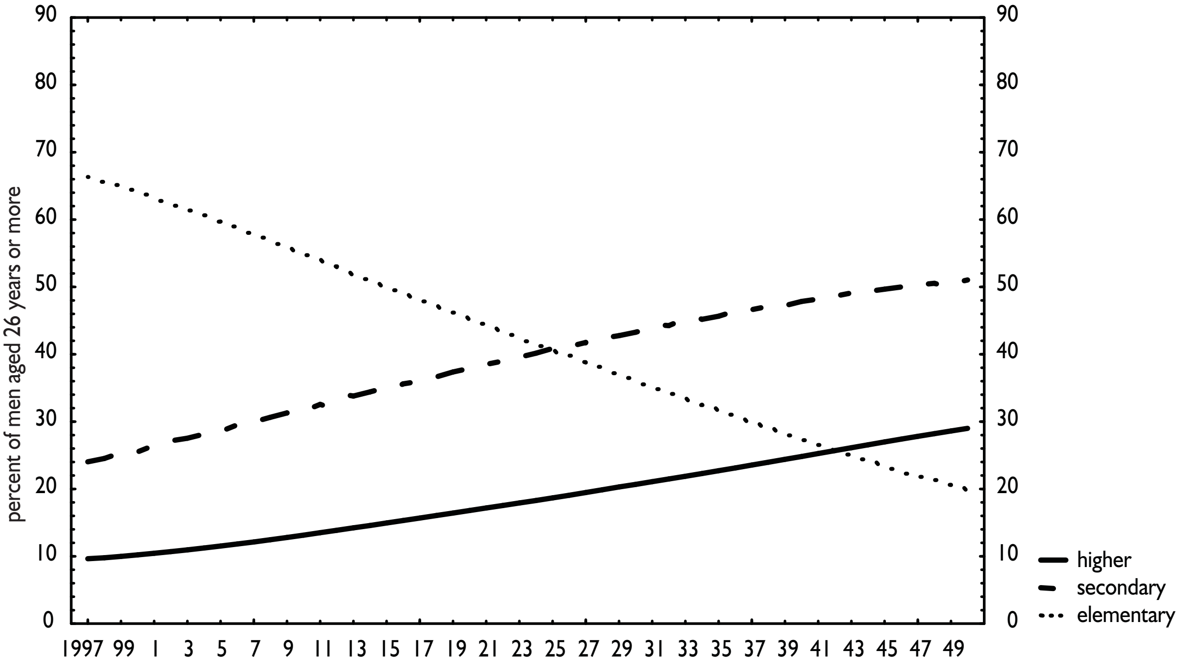


Figure 19. Education of Women

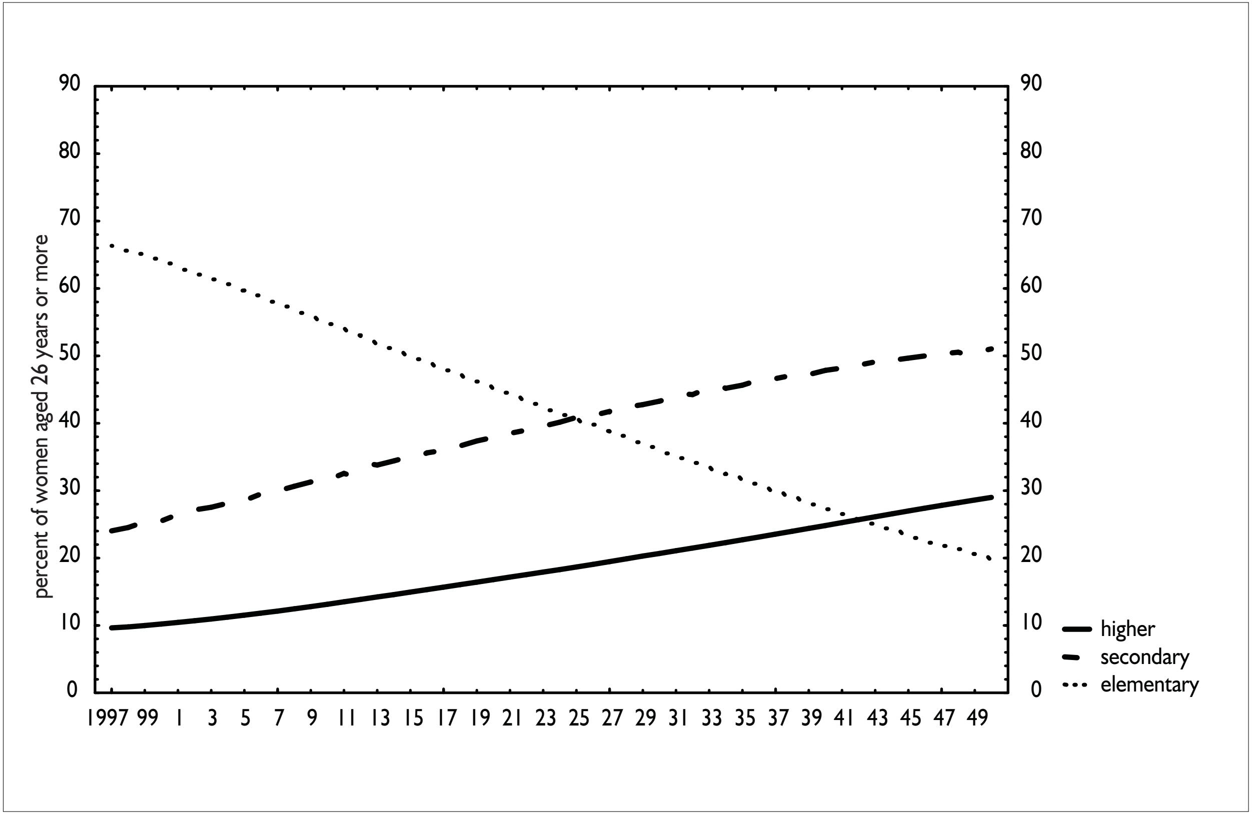


Figure 20. Education of Men and Women

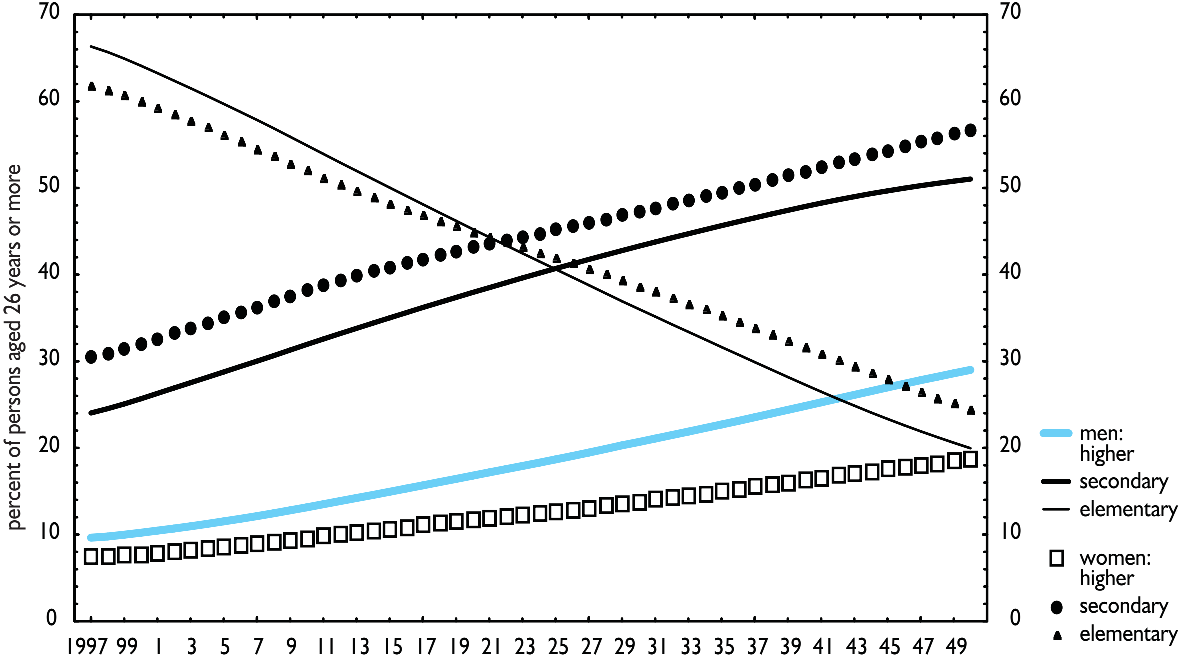


Figure 21. Sources of Earned Income of Persons of Working Age

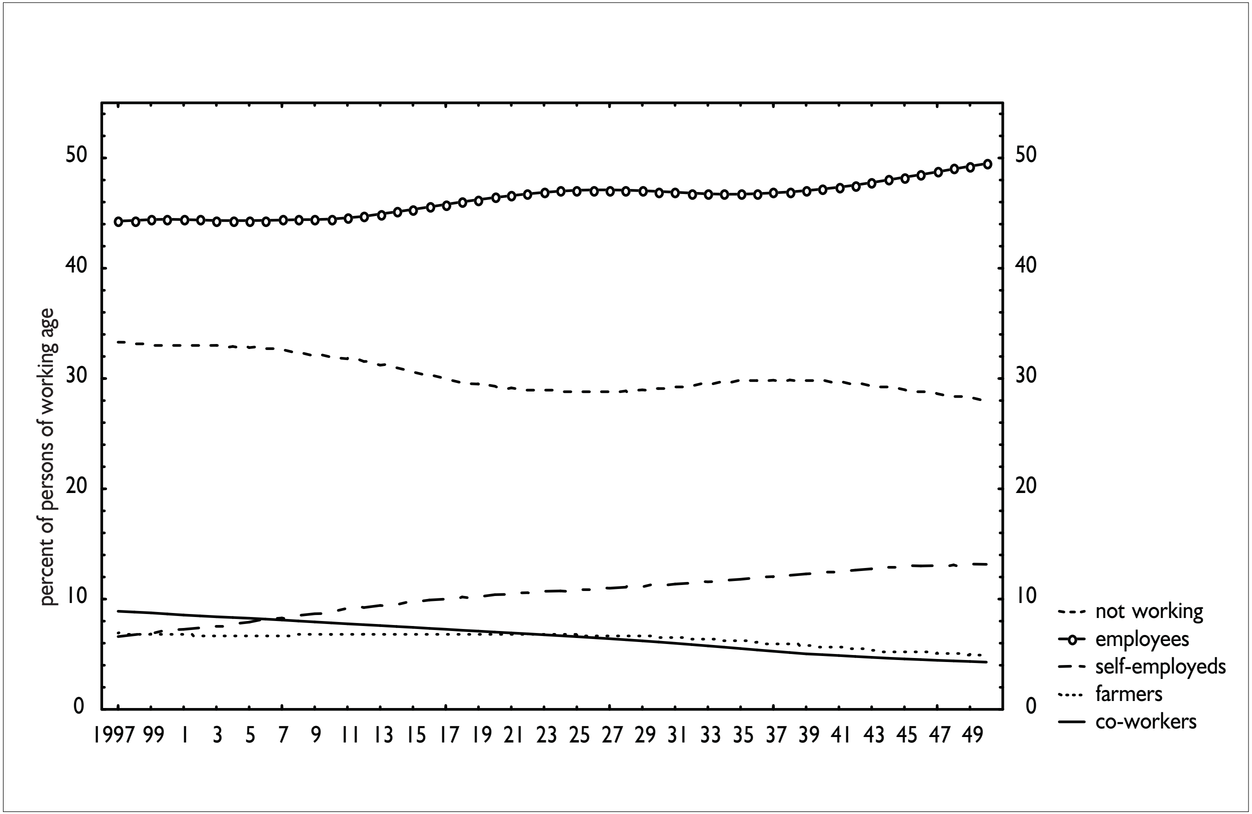
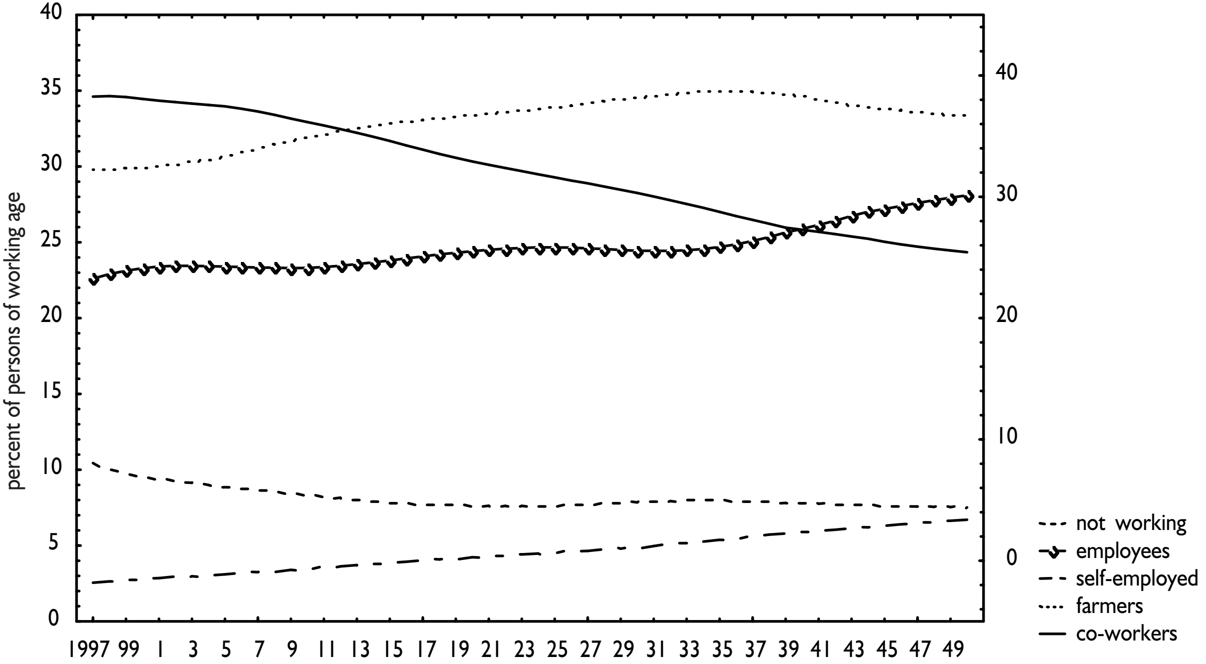


Figure 22. Sources of Earned Income of the Agricultural Community of Working Age



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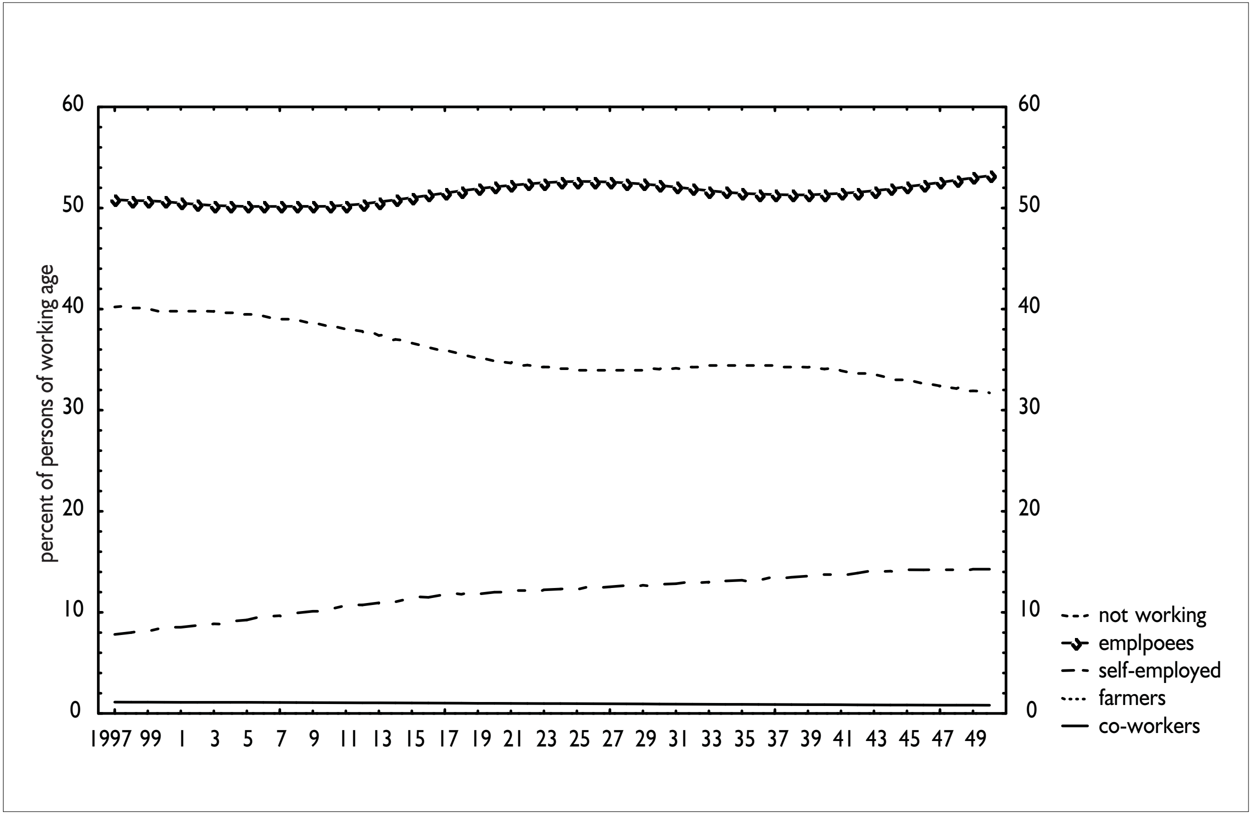
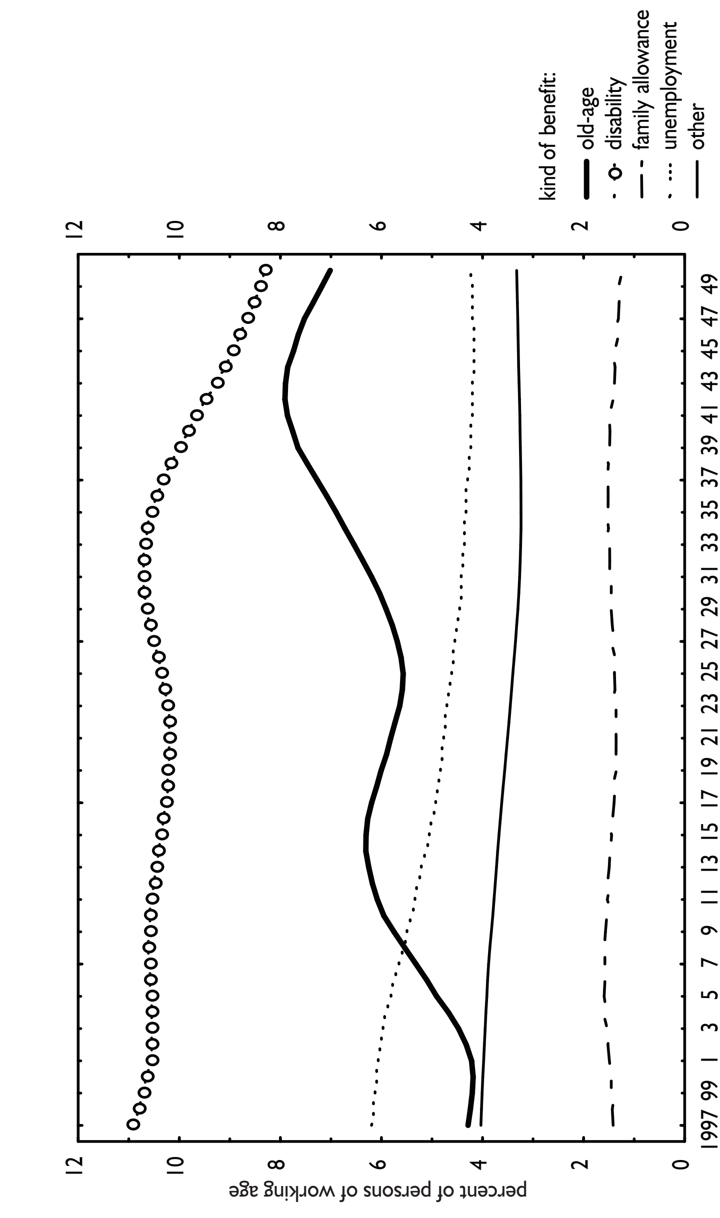


Figure24. Sources of Unearned Income of Persons of Working Age



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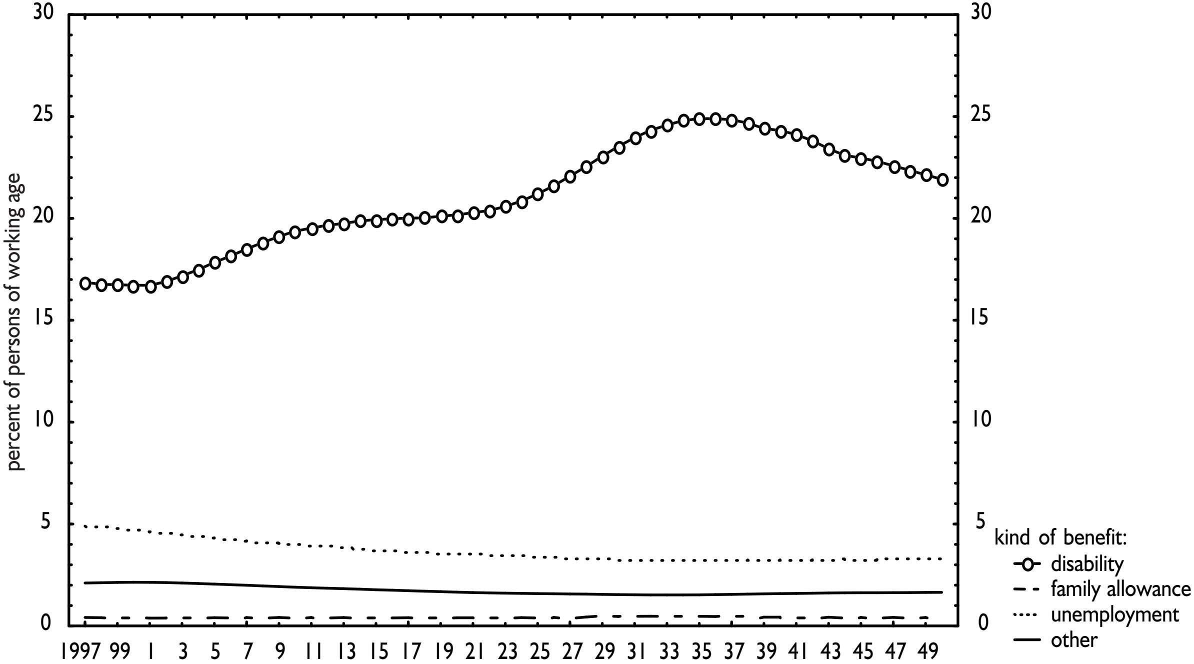

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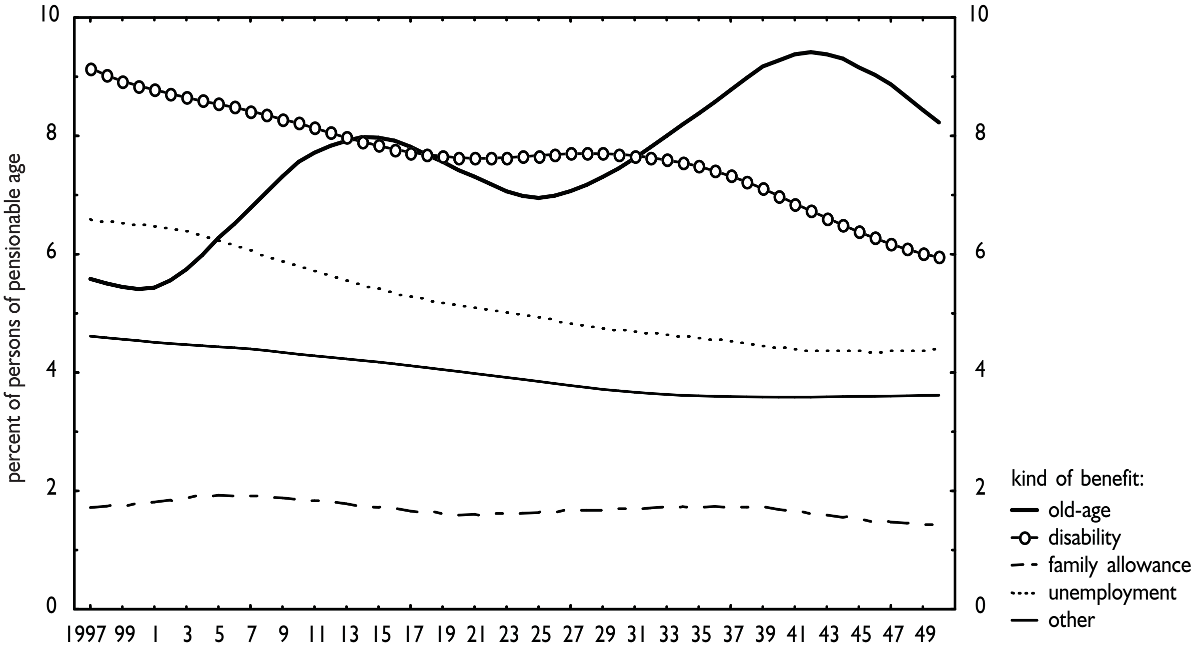
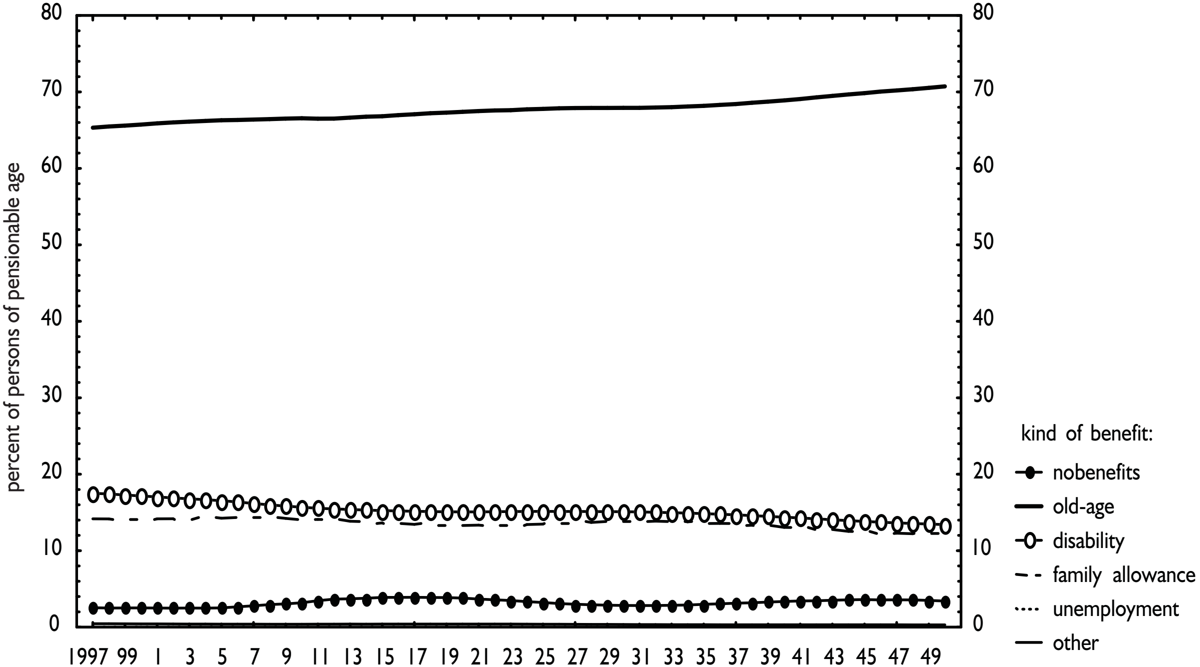


Figure 27. Sources of Unearned Income of Persons over Retirement Age



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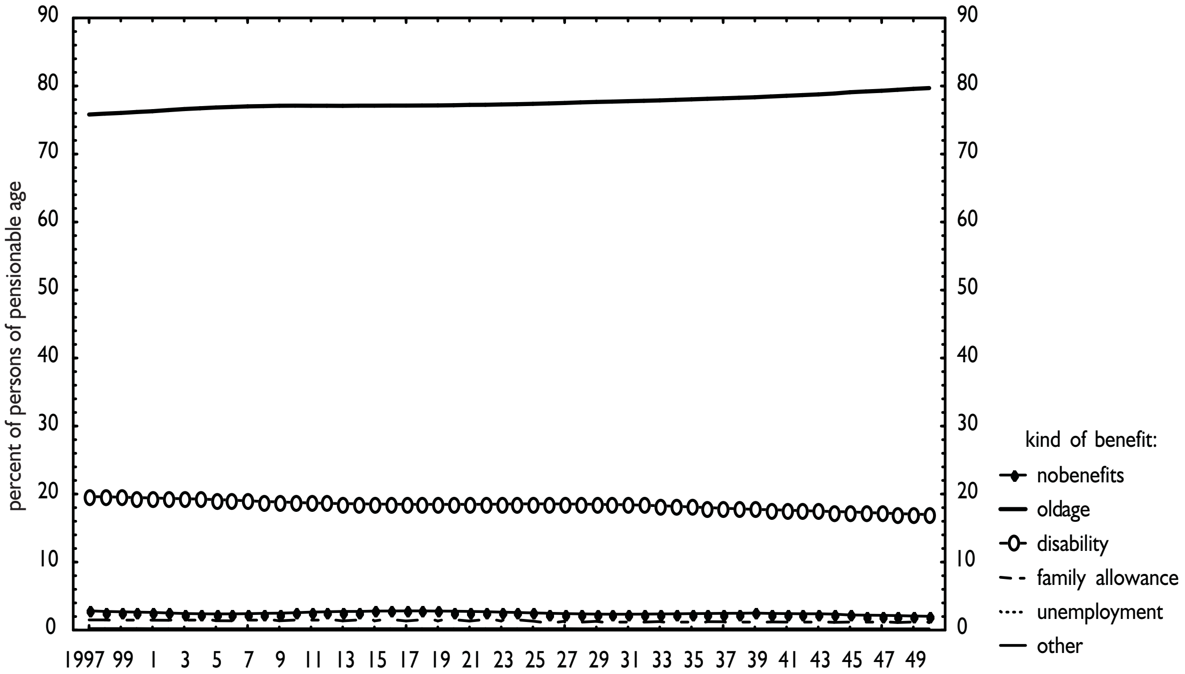

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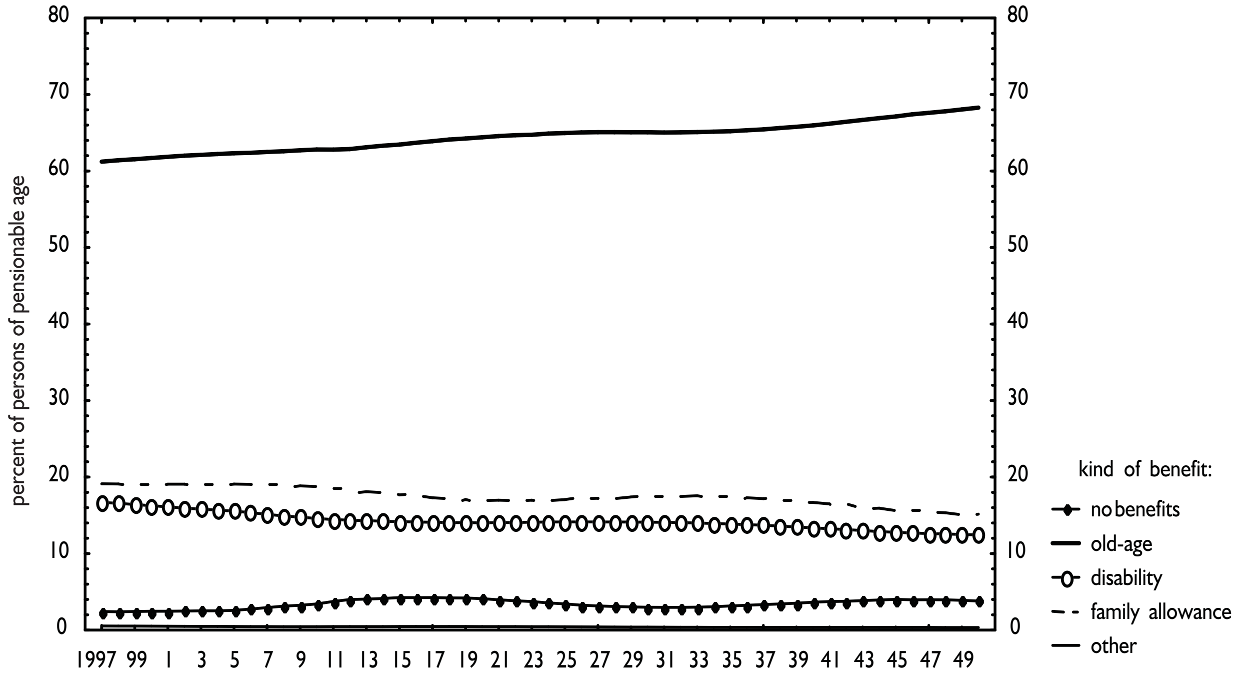
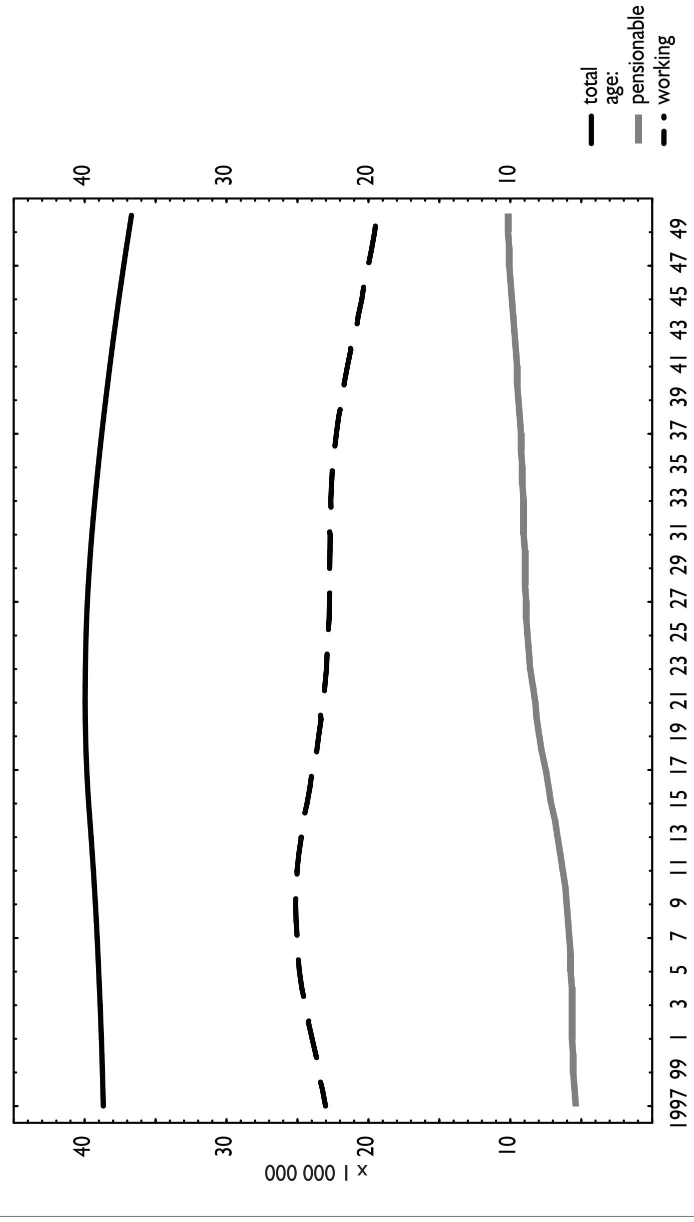


Figure 30. Population of Working Age and over Retirement Age



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